

# Oil and Gas – Black Gold!



[http://en.wikipedia.org/wiki/Image:Moscow\\_traffic\\_congestion.JPG](http://en.wikipedia.org/wiki/Image:Moscow_traffic_congestion.JPG)  
[en.wikipedia.org/wiki/Image:Ceratium\\_hirundinella.jpg](http://en.wikipedia.org/wiki/Image:Ceratium_hirundinella.jpg)



[http://upload.wikimedia.org/wikipedia/commons/c/ce/Oil\\_well.jpg](http://upload.wikimedia.org/wikipedia/commons/c/ce/Oil_well.jpg)  
[en.wikipedia.org/wiki/Image:Oil\\_platform.jpg](http://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?





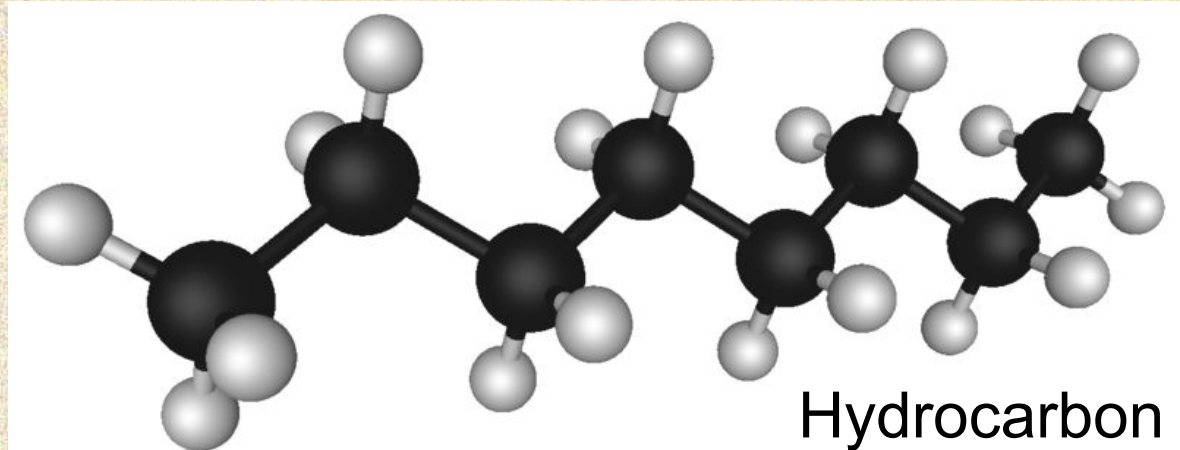
# Origin (1): Chemistry

[en.wikipedia.org/wiki/Image:Petroleum.JPG](https://en.wikipedia.org/wiki/Image:Petroleum.JPG)



Crude Oil

[en.wikipedia.org/wiki/Image:Octane\\_molecule\\_3D\\_model.png](https://en.wikipedia.org/wiki/Image:Octane_molecule_3D_model.png)



- 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**.

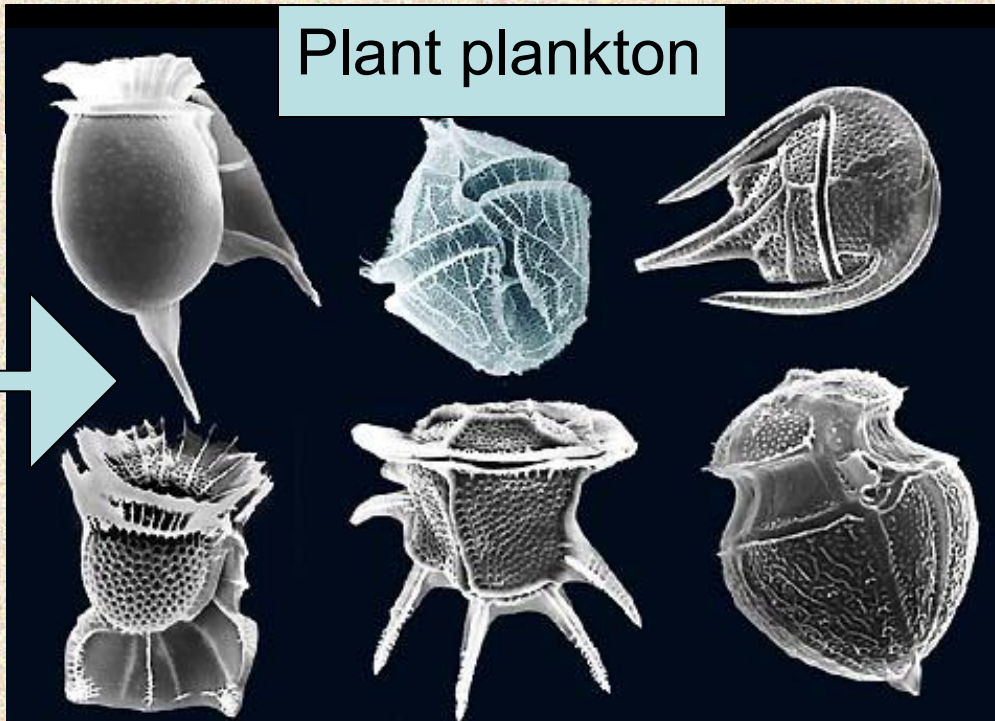


# Origin (2): Plankton

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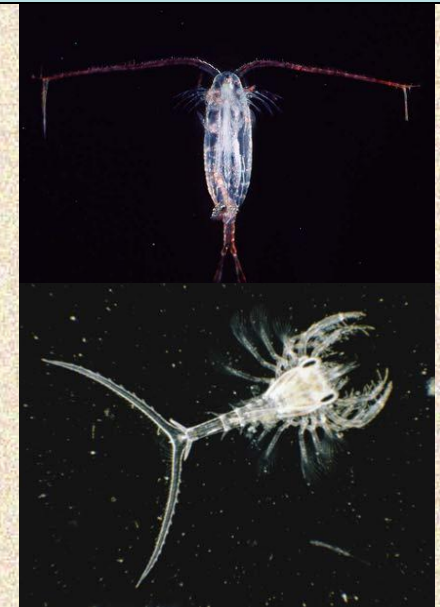
10,000 of these bugs  
would fit on a pinhead!

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](http://serc.carleton.edu/images/microbelife/topics/red_tide_genera.v3.jpg)



© Miriam Godfrey

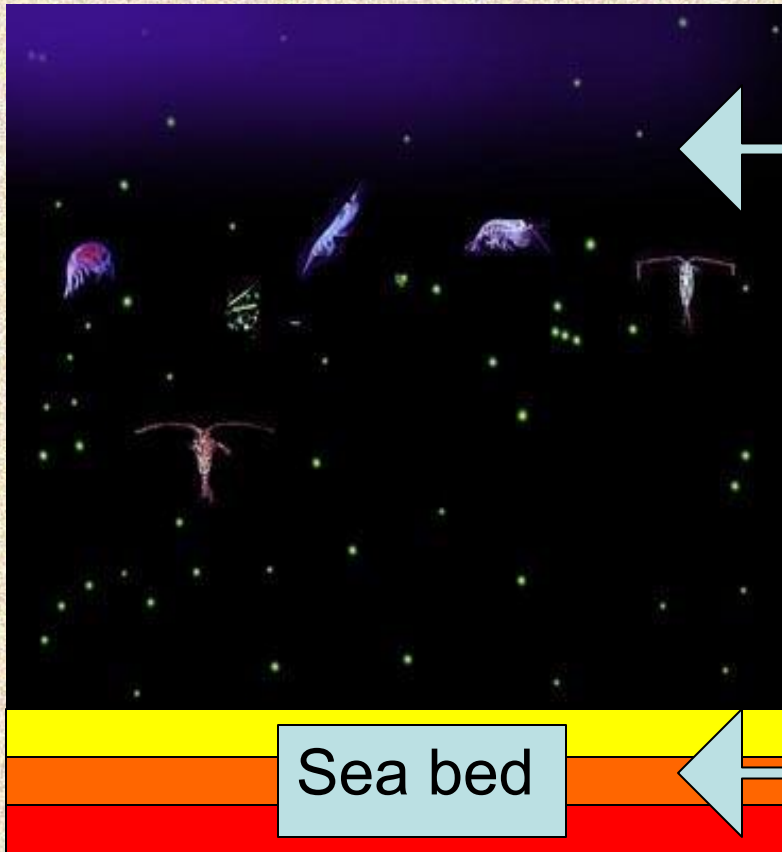
Dinoflagellate bloom

- 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](http://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](http://en.wikipedia.org/wiki/Image:Nerr0328.jpg)

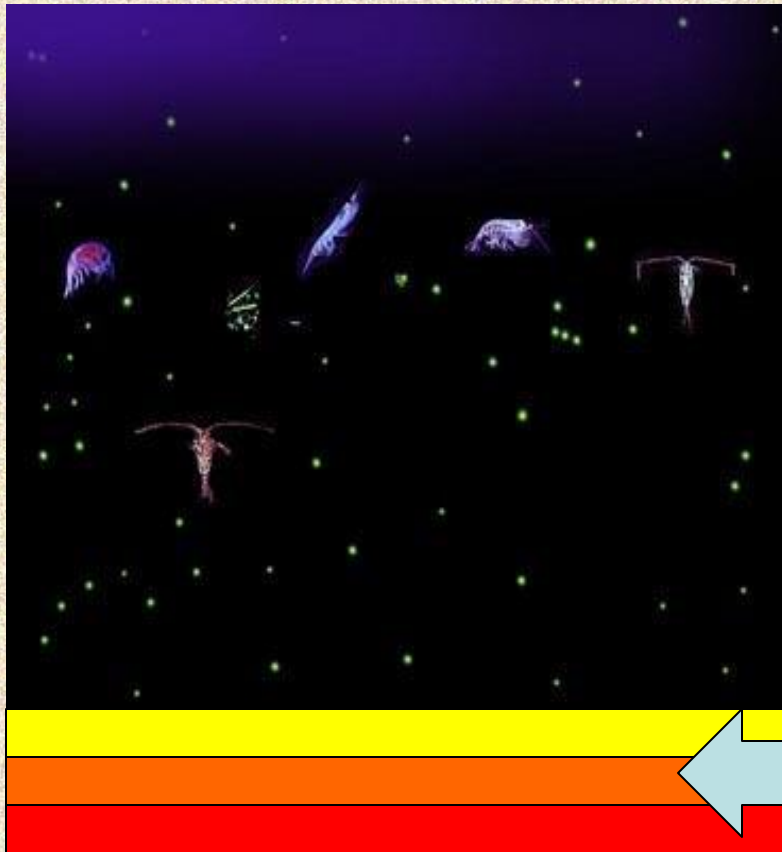


If there are any animals on the sea bed these will feed on the organic particles

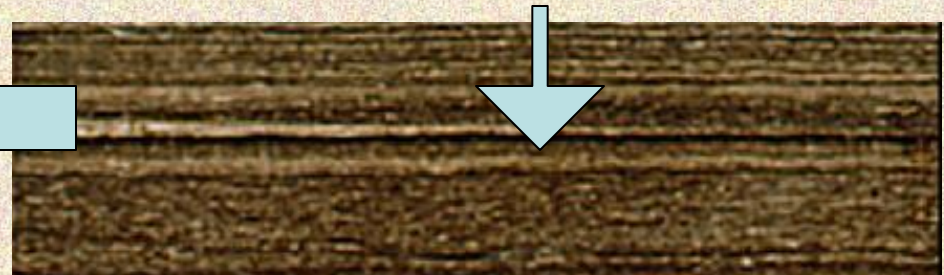


# Origin (5): Black Shale

[upload.wikimedia.org/wikipedia/en/0/04/Plankton.jpg](http://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

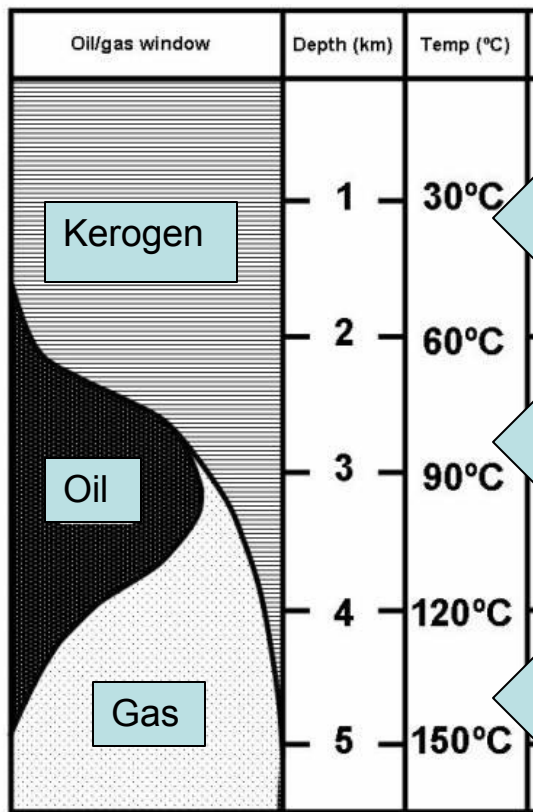
As Black Shale is buried, **it is heated**.

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**

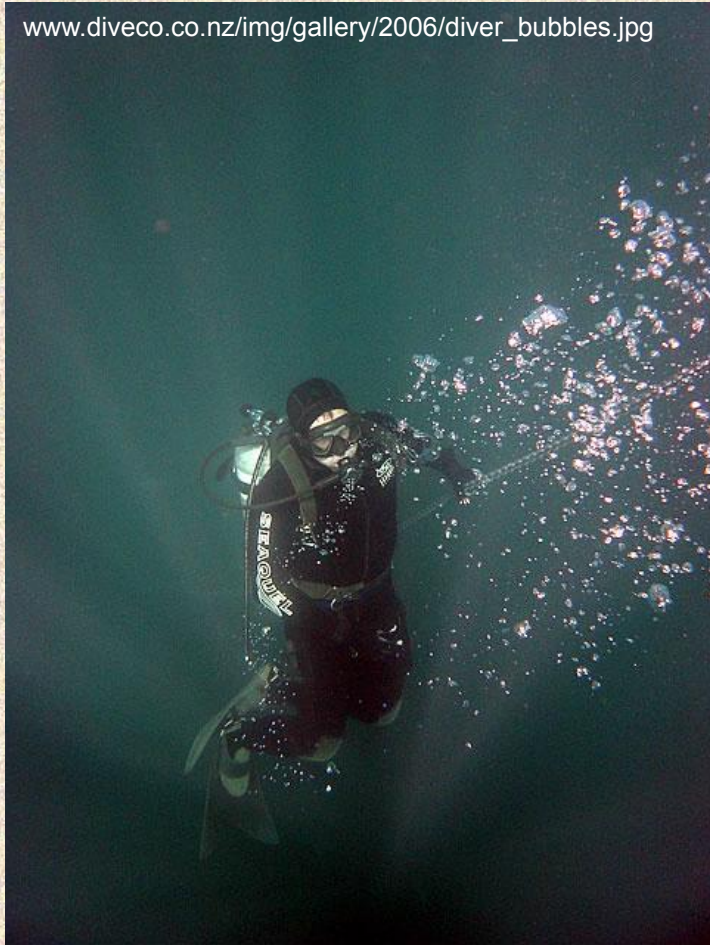


[www.oilandgasgeology.com/oil\\_gas\\_window.jpg](http://www.oilandgasgeology.com/oil_gas_window.jpg)

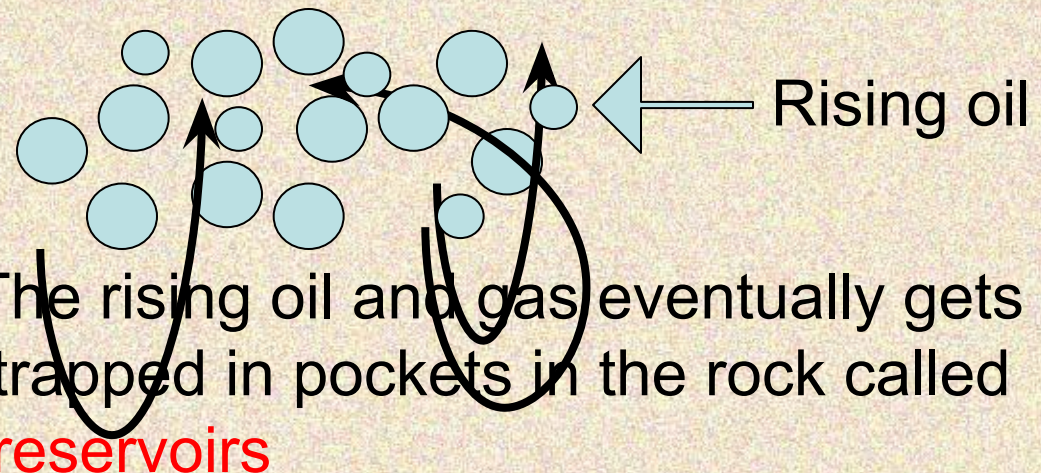


# Origin (7): Migration

[www.diveco.co.nz/img/gallery/2006/diver\\_bubbles.jpg](http://www.diveco.co.nz/img/gallery/2006/diver_bubbles.jpg)



- 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

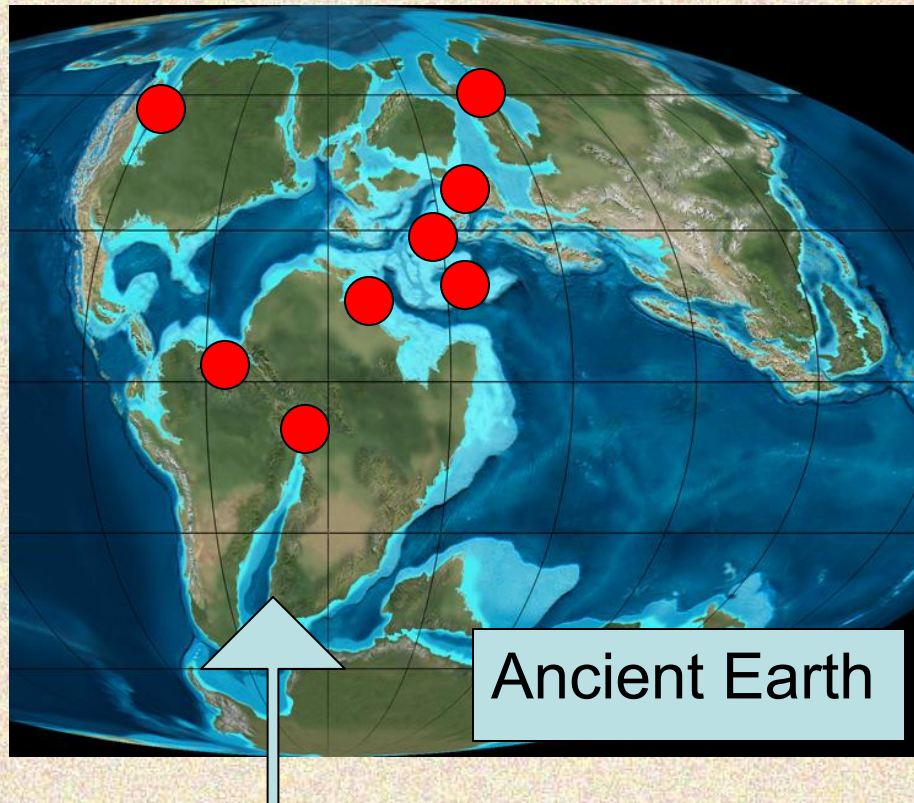


- The rising oil and gas eventually gets trapped in pockets in the rock called **reservoirs**



# Origin (8): Ancient Earth

© Ron Blakey, Arizona Flagstaff



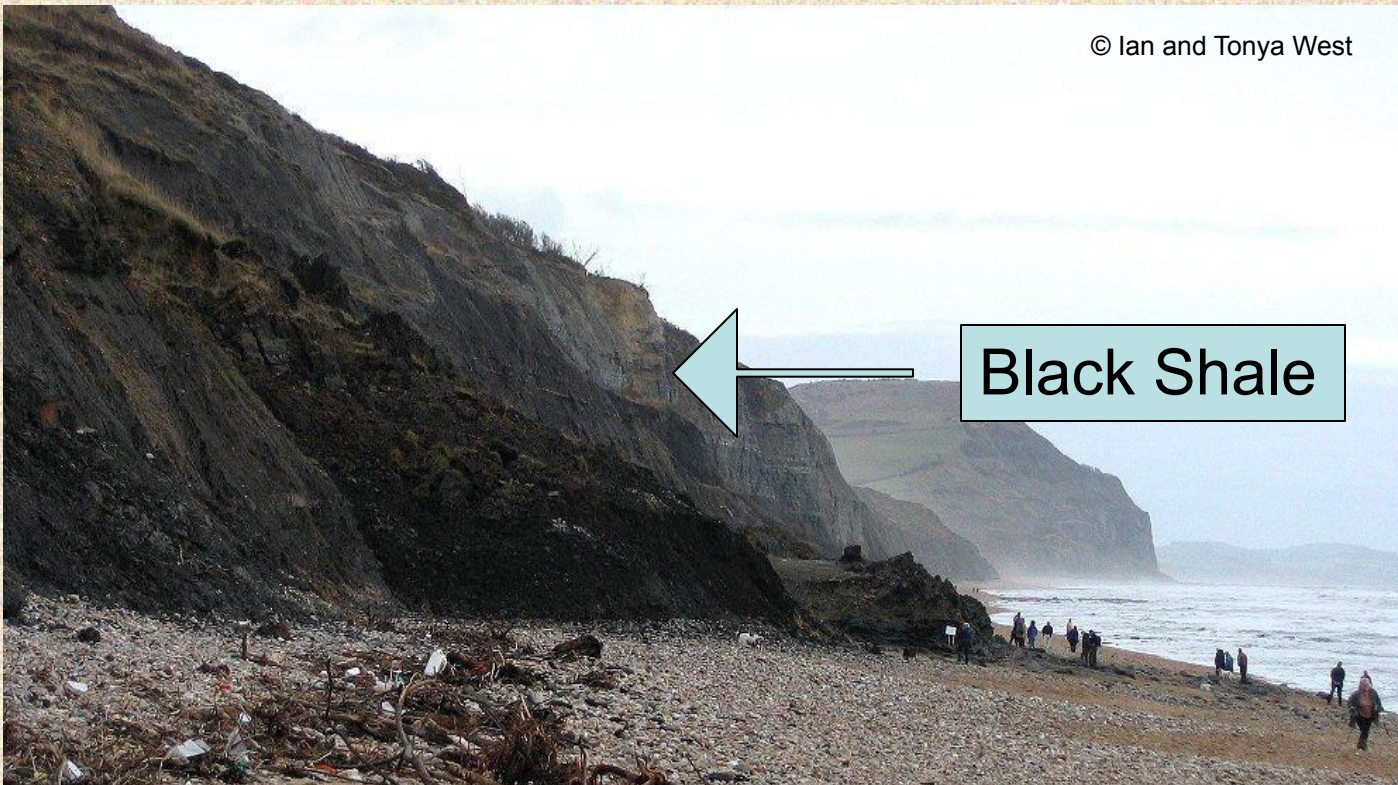
During mid-Mesozoic times around 150 million years ago, **conditions were just right** to build up huge thicknesses of Black Shale source rocks

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](https://en.wikipedia.org/wiki/Image:Windpark_Galicia.jpg)



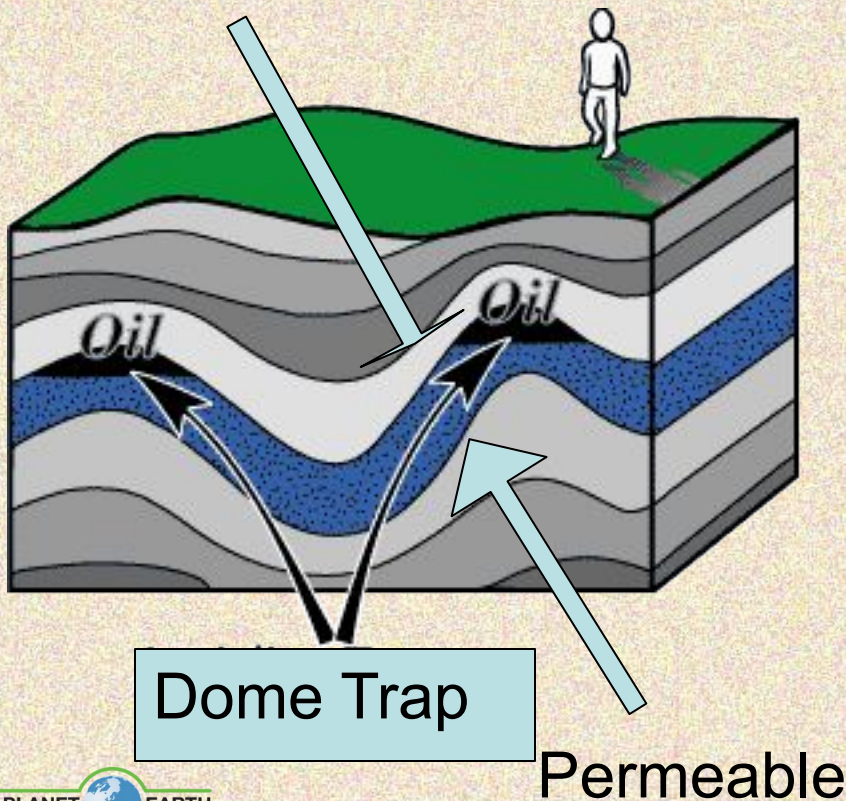
[en.wikipedia.org/wiki/Image:Oil\\_platform.jpg](https://en.wikipedia.org/wiki/Image:Oil_platform.jpg)



# Exploration and Production (1): Oil Traps

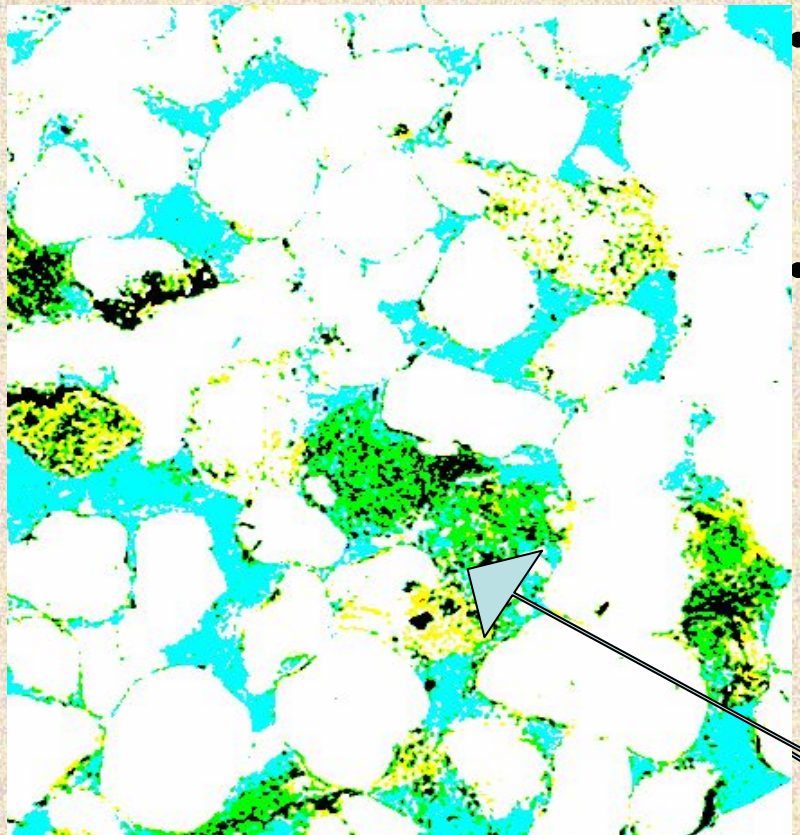
- Some rocks are **permeable** and allow oil and gas to freely pass through them
- Other rocks are **impermeable** and block the upward passage of oil and gas
- Where oil and gas rises up into a dome (or anticline) capped by impermeable rocks it can't escape. This is one type of an **Oil Trap**.

Impermeable





# Exploration and Production (2): Reservoir Rocks



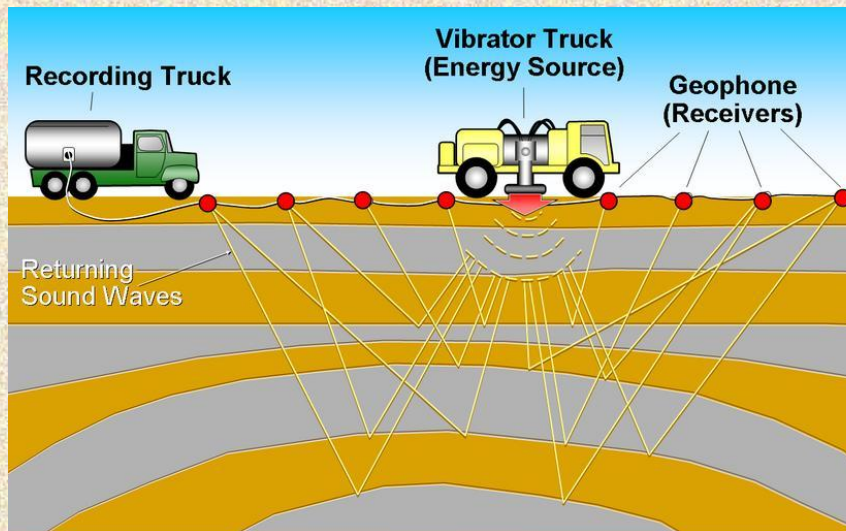
- The permeable strata in an oil trap is known as the **Reservoir Rock**
- Reservoir rocks have lots of interconnected holes called **pores**. These absorb the oil and gas like a sponge

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

Earth Science World Image Bank Image #h5innl



# 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





# Exploration and Production (4): Drilling the well



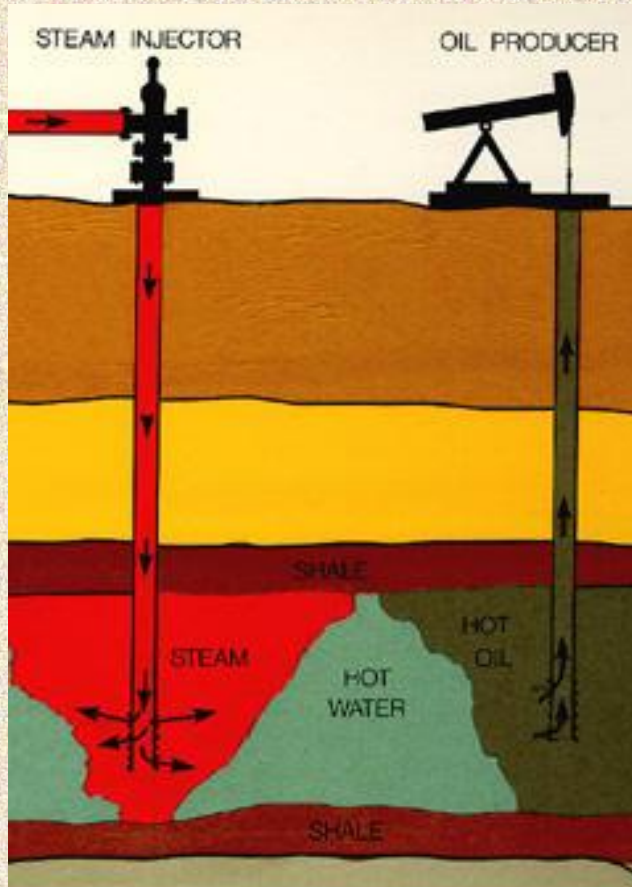
[en.wikipedia.org/wiki/Image:Oil\\_platform.jpg](https://en.wikipedia.org/wiki/Image:Oil_platform.jpg)

- Once an **oil or gas prospect** has been identified, a hole is drilled to assess the potential
- The cost of drilling is very great. On an offshore rig, it may cost **\$10,000 for each metre drilled.**
- A company incurs vast losses for every “dry hole” drilled





# Exploration and Production (5): Enhanced Recovery



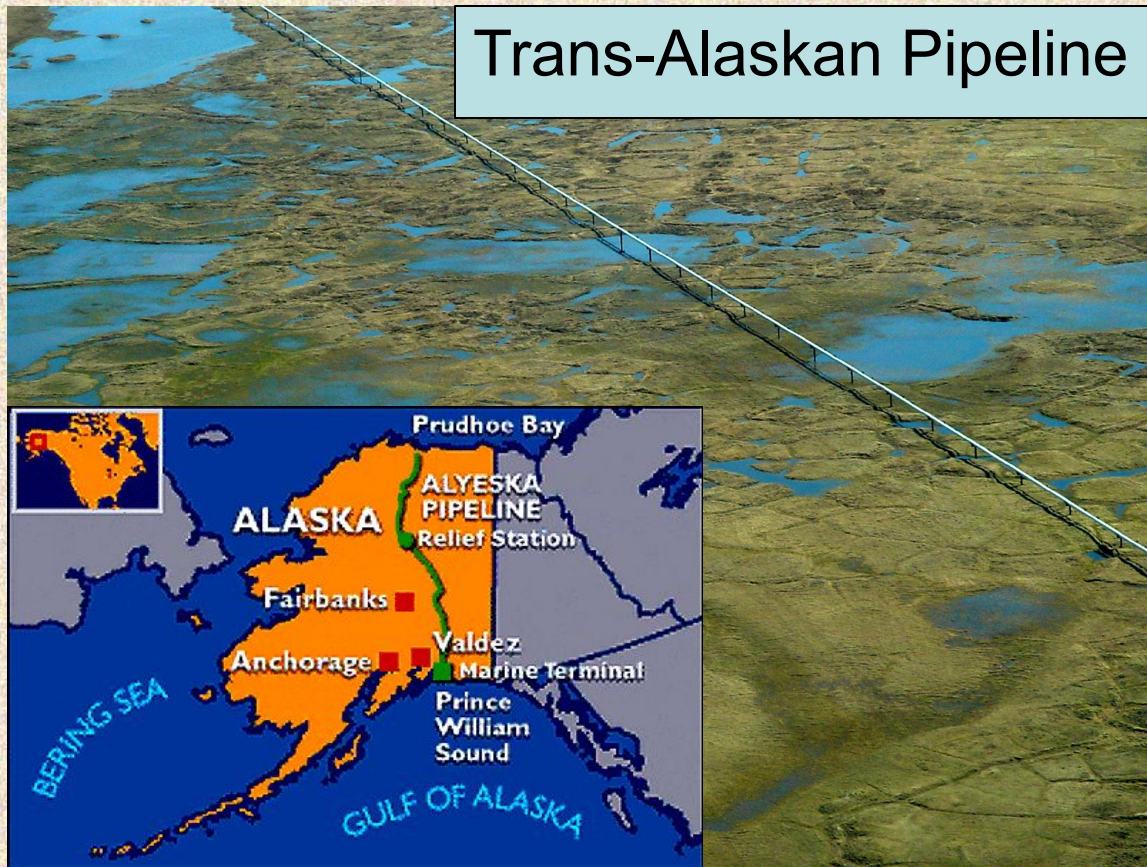
- Although oil and gas are less dense than water and naturally rise up a well to the surface, in reality **only 40-50%** of the total will do so.
- To **enhance recovery**, a hole is drilled adjacent to the well and steam is pumped down. The hot water helps to push the oil out of the rock and up into the well.

© California Department of Conservation



# Exploration and Production (6): Transport

## Trans-Alaskan Pipeline



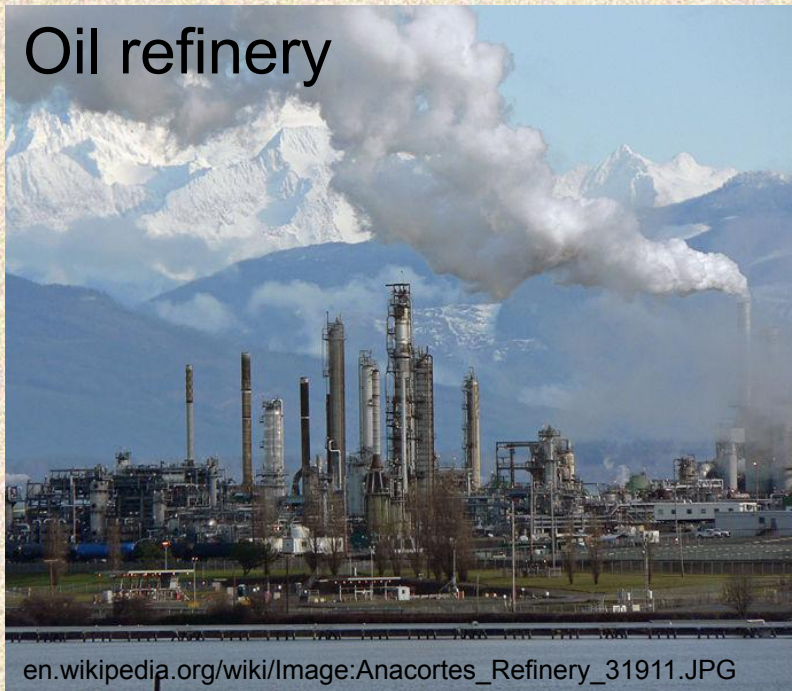
- Once extracted oil and gas must be sent to a refinery for processing
- **Pipelines** transport most of the world's oil from well to refinery
- Massive **Oil Tankers** also play an important role in distribution

United States Geological Survey

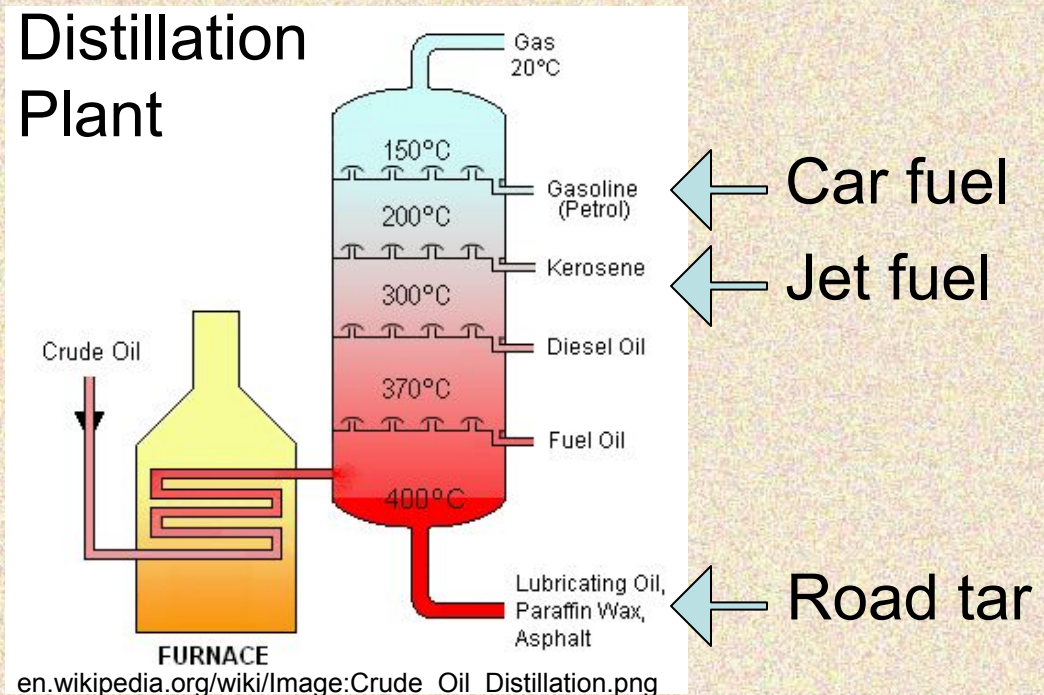


# Exploration and Production (7): At the Refinery

Oil refinery



Distillation  
Plant

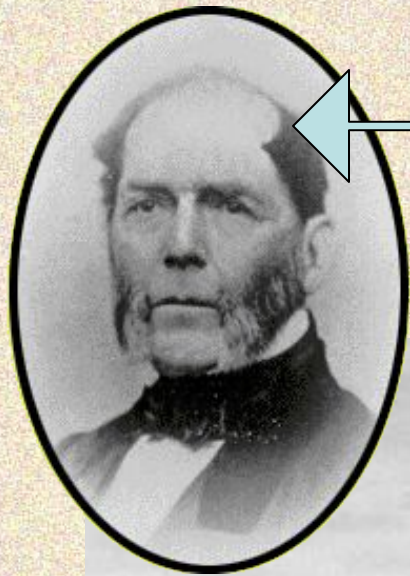


- Before it can be used crude oil must be refined.
- Hydrocarbons can be separated using **distillation**, which produces different fractions (or types) of oil and gas



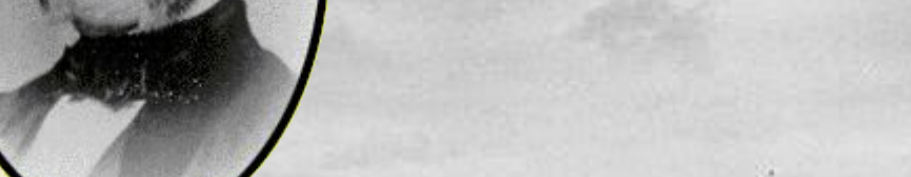


# Exploration and Production (8): Early History



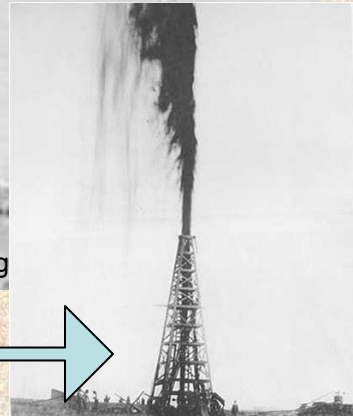
Abraham Gesner  
(1797-1864)

[en.wikipedia.org/wiki/Image:Abraham\\_Gesner.gif](https://en.wikipedia.org/wiki/Image:Abraham_Gesner.gif)



[en.wikipedia.org/wiki/Image:Oilfields\\_California.jpg](https://en.wikipedia.org/wiki/Image:Oilfields_California.jpg)

Californian oil gusher

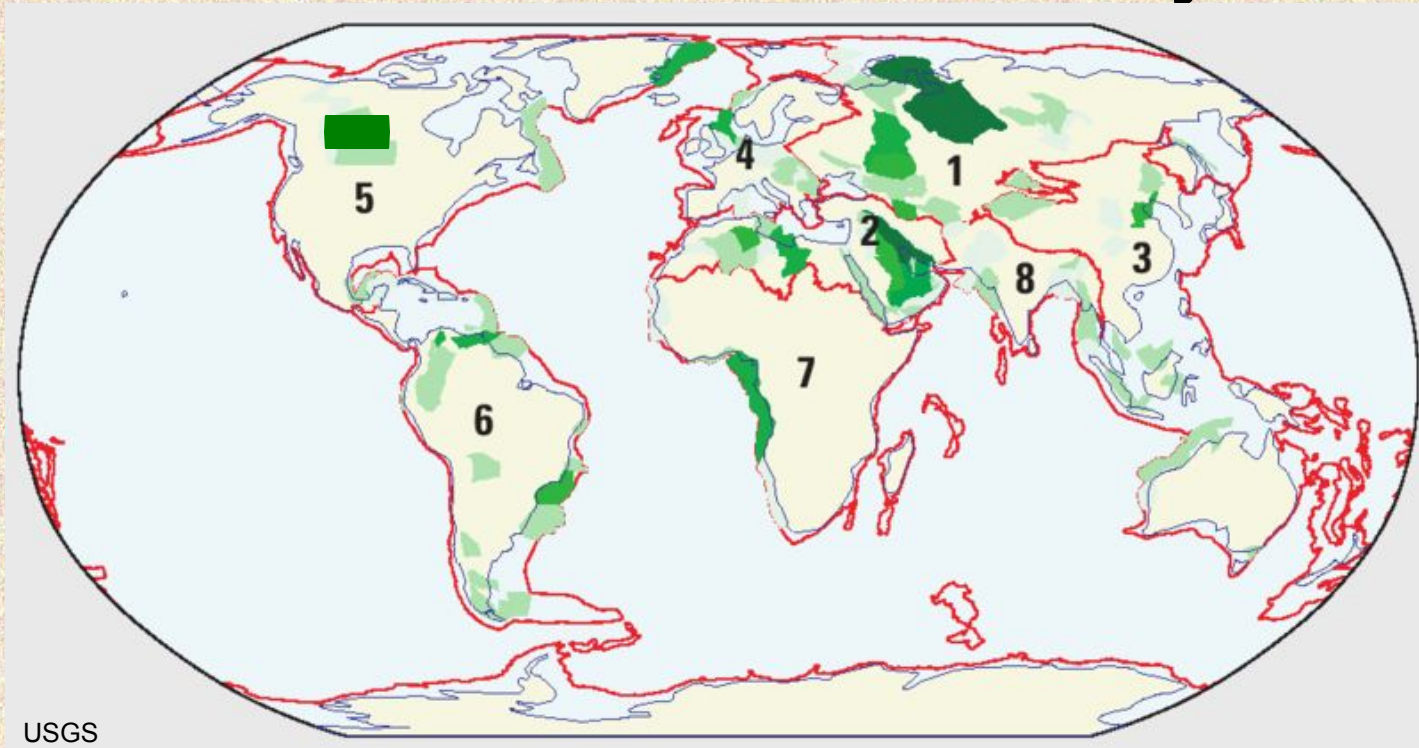


[en.wikipedia.org/wiki/Image:Lucas\\_gusher.jpg](https://en.wikipedia.org/wiki/Image:Lucas_gusher.jpg)

- The modern era of oil usage began in 1846 when Gesner perfected the art of **paraffin distillation**.
- This triggered a massive **worldwide boom** in oil production.
- California was centre of activity in the early 1900s, famous for its **gushers**.



# Exploration and Production (9): The Situation Today



Global oil and gas occurrences are now well understood (provinces shown in green). Only **Antarctica and the Arctic** remain unexplored.





# Practical Exercise 2

## The Oil Prospector Game





# Politics (1): Fuel source

<http://en.wikipedia.org/wiki/Image:Shellgasstationlosthills.jpg>



- 84% of crude oil is refined into fuel, principally for cars and planes



[blogs.sun.com/richb/resource/NBC\\_at\\_the\\_Pump.jpg](http://blogs.sun.com/richb/resource/NBC_at_the_Pump.jpg)

- Demand is ever increasing, especially due to growth of Chinese economy



# Politics (2): Other uses

[en.wikipedia.org/wiki/Image:CD-R.jpg](http://en.wikipedia.org/wiki/Image:CD-R.jpg)



CDs and DVDs



Plastic

[en.wikipedia.org/wiki/Image:Lilt.jpg](http://en.wikipedia.org/wiki/Image:Lilt.jpg)



Fertilizers and  
Pesticides

[en.wikipedia.org/wiki/Image:Konservering.jpg](http://en.wikipedia.org/wiki/Image:Konservering.jpg)



Food additives

- The remaining 16% of crude oil is used for a range of purposes shown above as well as synthetic fibres, dyes and detergents



# Politics (3): Main Producers - OPEC

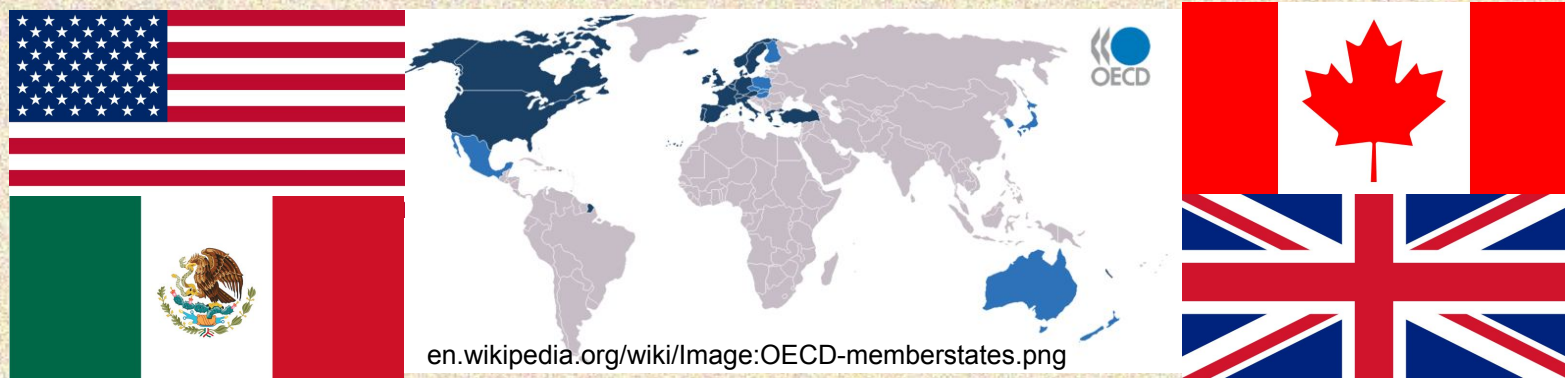
[en.wikipedia.org/wiki/Image:Opec\\_Organization\\_of\\_the\\_Petroleum\\_Exporting\\_Countries\\_countries.PNG](https://en.wikipedia.org/wiki/Image:Opec_Organization_of_the_Petroleum_Exporting_Countries_countries.PNG)



- Organization of the Petroleum Exporting Countries (OPEC) is a group of 13 countries that **produce 36%** of the world's oil, or **32 million barrels** of oil per day.
- The biggest producer is **Saudi Arabia**, but Iran, United Arab Emirates, Kuwait and Venezuela are also major suppliers



# Politics (4): Other Producers

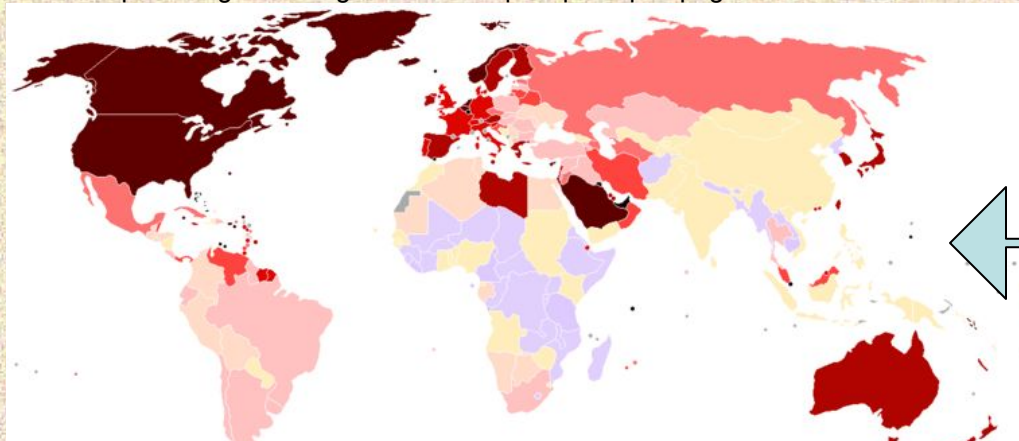


- Organization for Economic Co-operation and Development (OECD) produces 24% of all oil, or 21 million barrels per day.
- The USA is the biggest single producer in OECD but Mexico, Canada and the UK are also major suppliers
- Outside OECD, the states of the former Soviet Union are also major producers supplying a further 15% of global output



# Politics (5): Supply and Demand

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



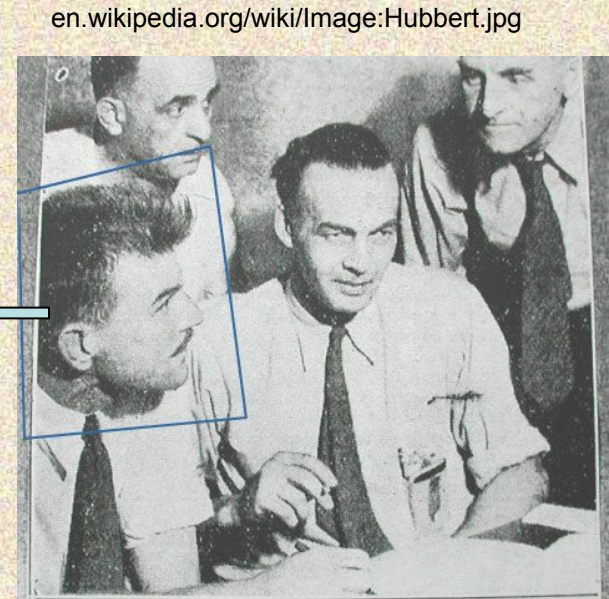
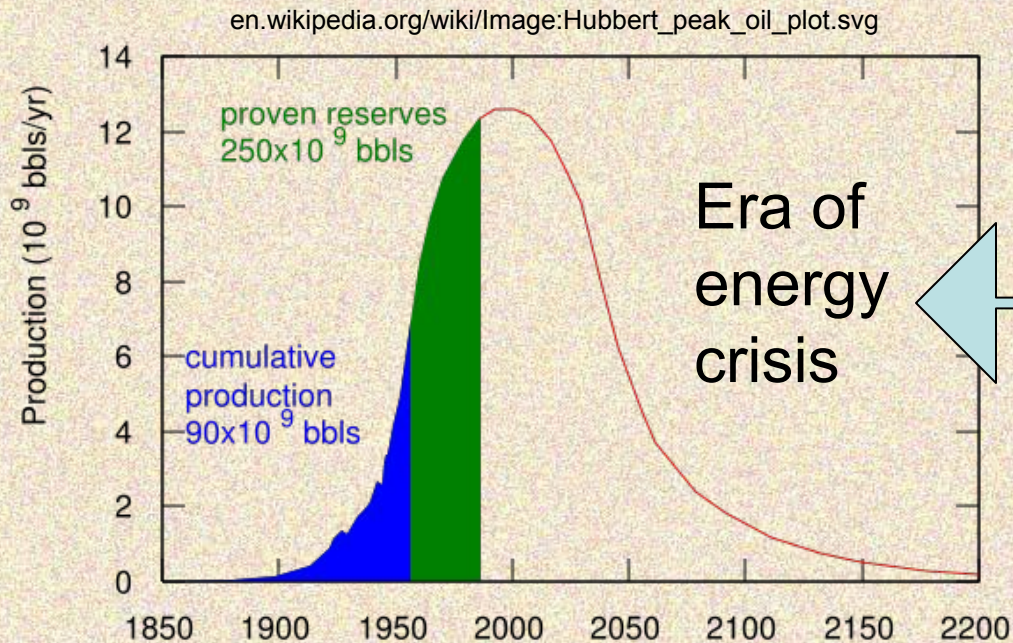
Oil consumption per person  
(darker reds indicate higher usage)

USA uses 24% of global supply but China shows the biggest year-to-year increase in usage

- In 2007, global consumption grew by 1.2 million barrels per day.
- OPEC and OECD nations can only raise production by a further 2.5 million barrels per day so a squeeze is on the cards



# Politics (6): Peak Oil



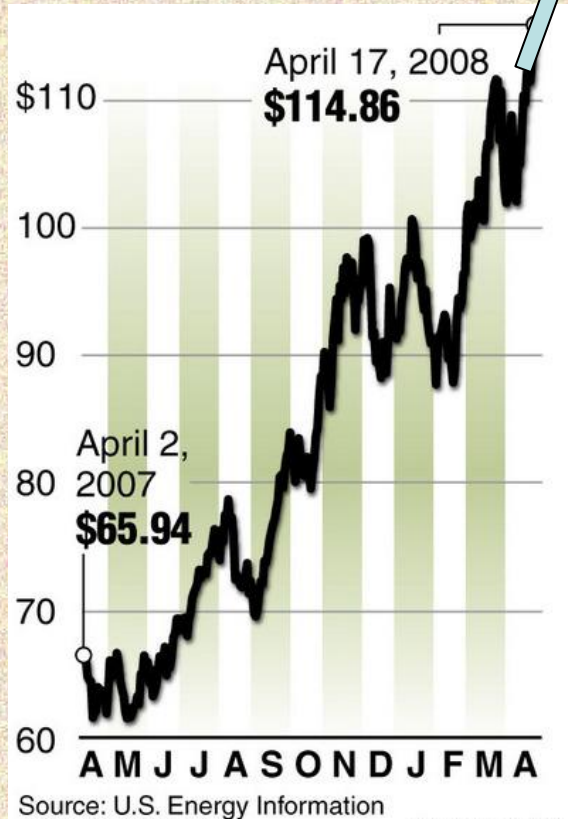
Hubbert (1903-1989)

- In 1956, Hubbert predicted that global oil production would peak around the **Year 2000** and trigger an **Energy Crisis** with power blackouts and rising costs of energy and fuel



# Politics (7): Rising Oil Prices

**\$139** by June 2008



- Oil prices have been steadily rising for several years and in June 2008 stand at a record high of **\$139 per barrel**.
- Is the rise due to a squeeze in availability (**peak oil**) or are other political or economic factors to blame?



# Politics (8): Canada's Tar Sands



- Higher oil prices and new technology mean unconventional oil deposits are now economically viable (e.g. tar sands)
- The Athabasca Deposit in Alberta contains 1.75 trillion barrels, or about **half of the world's proven oil reserves!**

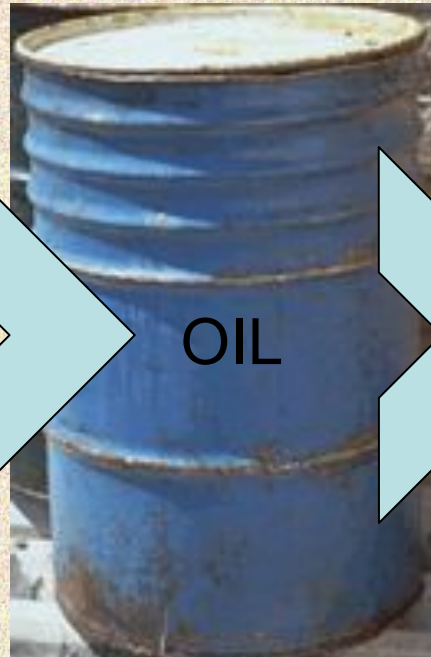


# Politics (9): Global Warming

[en.wikipedia.org/wiki/Image:Coal\\_anthracite.jpg](https://en.wikipedia.org/wiki/Image:Coal_anthracite.jpg)

[en.wikipedia.org/wiki/Image:Bluebbl.gif](https://en.wikipedia.org/wiki/Image:Bluebbl.gif)

[en.wikipedia.org/wiki/Image:Windpark\\_Galicia.jpg](https://en.wikipedia.org/wiki/Image:Windpark_Galicia.jpg)



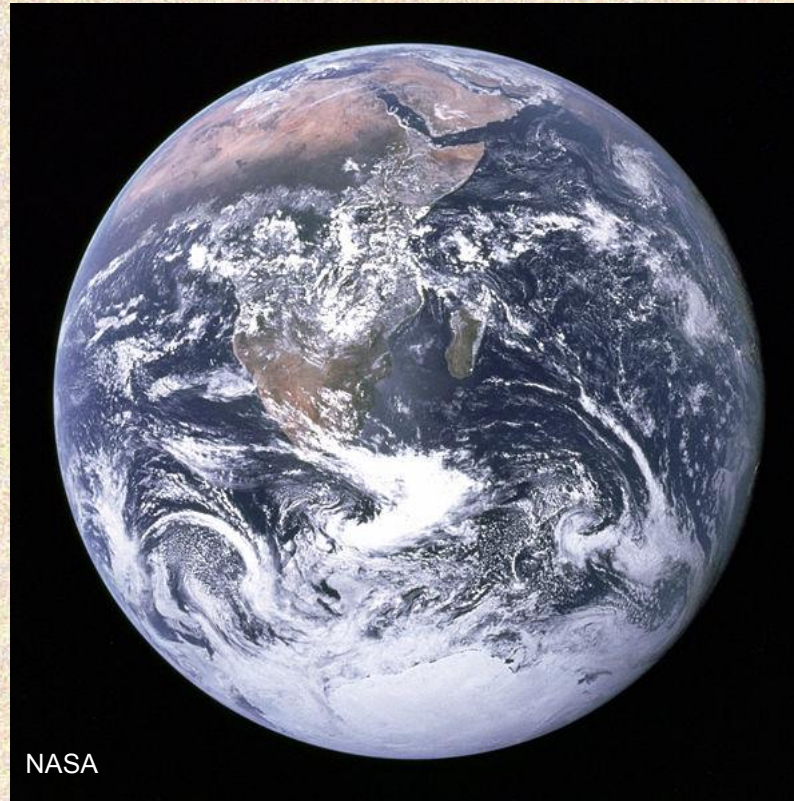
- Oil and Gas emit 15-30% less CO<sub>2</sub> than coal per watt of energy produced. Renewable energy is clean but not yet viable as fuel.



# Oil and Gas



[http://en.wikipedia.org/wiki/Image:Moscow\\_traffic\\_congestion.JPG](http://en.wikipedia.org/wiki/Image:Moscow_traffic_congestion.JPG)  
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[en.wikipedia.org/wiki/Image:Oil\\_platform.jpg](http://en.wikipedia.org/wiki/Image:Oil_platform.jpg)