Institute of Natural Resources
Department of Fuel Engineering and Chemical Cybernetics

Coal: formation, composition, classification, properties

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• Plan

- What is coal?
- Coal mining
- Coal formation
- Coal components
- Coal physical parameters
- Coal ranks

What is coal?

Coal is a solid fossil fuel that forms underground from partially decomposed plant material.

It is made up of:

- ✓ carbon,
- ✓ nitrogen,
- ✓ oxygen,
- ✓ hydrogen,
- ✓ sulphur.

In the past coal was the major source of energy (home heating, trains).

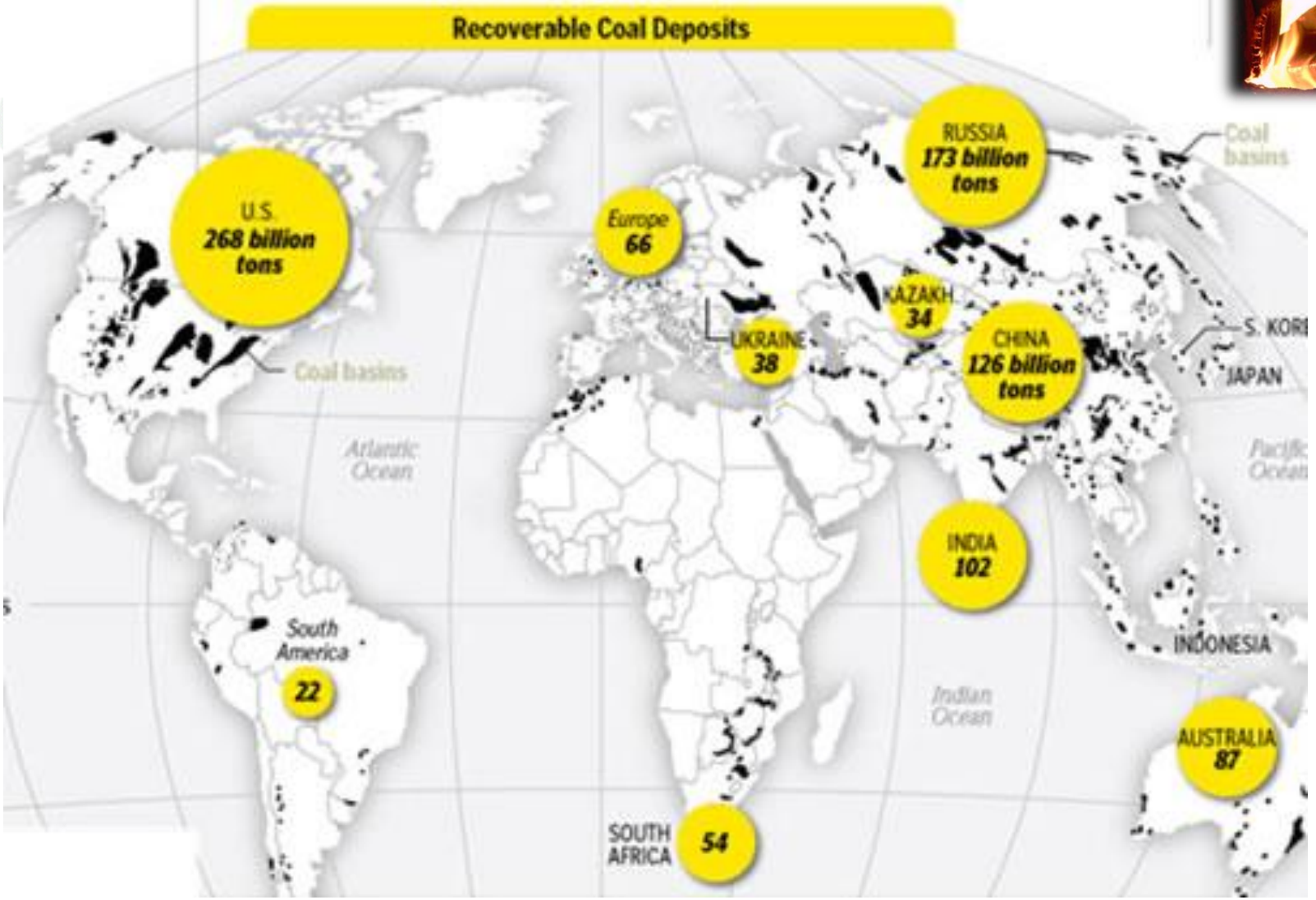
What is coal?

People began to use coal less because burning coal produces large amounts of air pollution.

Power plants burn coal for heat to turn turbines that generate electrical energy.

Power plants use pollution controls (scrubbers, filters) to prevent air pollution from the burning of coal.

• Coal reserves



Coal mining

Coal is solid like substance that need to be dug.

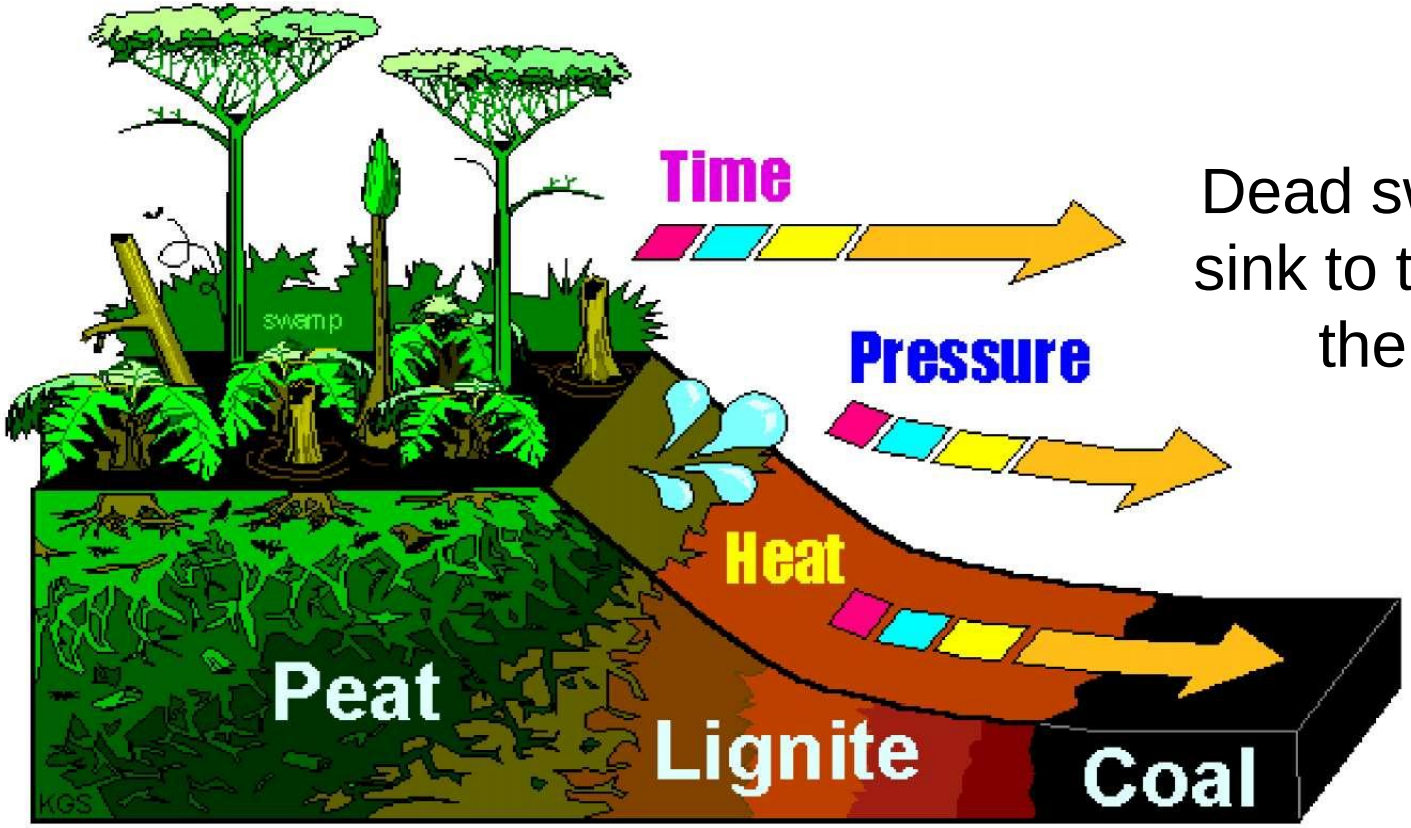
Most popular method to dig coal from underground:

is to build a horizontal shaft and coal miners travel via lifts or trains to dig the coal deep underground.

✓Once dug, coal is then shipped to coal power stations by trucks or trains.

✓Coal power stations require huge reserves of coal to generate electricity on a constant basis.

Coal formation



Dead swamp plants sink to the bottom of the swamp.

If they do not decay completely, **coal formation may begin**.

• Coal formation

Stage 1: Formation of Peat
Sunken swamp plants that have not decayed completely can change into peat. About 60% of an average sample of dried peat is carbon.

In some parts of the world, peat is dried and burned for heat or as fuel.

Stage 2: Formation of Lignite
If sediment buries the peat, pressure and temperature increase. The peat slowly changes into a type of coal called *lignite*. Lignite is harder than peat, and about 70% of an average sample of lignite is carbon.

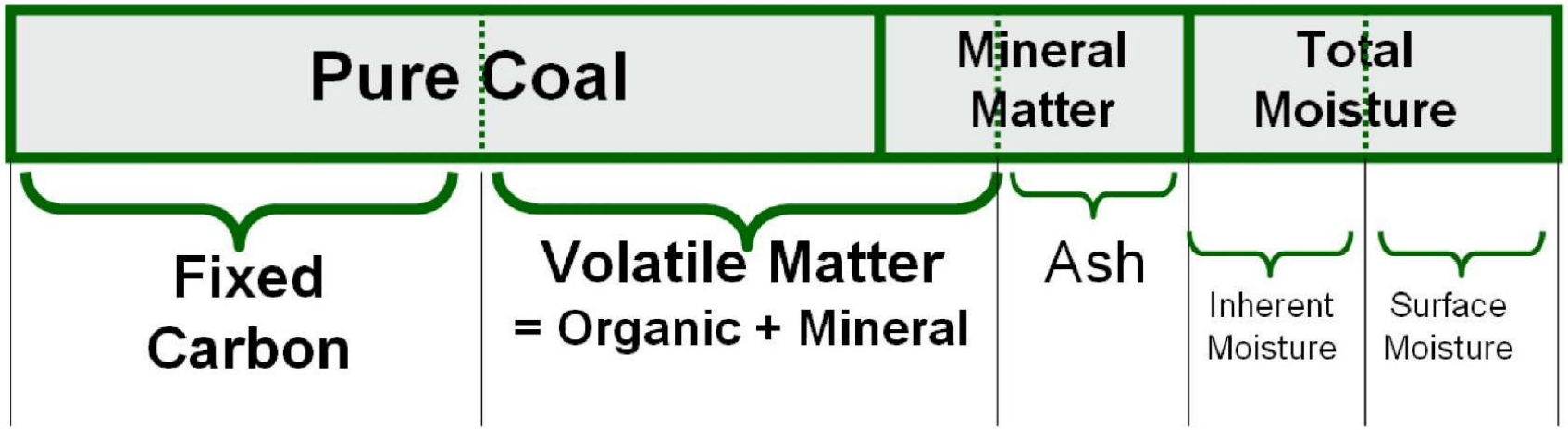
• Coal formation

Stage 3: Formation of Bituminous Coal
If more sediment is added, pressure and temperature force more water and gases out of the lignite. Lignite slowly changes into bituminous coal. About 80% of an average sample of bituminous coal is carbon.

Stage 4: Formation of Anthracite
If more sediment accumulates, temperature and pressure continue to increase. Bituminous coal slowly changes into anthracite. Anthracite is the hardest type of coal. About 90% of an average sample of anthracite is carbon.

The formation of coal can stop at any stage of the process.

Coal components



Volatile matter consists of aliphatic carbon atoms or aromatic hydrocarbons and mineral matter.

Ash consists of inorganic matter from the earth's crust (limestone, iron, aluminum, clay, silica, and trace elements of zinc, copper, boron, lead, arsenic, cadmium, chromium, selenium).

Coal physical parameters

- ✓ carbon content;
- ✓ moisture content;
- ✓ volatile;
- ✓ calorific value.

Carbon forms more than 50% by weight and more than 70% by volume of coal.

With higher rank coals containing less hydrogen, oxygen and nitrogen.

Coal physical parameters

Moisture content is determined by heating an air-dried coal sample at 105-110 C under specified conditions until a constant weight is obtained.

Volatile matter is material that is driven off when coal is heated to 950 C in the absence of air under specified conditions.

- ✓ Volatile matter is measured practically by determining the loss of weight.
- ✓ Volatile matter decreases as rank increases.

Calorific value is the amount of chemical energy stored in a coal that is released as thermal energy upon combustion.

- ✓ Calorific value is directly related to rank.

Coal ranks

The **rank of coal is based** on the degree to which the orginal plant material has been transformed into carbon.

- ✓anthracite
- ✓bituminous coal
- ✓subbituminous coal
- ✓lignite

carbon content and heat given out **decreases**

dirtyness of the fuel and moisture content **increases**

- **Coal ranks**

Lignite coal

- ✓ brownish black, more like soil than a rock;
- ✓ has a high ***moisture content (up to 45%)*** and a high suphur content;
- ✓ tends to disintegrate when exposed to the weather;
- ✓ also called **brown coal**;
- ✓ used for electric power generation;
- ✓ a young type of coal;
- ✓ has a ***colorific value of less than 5 kw/kg***.

Coal ranks

Subbituminous coal

- ✓ black, also called black lignite;
- ✓ contains ***20-30% moisture***;
- ✓ used for generating electricity and space heating;
- ✓ has ***calorific values*** ranging from ***5-6.8 kW/kg***.

Bituminous coal

- ✓ soft, dense, black coal, often has bands of bright and dull material in it;
- ✓ the most common coal;
- ✓ has a ***moisture content less than 20%***;
- ✓ used for generating electricity, making coke, and space heating;
- ✓ has ***calorific values*** ranging from ***6.8-9 kW/kg***.

- **Coal ranks**

Anthracite coal

- ✓ hard, black and lustrous.
- ✓ low in suplhur and high in carbon;
- ✓ the highest rank of coal;
- ✓ moisture content generally is less than 15%;
- ✓ has a calorfific values of around 9 kW/kg or above.