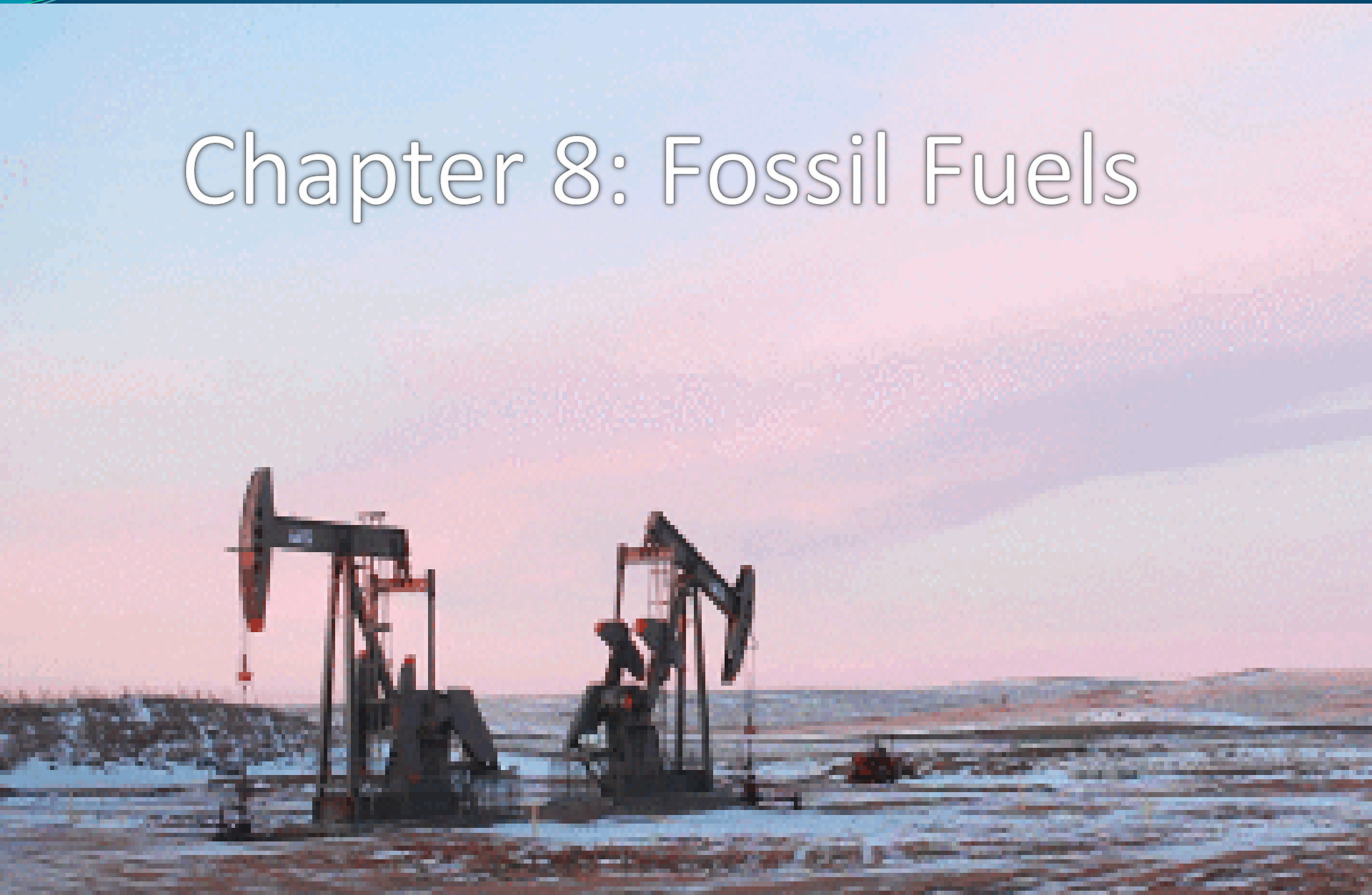
Chapter 8: Fossil Fuels

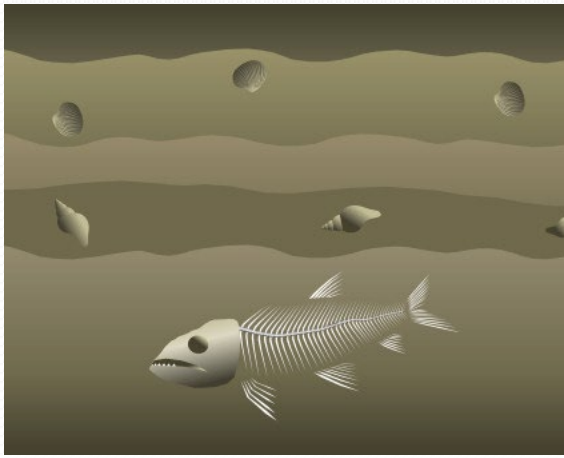


A long time ago, in a province not so far away…

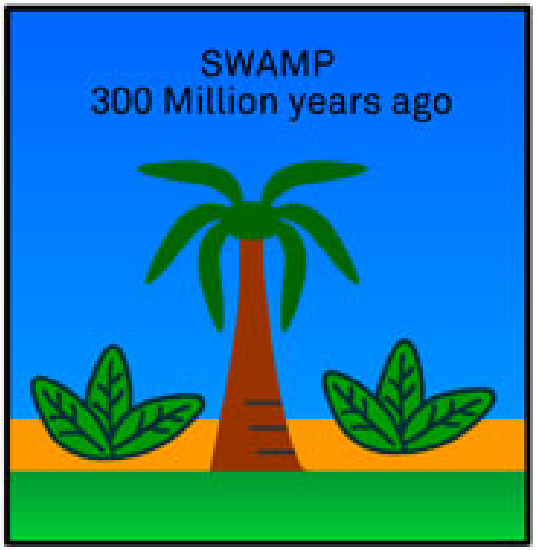
- Millions of years ago Alberta had a much warmer climate
- Lots of swamps and bogs, with a wide variety of vegetation
- This lead to the large amount of oil reserves we hold

How Fossil Fuels Came To Be

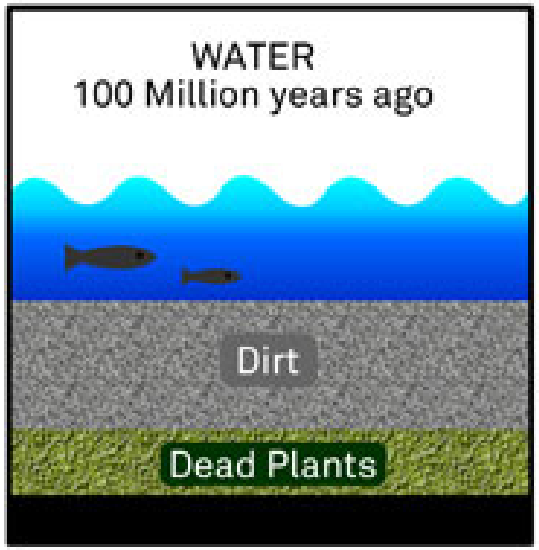
- When plant and animals died in the swamp their remains decompose more slowly → Remains cumulated
- Over time the swamps will be covered in sediment to form a rocky layer
- Pressure of building layers turn the energy remaining into fossil fuels
- Living organisms that were not turned into fossils



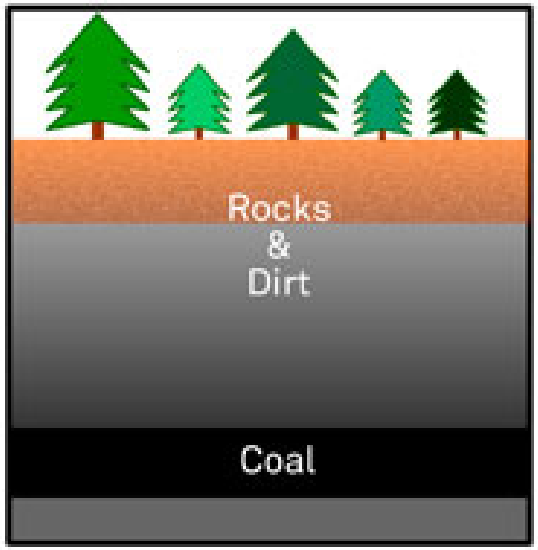
How coal was formed:



Before the dinosaurs, many giant plants died in swamps.



Over millions of years, the plants were buried under water and dirt.



Heat and pressure turned the dead plants into coal.

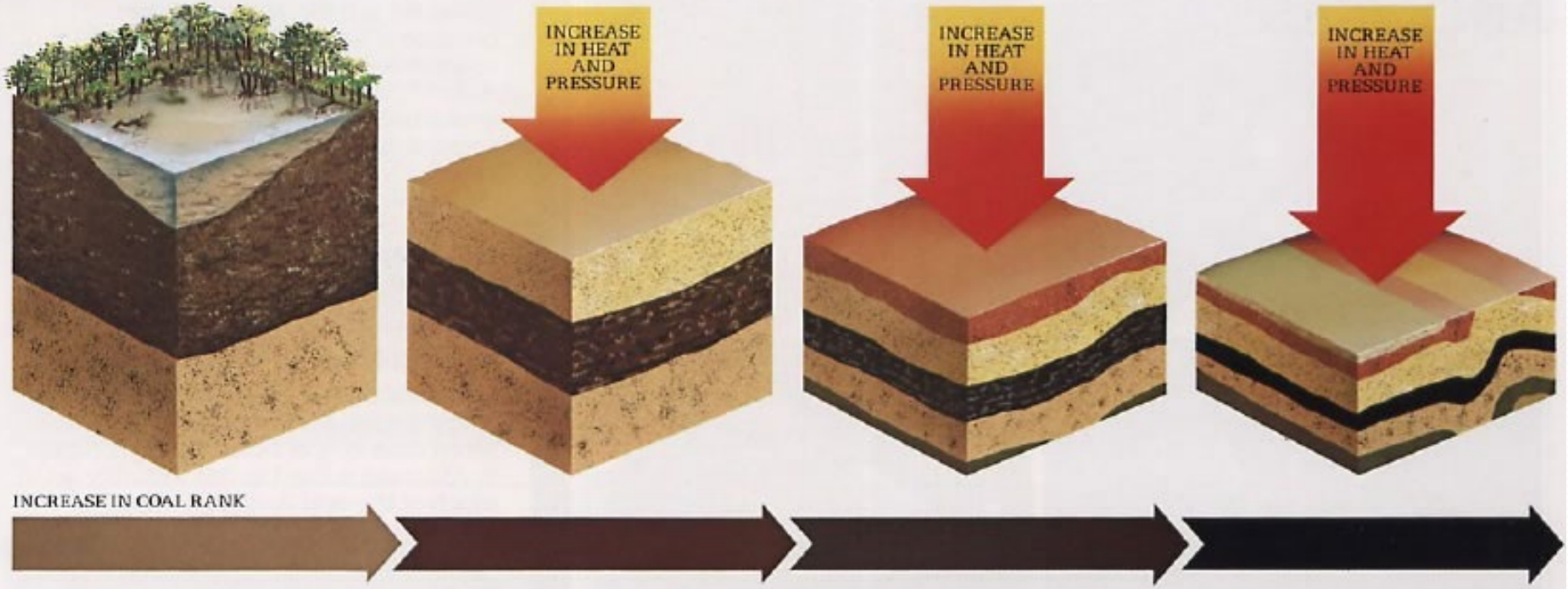
Fossil Fuels

- Includes: coal, crude oil, natural gas
- Take a long time to develop (**non-renewable**)
- 1. Forms in ancient swamps around 300 mya
- 2. Plants died and fell into the swamp. Remains could not decompose without oxygen. Formed a layer of **lignite** (soft coal)

Fossil Fuels

- 3. More layers of sediment piled on top and increased the compression force. As it got deeper heat also increased and formed **bitumous** coal
- 4. Some areas had increased heat and pressure and turned this bitumous coal into **anthracite** (hard coal)

CHANGES IN RANK OF COAL



PEAT
Carbon content 60%,
volatile matter > 53%,
average calorific value 16800 kj/kg,
moisture content > 75% (in-situ).

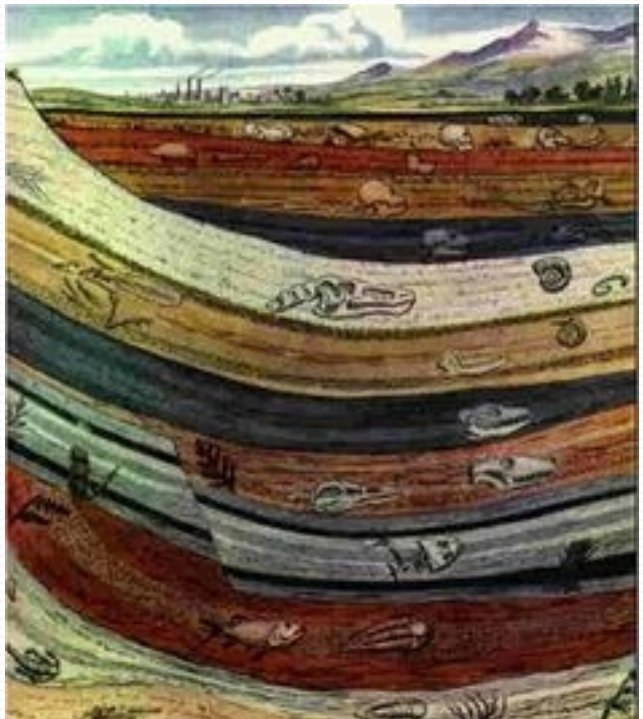
BROWN COAL
Carbon content 60-71%,
volatile matter 53-49%,
average calorific value 23000 kj/kg,
moisture content 35% (in-situ).

SUB-BITUMINOUS COAL
Carbon content 71-77%,
volatile matter 49-52%,
average calorific value 29300 kj/kg,
moisture content 25-10% (in-situ).

BITUMINOUS COAL
Carbon content 77-87%,
volatile matter 42-29%,
average calorific value 36250 kj/kg,
moisture content 8% (in situ).

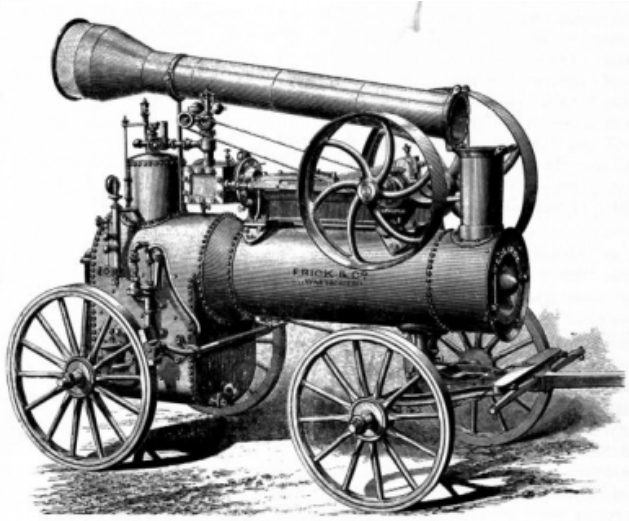
The Process

- Layers of sediment are often several kilometers thick
- Heat and pressure change the decaying matter into coal, oil, and natural gas – all have similar processes



Coal

- Has been used as a fuel for over 300 years
- Present in most parts of the world, but not utilized until the **steam engine** was created
- Still popular because it's inexpensive, easy to mine, and easy to transport

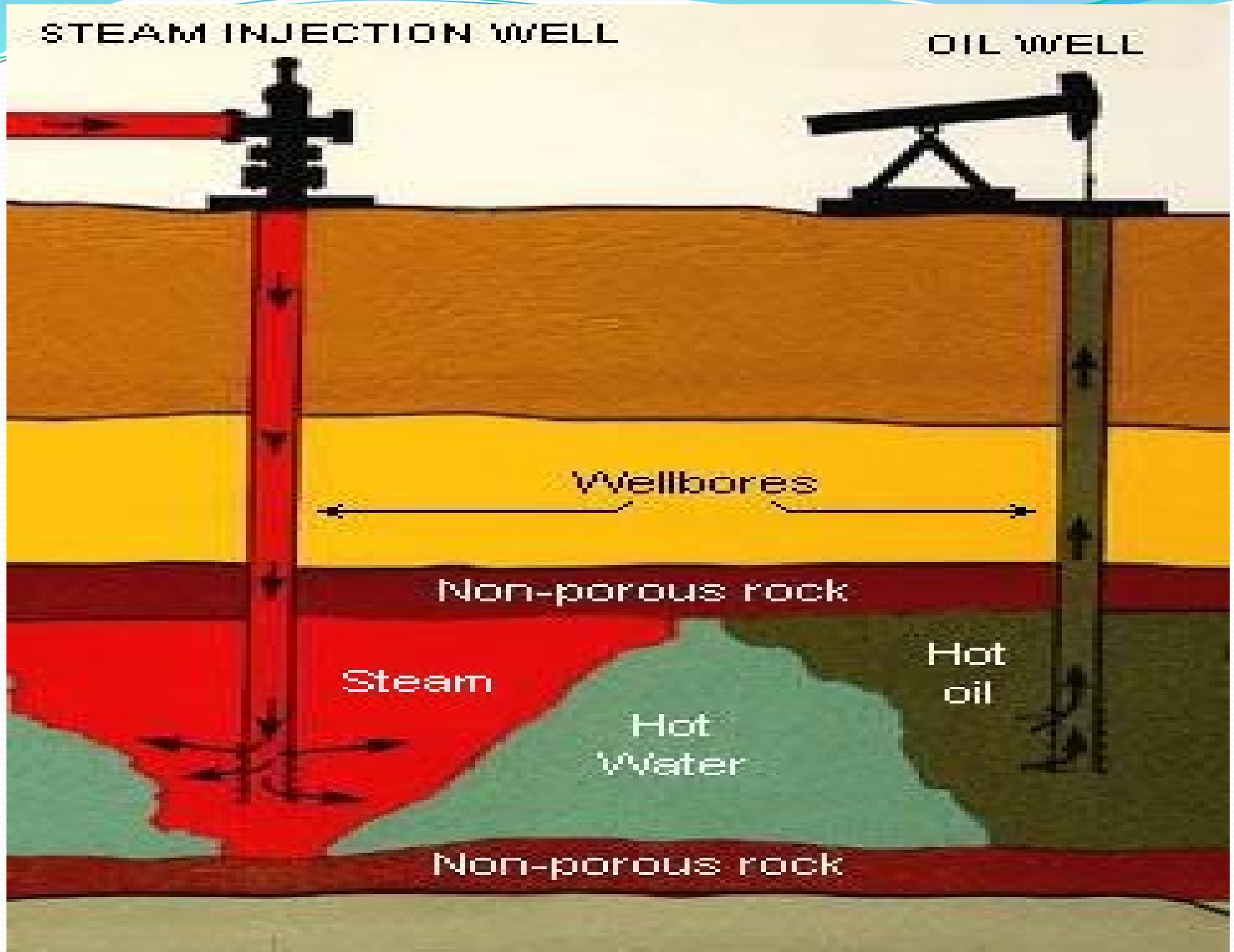


Natural Gas

- Have not been used as long as coal
- **Natural gas** is difficult and dangerous to control and transport. This is why it has only recently been used

Oil

- **Crude oil** or **petroleum** is found as a liquid.
- It is extracted by drilling a hole into the ground
- Sometimes the pressure on the fuel will cause it to come to the surface on its own, other times it will need to be pumped out


STEAM INJECTION WELL
OIL WELL
Wellbores
Non-porous rock
Steam
Hot
oil
Hot
Water
Non-porous rock

Extraction

- Fossil fuels have been an important part of Alberta since the late 1800s
- For more than a century coal was the main energy source of Canadian Pacific Railway and most industries in Alberta
- Previously talked about how coal used to power electricity production (Ch.6)
- Most of the iron and steel in Alberta has been produced in other parts of the world, but many of them use coal from Alberta to get the energy they need

Mining Coal

- Look for a layer or seam of coal
- Deposits quarried similarly to sand or gravel
- Called **open-pit mines**
- Deeper deposits are dug out using a series of underground tunnels
- Machines play a large part in extraction

Oil

- In the past oil was only used to make kerosene, which was a fuel for lamps and stoves
- Today it is the most important source of energy in the world
- One problem with mining crude oil is knowing where to drill

W.S. Heron

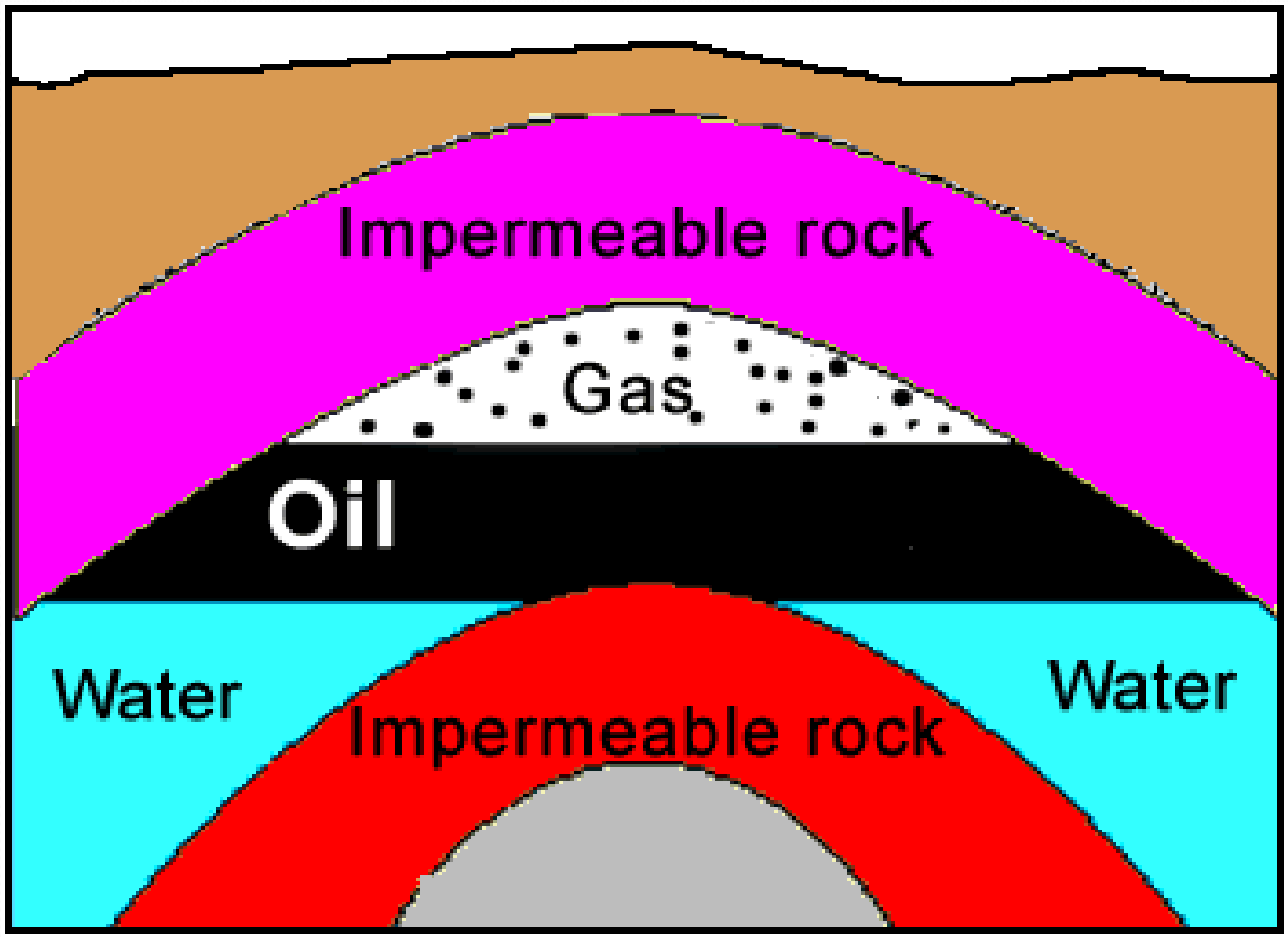
- In 1914 noticed oil seeping from the ground on a farm near Turner Valley
- He purchased the farm and mining rights and started drilling
- He discovered oil in Turner Valley, Woodbend, Leduc, and Redwater
- Helped turn Alberta into the oil powerhouse it is today!


ALBERTA
High Level
Fort McMurray
Peace River
Grande Prairie
Slave Lake
Redwater
Woodbend
Hinton
Edson
Edmonton
Jasper
Lloydminster
Red Deer
Coronation
Leduc
Banff
Calgary
Turner Valley
Medicine Hat
Pincher Creek
Lethbridge

Oil Extraction

- Often thought that oil forms in large pools underground
- Actually forms in tiny pores between the particles that make up rocks
- As earth's crust changes and causes great amounts of pressure to shift and forces the oil droplets into porous rocks called **reservoir rocks**
- Further Earth movement can trap these reserves between impermeable rocks

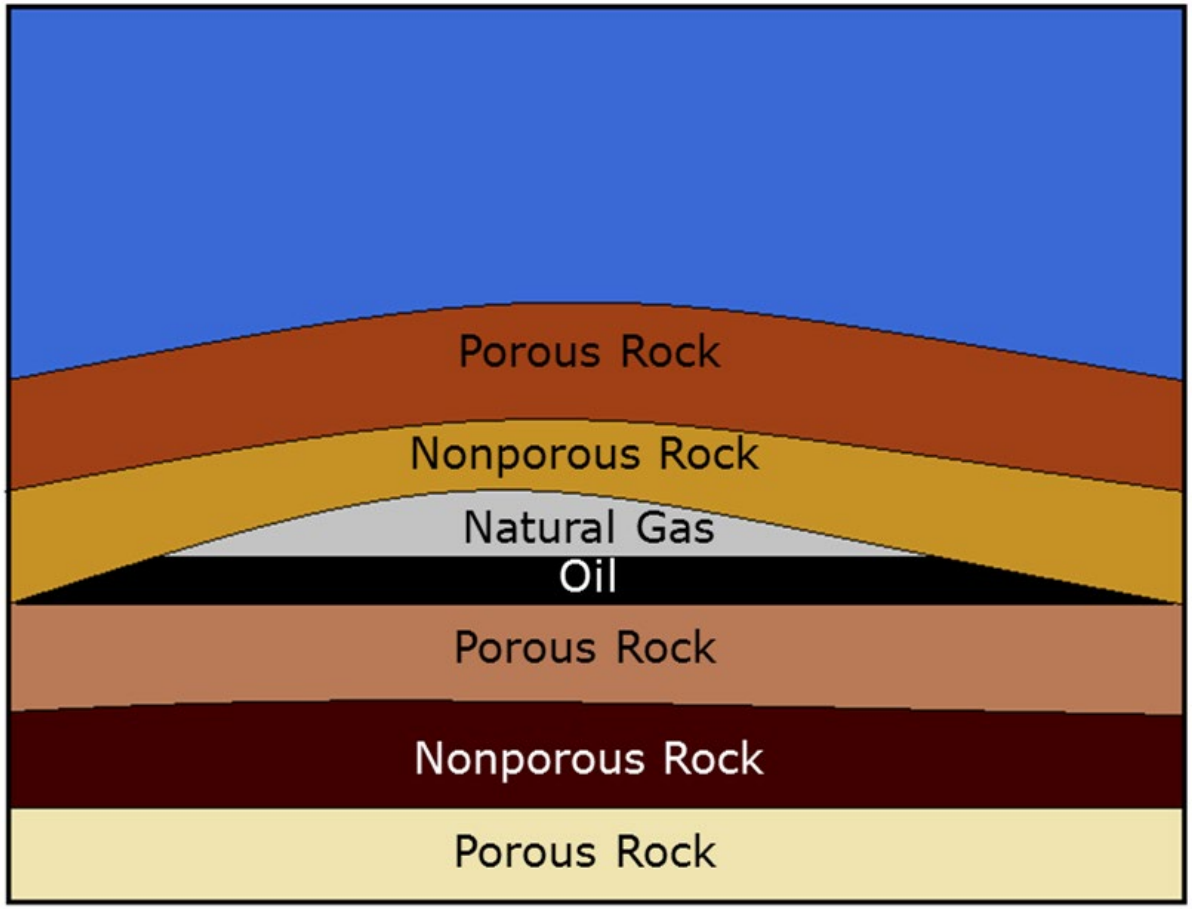
Reservoir Rocks

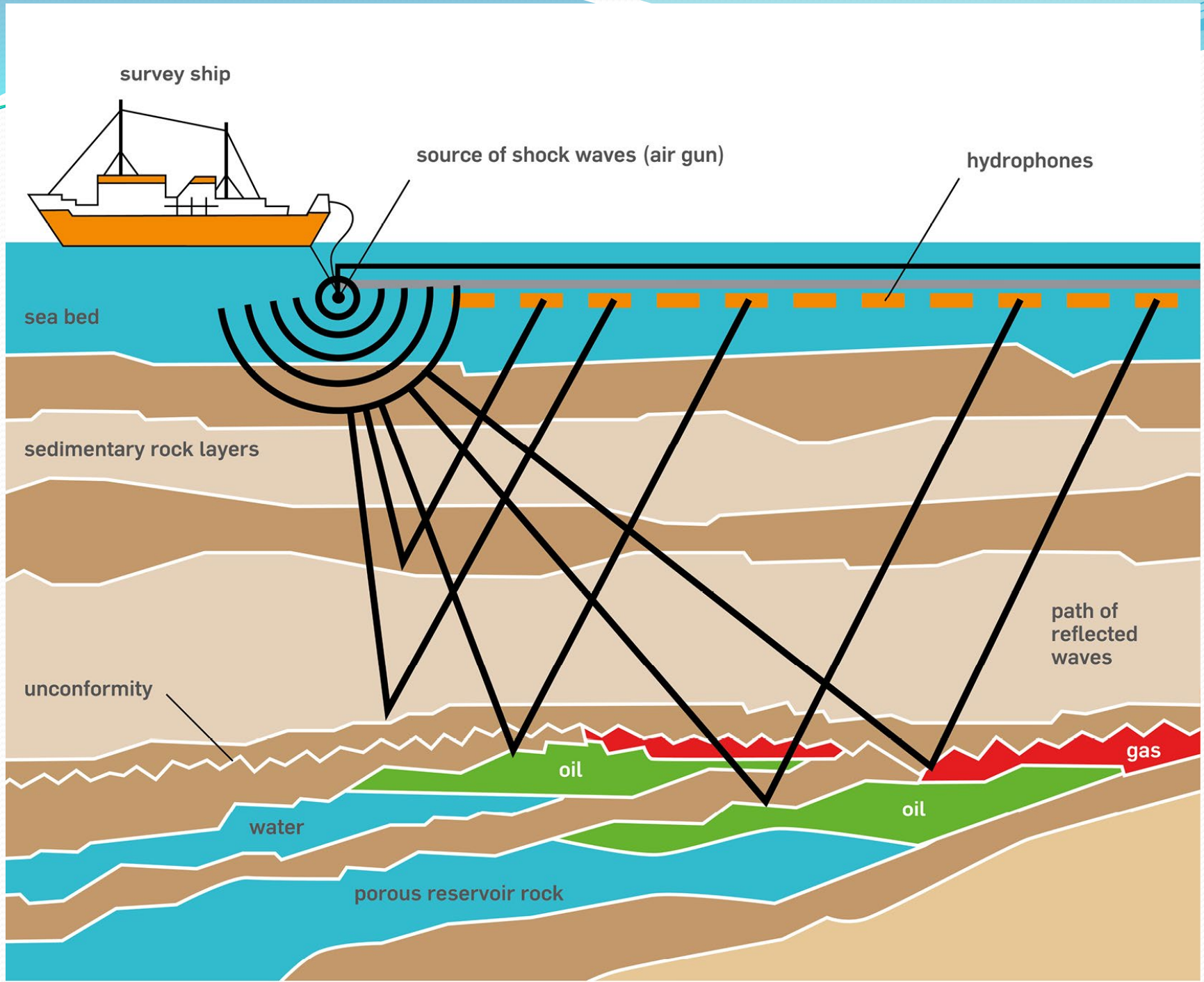


Finding Oil

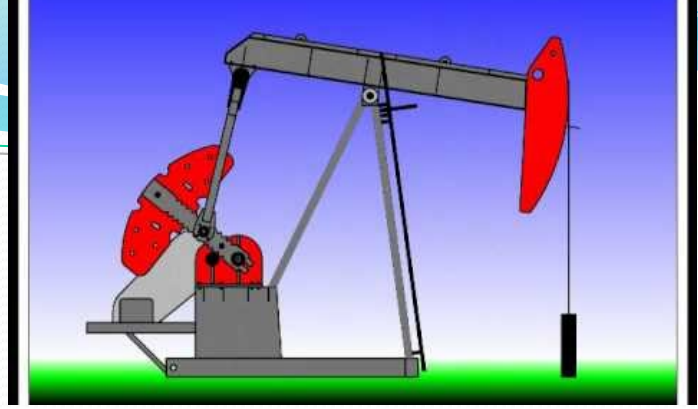
- Geologists use a number of technologies to determine the location of potential reservoirs
- One of the more common methods is the **seismic survey**
- Shock waves are sent through the Earth's crust. The returning soundwaves reflect off of rock and detected by sensitive equipment
- Geologists then interpret these images looking for certain patterns or structures

Reservoir Rocks




survey ship
source of shock waves (air gun)
hydrophones
sea bed
sedimentary rock layers
path of reflected waves
unconformity
oil
gas
oil
water
porous reservoir rock

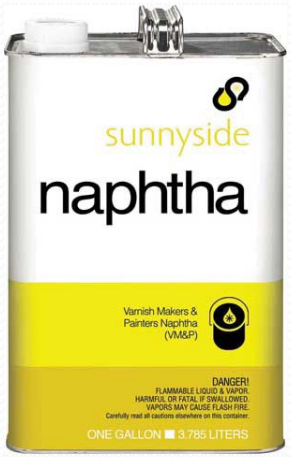
Drilling



- Once location is identified they start to drill
- At the beginning the pressure may cause oil to rise to the surface on it's own
- After the pressure decreases a pump may be needed to extract the rest of the oil
- In most cases a **pump jack** is installed, but in some areas a **lift pump** may be used

Refining Oil

- Once it is taken from the ground it can be turned into many useful products through a process called **distillation**
- Allows for separation of materials with low boiling points from those with high boiling points
- Heavy lubricants (motor oil, kerosene) are separated from lighter liquids (gasoline, naphtha)



Natural Gas

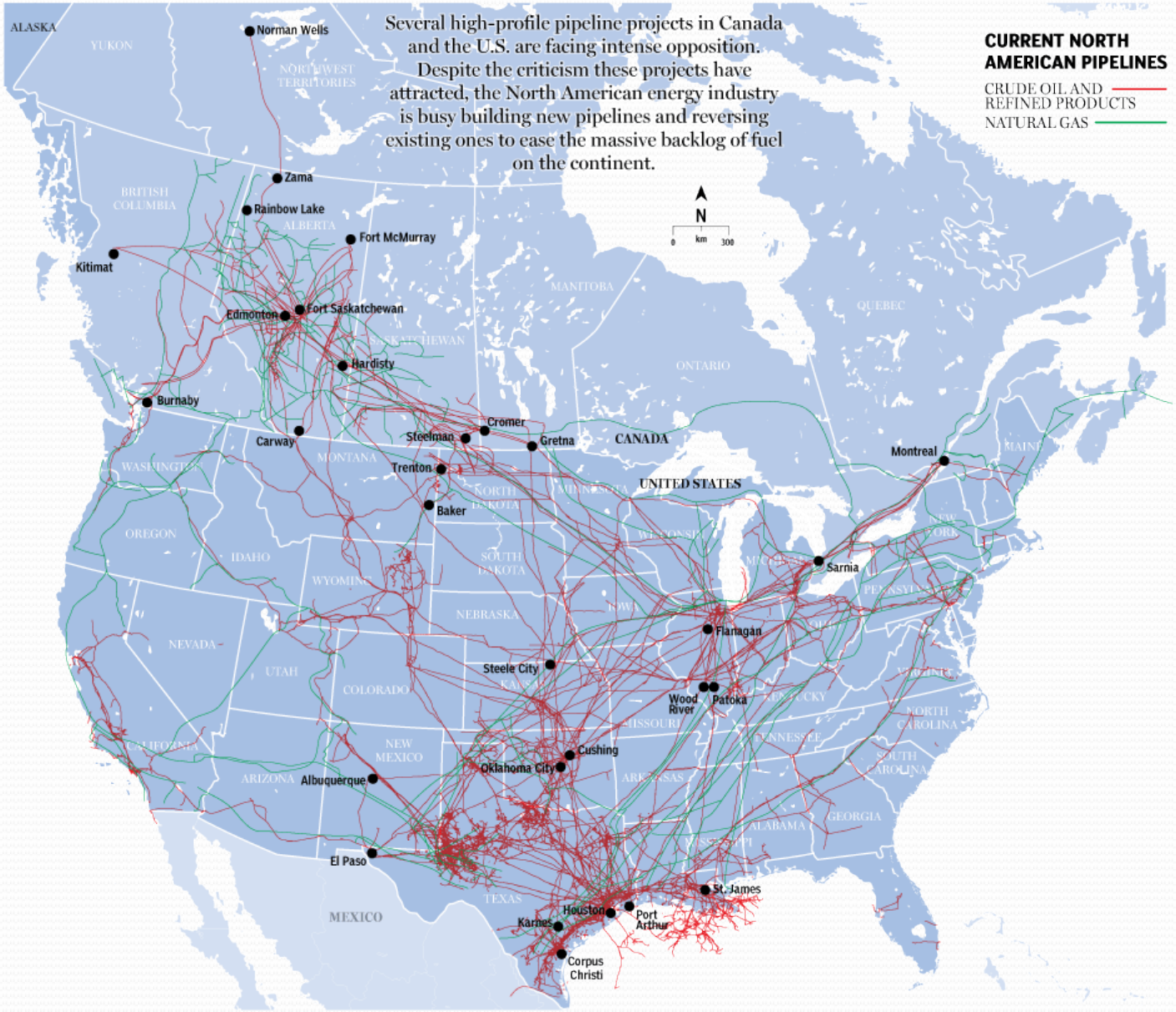
- Along with oil is created in a similar way to coal but often a product of marine organic matter
- Until a few decades ago was seen as waste and burned off as it was difficult to control
- Today it is primarily pumped across Canada through **pipelines** and also through train, truck, and ship

Pipelines

- Transport natural gas from source to towns and cities
- Natural gas is popular because it causes less pollution than either coal or gasoline and provides immediate heat
- Like other fossil fuels when natural gas is burned the stored energy is transformed to thermal energy for heating and cooking

PIPELINES

OF THE UNITED STATES AND CANADA



Combustion

- A fuel is burned in the presence of oxygen to produce carbon dioxide, water, and energy

$$2C_8H_{18} + 25O_2 \rightarrow 18H_20 + 16CO_2 + \textbf{energy}$$

(octane + oxygen → water + carbon dioxide + energy)

All fossil fuels made of carbon and hydrogen – **hydrocarbons**

Similar to Cellular Respiration

- **Combustion**

$$2C_8H_{18} + 25O_2 \rightarrow 18H_20 + 16CO_2 + \textbf{energy}$$

(octane + oxygen → water + carbon dioxide + energy)

- **Cellular Respiration**

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 25ATP$$

or

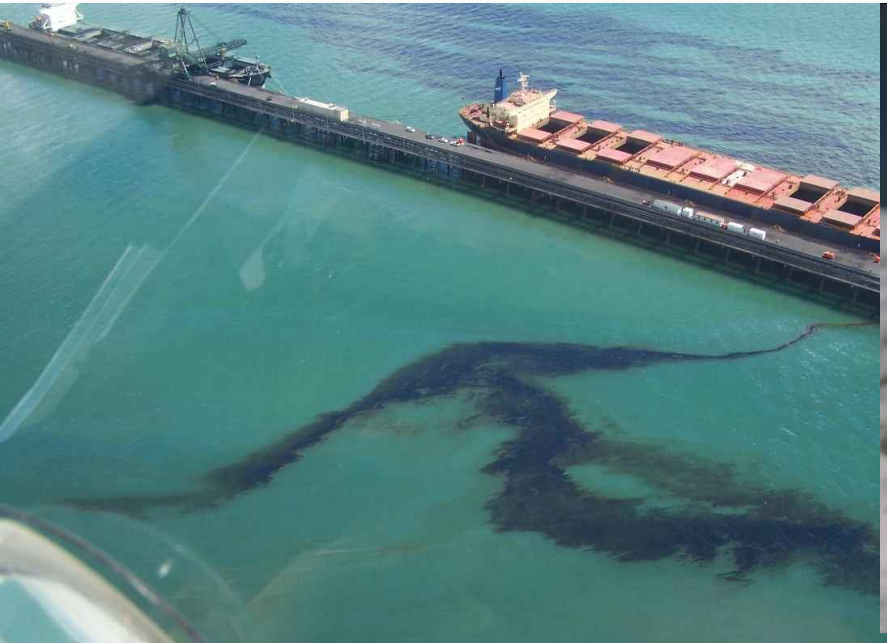
glucose + oxygen → carbon dioxide + water + ATP

Other Side of the Coin

- Although we seem pretty dependant on these fuels as they integrate into our everyday life, they can also cause problems
- The are non-renewable
- Demand is increasing, supply is decreasing

Oil Spills

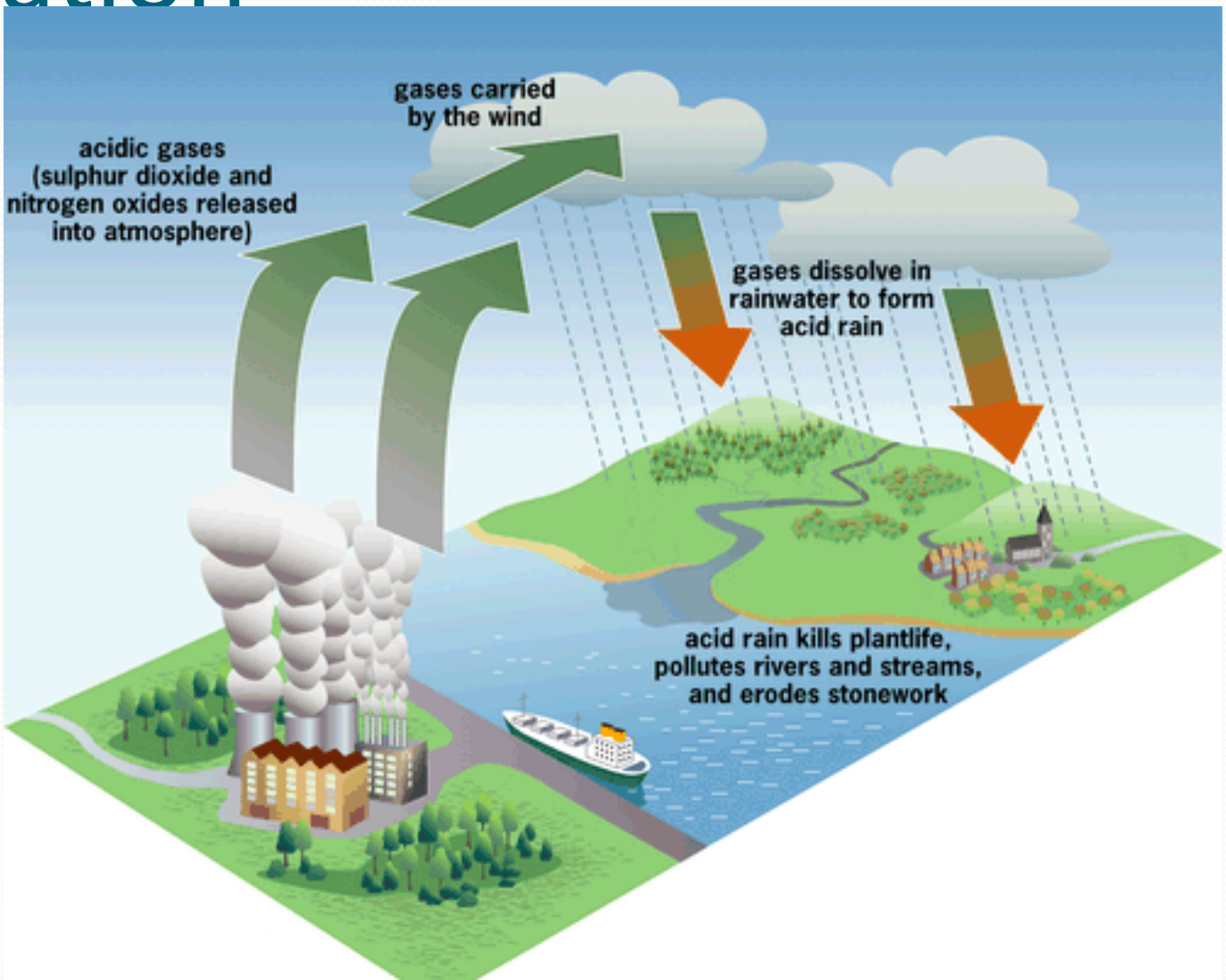
- Damage to tankers or pipelines can cause oil to leak into the surrounding environment
- Toxic if consumed, and if it coats the animal can destroy natural insulation or water proofing



Air Pollution

- Considered as any chemical in that air that can cause harm to living things or the environment
- Can combine with each other to produce acid rain
- Also known as **acid deposition** since the acid isn't always in the form of rain, can be fog or mist, as well as rain

Formation


gases carried
by the wind
acidic gases
(sulphur dioxide and
nitrogen oxides released
into atmosphere)
gases dissolve in
rainwater to form
acid rain
acid rain kills plantlife,
pollutes rivers and streams,
and erodes stonework

Greenhouse Gases

- Humanity burns millions of litres of gasoline daily – heating, vehicles, generate energy
- All these combustion reactions release millions of tonnes of CO_2 into the atmosphere
- Causes a process known as **Global Warming**