Petroleum Geology
جيولوجيا البترول

المحاضرة الخامسة
نشأة البترول

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SPU-2019/2020

OIL AND GAS – BLACK GOLD!

NASA

http://en.wikipedia.org/wiki/Image:Moscow_traffic_congestion.JPG
en.wikipedia.org/wiki/Image:Ceratium_hirundinella.jpg

http://upload.wikimedia.org/wikipedia/commons/c/ce/Oil_well.jpg
en.wikipedia.org/wiki/Image:Oil_platform.jpg

TALK OUTLINE

Part 1: Origin – How do oil and gas form?
Practical: Non-Renewable Energy

Part 2: Exploration and Production –
How do we find oil and gas and how is it produced?
Practical: Prospector Game

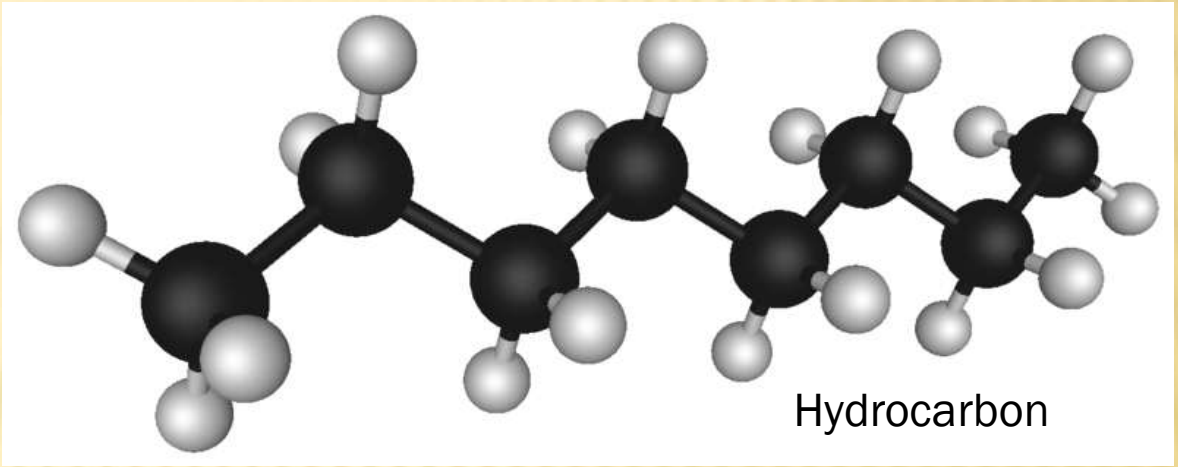
Part 3: Politics – Why are oil and gas important?

ORIGIN (1): CHEMISTRY

en.wikipedia.org/wiki/Image:Petroleum.JPG

Crude Oil

en.wikipedia.org/wiki/Image:Octane_molecule_3D_model.png



Hydrocarbon

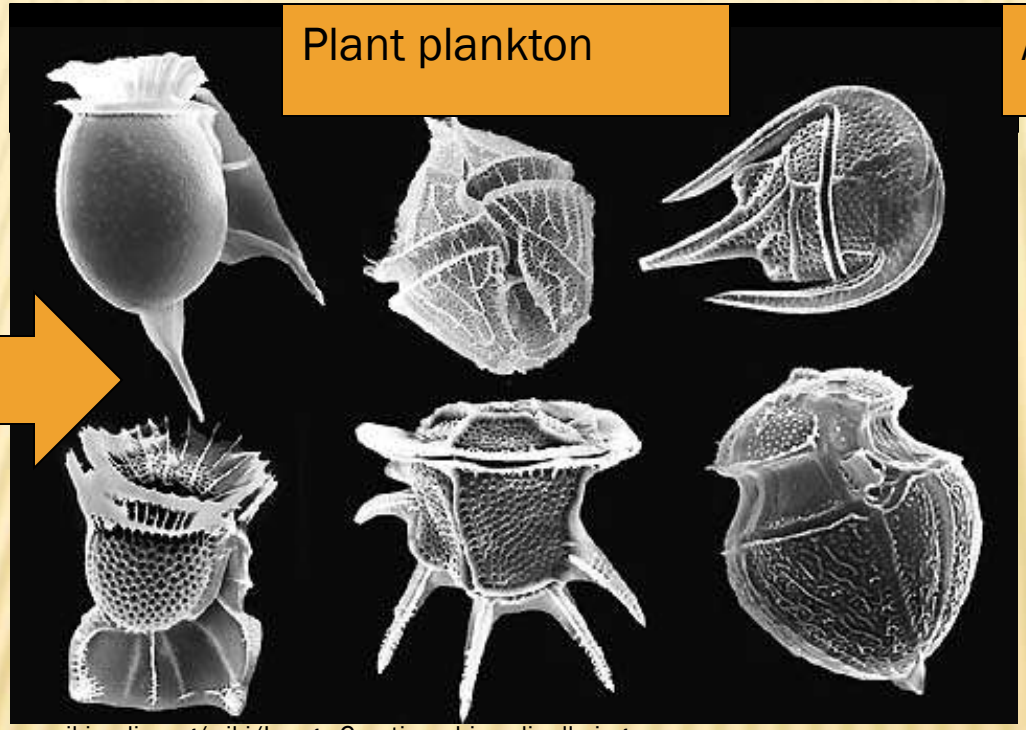
- Oil and gas are made of a mixture of different hydrocarbons.
- As the name suggests these are large molecules made up of hydrogen atoms attached to a backbone of carbon.

ORIGIN (2): PLANKTON

10,000 of these bugs would fit on a pinhead!

cache.eb.com/eb/image?id=93510

Plant plankton



en.wikipedia.org/wiki/Image:Ceratium_hirundinella.jpg

Animal plankton

en.wikipedia.org/wiki/Image:Copepod.

- Most oil and gas starts life as microscopic plants and animals that live in the ocean.

ORIGIN (3): BLOOMS

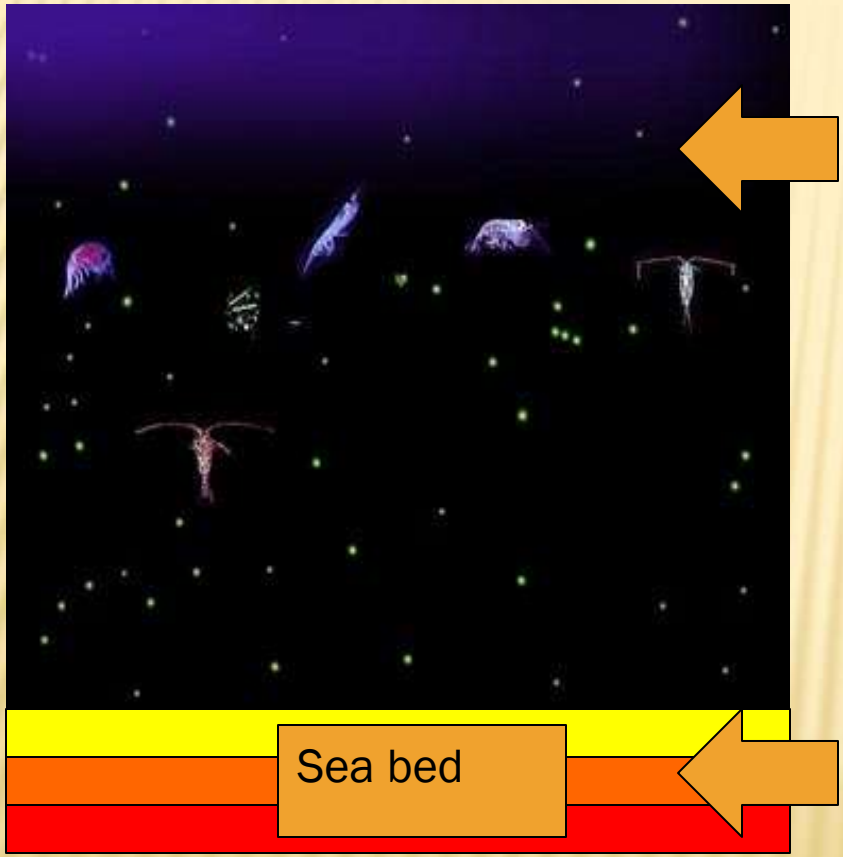
serc.carleton.edu/images/microbelife/topics/red_tide_genera.v3.jpg

Dinoflagellate bloom

- Today, most plankton can be found where deep ocean currents rise to the surface
- This upwelling water is rich in nutrients and causes the plankton to bloom
- Blooms of certain plankton called dinoflagellates may give the water a red tinge

ORIGIN (4): ON THE SEA BED

upload.wikimedia.org/wikipedia/en/0/04/Plankton.jpg



When the plankton dies it rains down on sea bed to form an organic mush

en.wikipedia.org/wiki/Image:Nerr0328.jpg

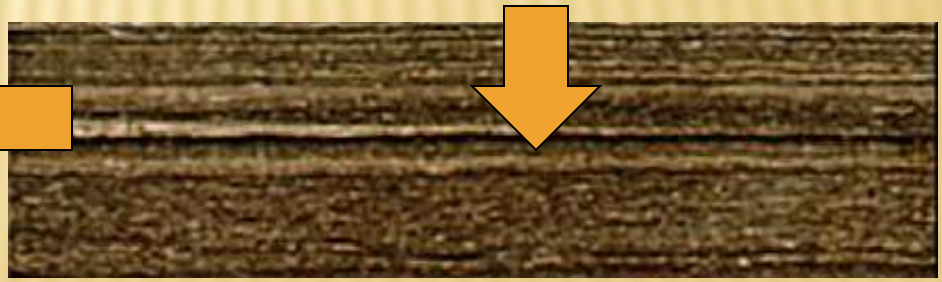
If there are any animals on the sea bed these will feed on the organic particles

ORIGIN (5): BLACK SHALE

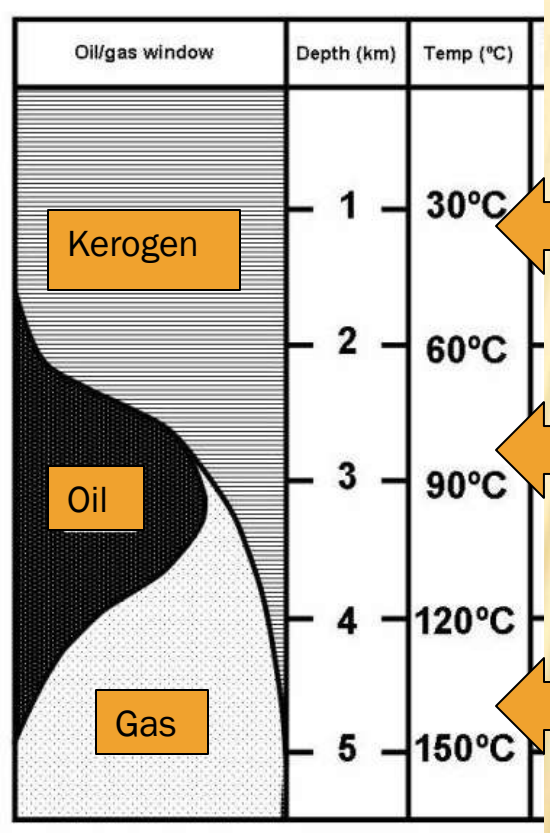
upload.wikimedia.org/wikipedia/en/0/04/Plankton.jpg

- However, if there is little or no oxygen in the water then animals can't survive and the organic mush accumulates

- Where sediment contains more than 5% organic matter, it eventually forms a rock known as a Black Shale



ORIGIN (6): COOKING



www.oilandgasgeology.com/oil_gas_window.jpg

As Black Shale is buried, it is heated.

Organic matter is first changed by the increase in temperature into kerogen, which is a solid form of hydrocarbon

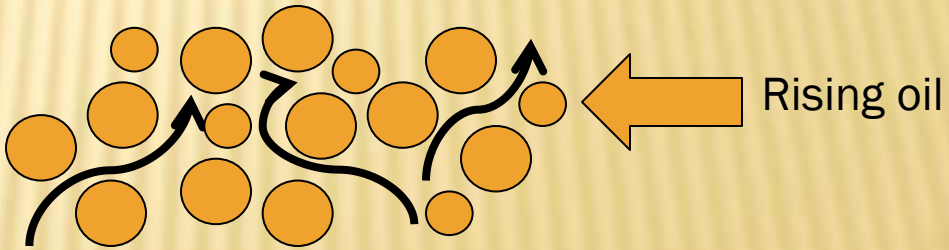
Around 90°C, it is changed into a liquid state, which we call oil

Around 150°C, it is changed into a gas

A rock that has produced oil and gas in this way is known as a Source Rock

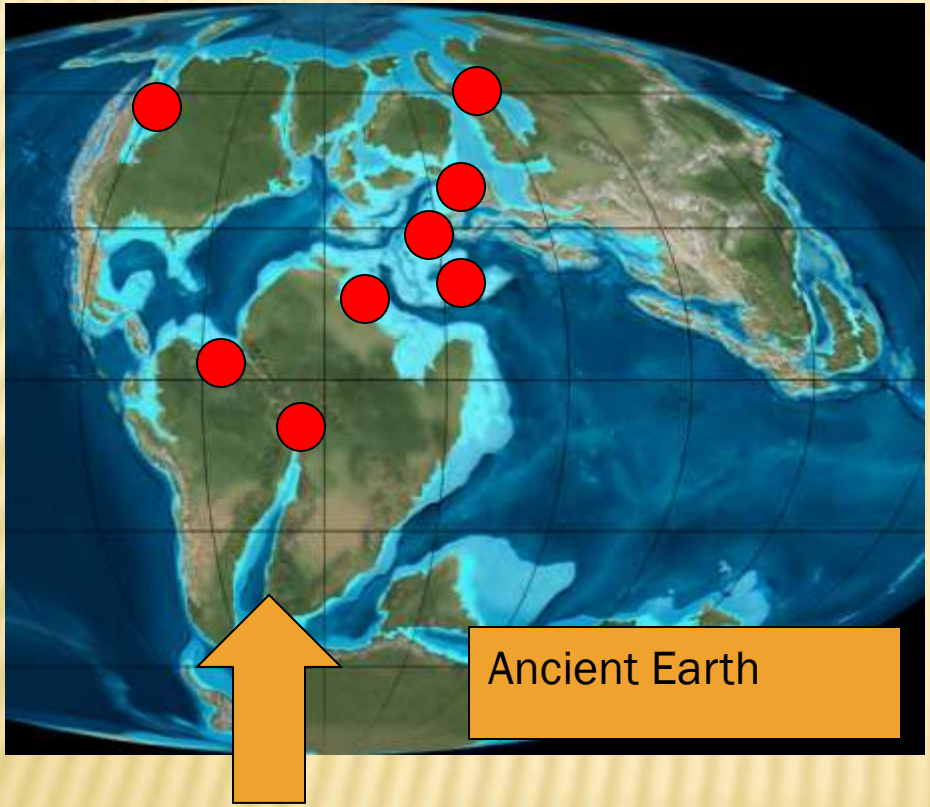
ORIGIN (7): MIGRATION

- Hot oil and gas is less dense than the source rock in which it occurs
- Oil and gas migrate upwards up through the rock in much the same way that the air bubbles of an underwater diver rise to the surface



- The rising oil and gas eventually gets trapped in pockets in the rock called reservoirs

ORIGIN (8): ANCIENT EARTH



- During mid-Mesozoic times around 150 million years ago, conditions were just right to build up huge thicknesses of Black Shale source rocks

The world's main oil deposits all formed in warm shallow seas where plankton bloomed but bottom waters were deoxygenated

ORIGIN (9): SOURCE OF NORTH SEA OIL

The Kimmeridge Clay is a Black Shale with up to 50% organic matter. It is the main source rock for the North Sea Oil & Gas Province

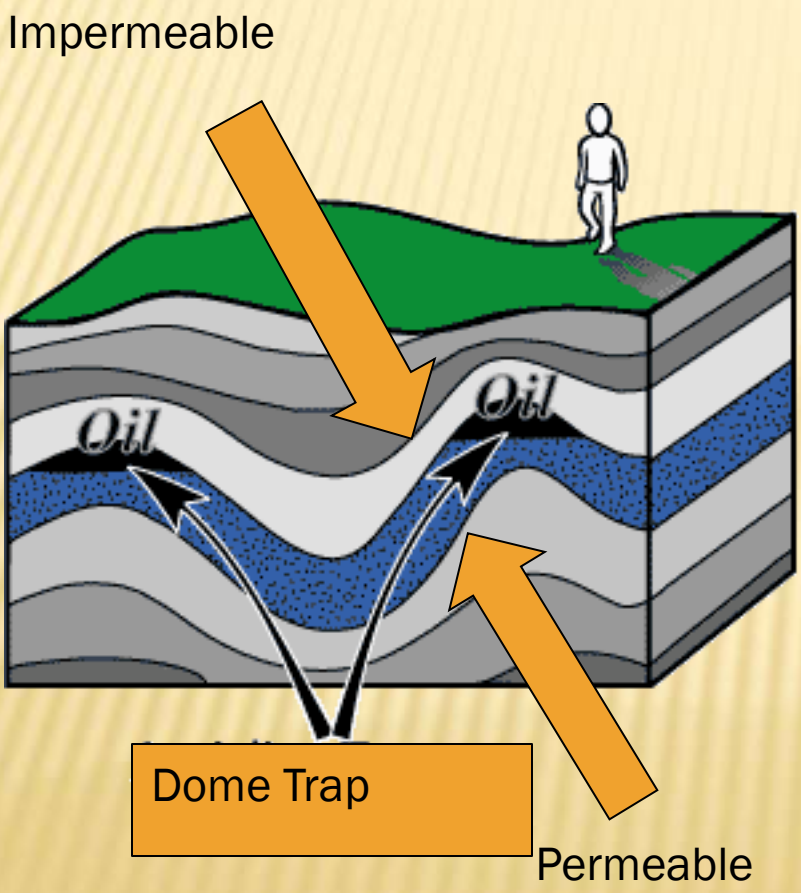
PRACTICAL EXERCISE 1

Renewable versus Non-Renewable Energy

en.wikipedia.org/wiki/Image:Windpark_Galicia.jpg

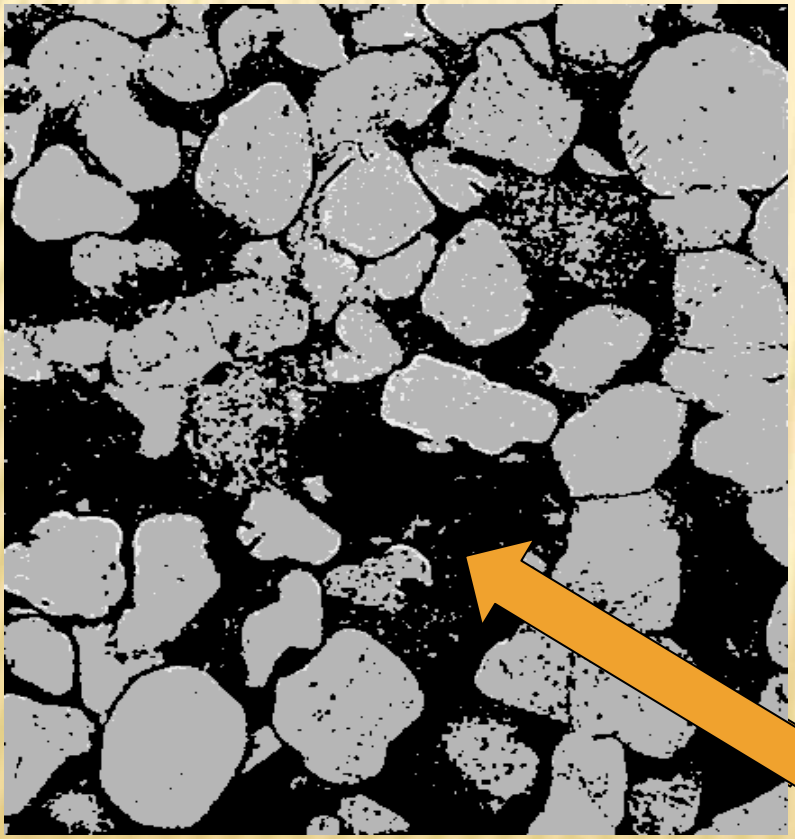
en.wikipedia.org/wiki/Image:Oil_platform.jpg

EXPLORATION AND PRODUCTION (1): OIL TRAPS



- Some rocks are permeable and allow oil and gas to freely pass through them
- Other rocks are impermeable and block the upward passage of oil and gas
- Where oil and gas rises up into a dome (or anticline) capped by impermeable rocks it can't escape. This is one type of an Oil Trap.

EXPLORATION AND PRODUCTION (2): RESERVOIR ROCKS

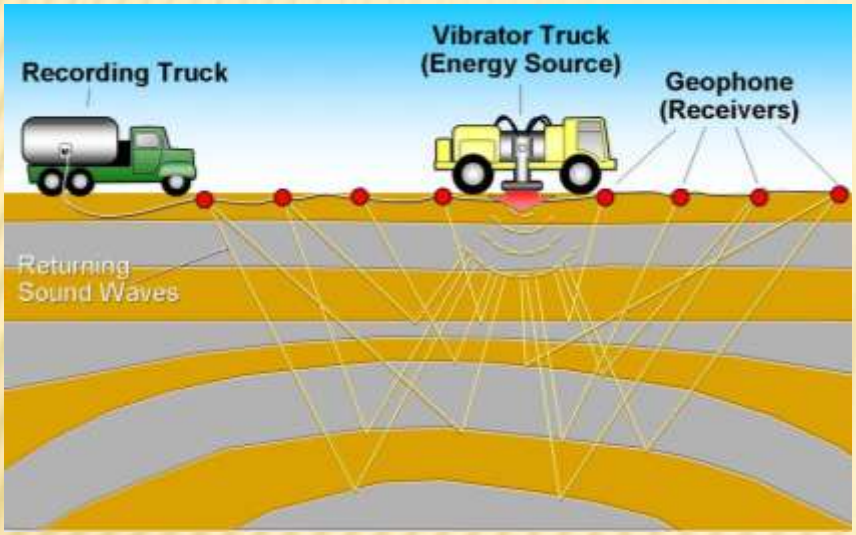


Earth Science World Image Bank Image #h5innl

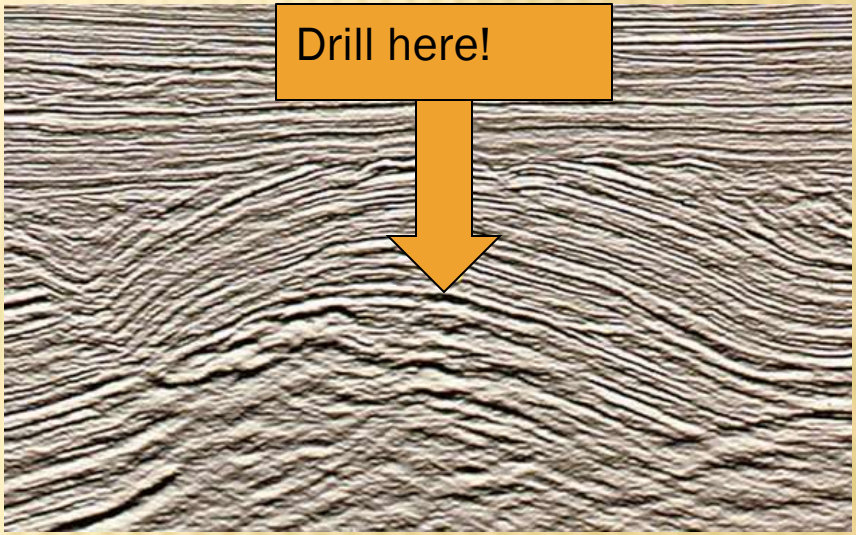
- The permeable strata in an oil trap is known as the Reservoir Rock
- Reservoir rocks have lots of interconnected holes called pores. These absorb the oil and gas like a sponge

As oil migrates it fills up the pores (oil-filled pores shown in black)

EXPLORATION AND PRODUCTION (3): SEISMIC SURVEYS



Earth Science World Image Bank Image #h5inor



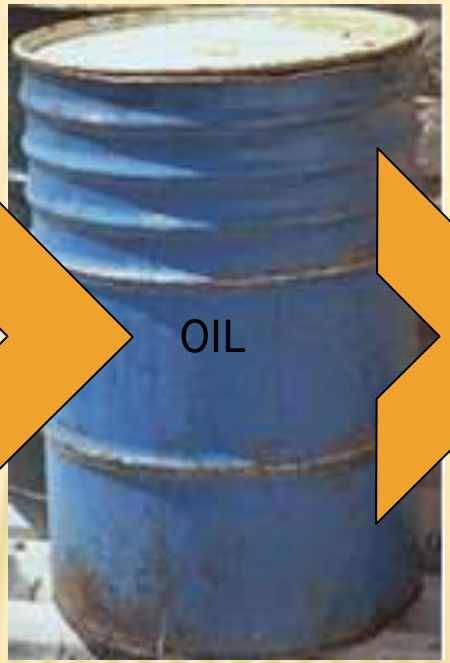
Earth Science World Image Bank Image #h5inpj

- Seismic surveys are used to locate likely rock structures underground in which oil and gas might be found
- Shock waves are fired into the ground. These bounce off layers of rock and reveal any structural domes that might contain oil

POLITICS (9): GLOBAL WARMING

en.wikipedia.org/wiki/Image:Coal_anthracite.jpg

en.wikipedia.org/wiki/Image:Bluebbl.gif



en.wikipedia.org/wiki/Image:Windpark_Galicia.jpg

- Oil and Gas emit 15-30% less CO_2 than coal per watt of energy produced. Renewable energy is clean but not yet viable as fuel.

OIL AND GAS

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