

FOSSIL FUELS ARE THEY DINOSAURS?

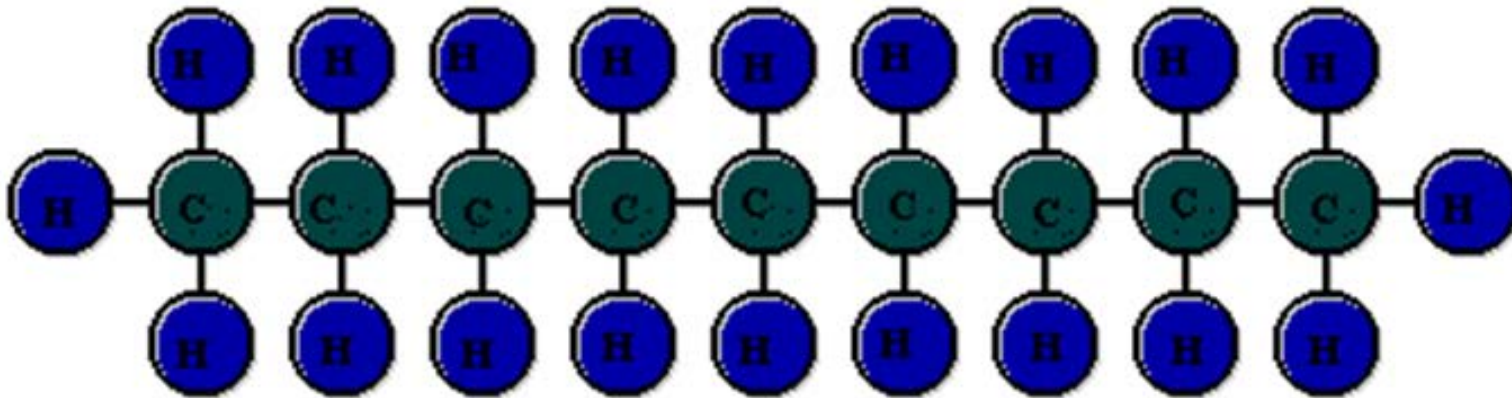
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University of the Witwatersrand

COMBUSTION



HYDROCARBONS

- Mainly Carbon and Hydrogen
- Also others like Oxygen and Sulphur



HYDROCARBONS

Periodic Table of Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																																						
1 H Hydrogen 1.00794	Atomic # Symbd Name Atomic Mass																2 He Helium 4.002602																																						
3 Li Lithium 6.941	4 Be Beryllium 9.012182	<div style="display: flex; justify-content: space-between;"> <div style="width: 15%;"> <p>C Solid</p> <p>Hg Liquid</p> <p>H Gas</p> <p>Rf Unknown</p> </div> <div style="width: 85%;"> <table border="1" style="width: 100%; text-align: center;"> <tr> <th colspan="10">Metals</th> <th colspan="2">Nonmetals</th> </tr> <tr> <td style="background-color: #f0e68c;">Alkali metals</td> <td style="background-color: #fff2cc;">Alkaline earth metals</td> <td style="background-color: #e6f2ff;">Lanthanoids</td> <td style="background-color: #e6f2ff;">Actinoids</td> <td style="background-color: #e6f2ff;">Transition metals</td> <td style="background-color: #e6f2ff;">Poor metals</td> <td style="background-color: #e6f2ff;">Other nonmetals</td> <td style="background-color: #e6f2ff;">Noble gases</td> <td colspan="4"></td> </tr> </table> </div> </div>																Metals										Nonmetals		Alkali metals	Alkaline earth metals	Lanthanoids	Actinoids	Transition metals	Poor metals	Other nonmetals	Noble gases					5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797	11 Na Sodium 22.98976928	12 Mg Magnesium 24.3050	13 Al Aluminium 26.9815386	14 Si Silicon 28.0855	15 P Phosphorus 30.973762	16 S Sulfur 32.065	17 Cl Chlorine 35.453	18 Ar Argon 39.948
Metals										Nonmetals																																													
Alkali metals	Alkaline earth metals	Lanthanoids	Actinoids	Transition metals	Poor metals	Other nonmetals	Noble gases																																																
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955912	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938045	26 Fe Iron 55.845	27 Co Cobalt 58.933195	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.92160	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.798																																						
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90588	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.90	43 Tc Technetium (97.9072)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.293																																						
55 Cs Caesium 132.9054519	56 Ba Barium 137.327	57-71 Rf	72 Hf Hafnium 178.49	73 Ta Tantalum 180.94788	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.084	79 Au Gold 196.966569	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98040	84 Po Polonium (209.9824)	85 At Astatine (209.9871)	86 Rn Radon (222.0176)																																						
87 Fr Francium (223)	88 Ra Radium (226)	89-103 Rf	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (288)	110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Uub Ununbium (285)	113 Uut Ununtrium (284)	114 Uuq Ununquadium (289)	115 Uup Ununpentium (288)	116 Uuh Ununhexium (292)	117 Uus Ununseptium	118 Uuo Ununoctium (294)																																						

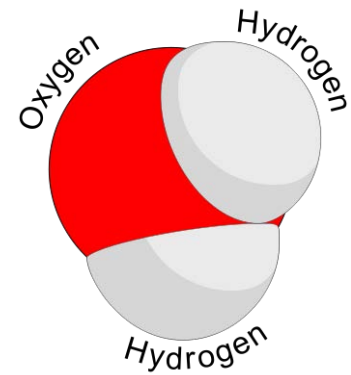
For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

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57 La Lanthanum 138.90547	58 Ce Cerium 140.116	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.242	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92535	66 Dy Dysprosium 162.500	67 Ho Holmium 164.93032	68 Er Erbium 167.259	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.054	71 Lu Lutetium 174.9668
89 Ac Actinium (227)	90 Th Thorium 232.03806	91 Pa Protactinium 231.03689	92 U Uranium 238.02891	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

HYDROGEN



HINDENBURG



CARBON



IDENTIFY THE HYDROCARBONS

- ◉ A Used engine oil
- ◉ B New engine oil
- ◉ C Peat
- ◉ D Tar
- ◉ E Charcoal
- ◉ F Coke
- ◉ G Anthracite
- ◉ H Coal

EXAMPLES ARE!



Coal

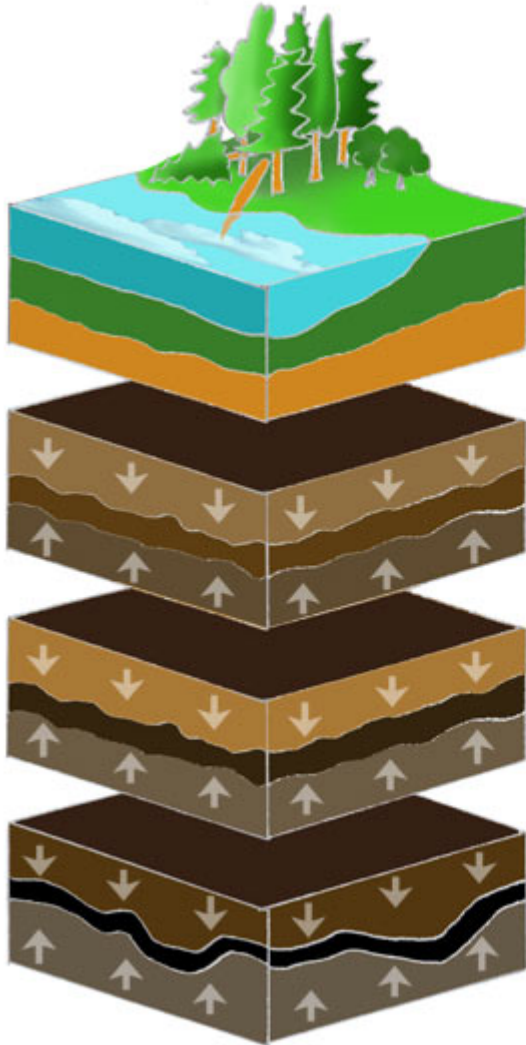


Natural Gas



Oil

FORMATION OF COAL



HUGE FORESTS GREW AROUND
300 MILLION YEARS AGO
COVERING MOST OF THE EARTH

THE VEGETATION DIES AND
FORMS PEAT

THE PEAT IS COMPRESSED BETWEEN
SEDIMENT LAYERS TO FORM LIGNITE

FURTHER COMPRESSION
FORMS BITUMINOUS AND
SUBBITUMINOUS COAL

EVENTUALLY ANTHRACITE FORMS

FOSSIL FUEL FACTS

- Rotting plant material becomes peat.
- Peat is buried and subject to high pressures and temperatures.
- Peat becomes lignite.
- Lignite becomes bituminous coal.
- Bituminous coal becomes anthracite.

HOW IS COAL FORMED

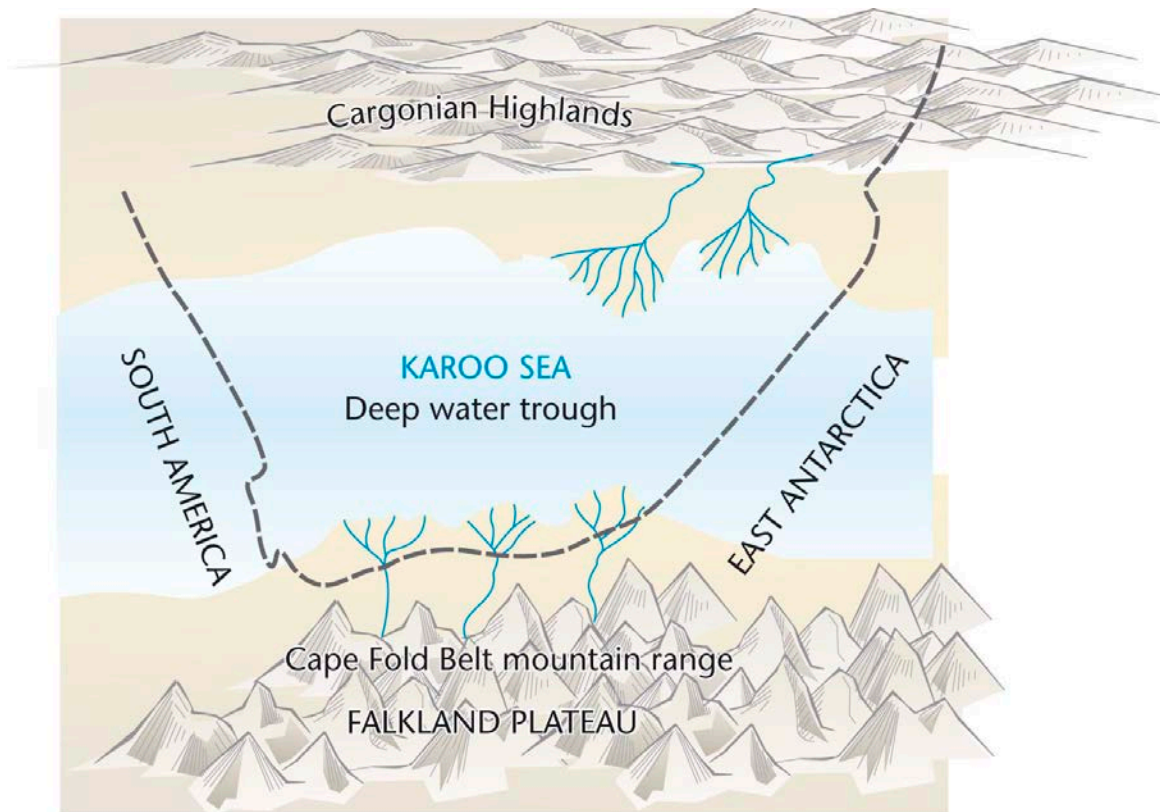
260 million years ago South Africa was covered with vast swamps



MODERN SWAMPS



WHERE WERE THEY FOUND?



PRESERVED AS FOSSILS



Ferns

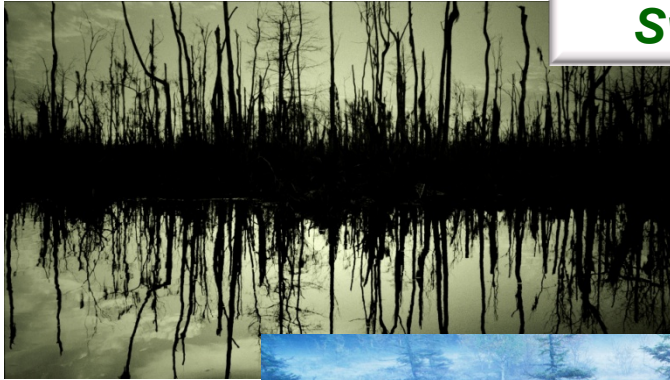


Glossopteris



Horse tails

PEAT



Swamp



Peat bog



Peat piled for burning

FOSSIL FUEL FACTS

- Over millions of years plants in the coal swamps died and were buried underwater with no oxygen.
- The dead plant material did not decompose forming peat.
- Burial of the peat created heat and pressure resulting in the peat being turned into coal.
- In South Africa peat is found in wetlands where it is protected.
- In the Northern Hemisphere peat is more common.
- Peat is can be burned or used as a potting soil, it is also used to grow mushrooms

LIGNITE

Lignite



Lignite Burning Power Station



FOSSIL FUEL FACTS

- Lignite or brown coal forms when peat is altered by relatively low temperatures and pressures over a long period of time.
- Lignite may still contain unaltered plant material.
- Fresh Lignite has a high moisture content (up to 66%) and a relatively low carbon content (20 - 35 %).
- Lignite contains many substances (volatiles) which turn into gas or smoke when burnt.
- We do not burn lignite in South Africa, but in other parts of the world it is burned in power stations.

BITUMINOUS COAL

Bituminous coal



Arnot Power Station

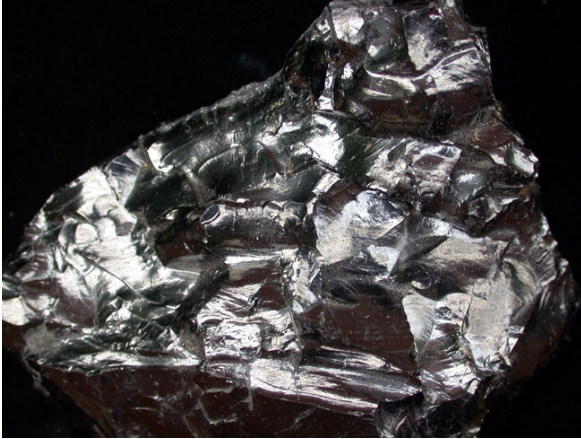


FOSSIL FUEL FACTS

- Bituminous coal is formed when lignite is subject to high pressures and temperatures.
- Bitumen is a type a sticky black tar-like substance.
- Bituminous coal is 60% to 80% carbon, together with substances like water, hydrogen and sulphur.
- Bituminous coal is the most common type of coal in South Africa. It is used for heating, cooking and in power stations.
- The high sulphur content of this coal can cause acid rain. Power stations need to “scrub” their waste gases to get rid of the sulphur.

ANTHRACITE

Anthracite



Clean burning



FOSSIL FUEL FACTS

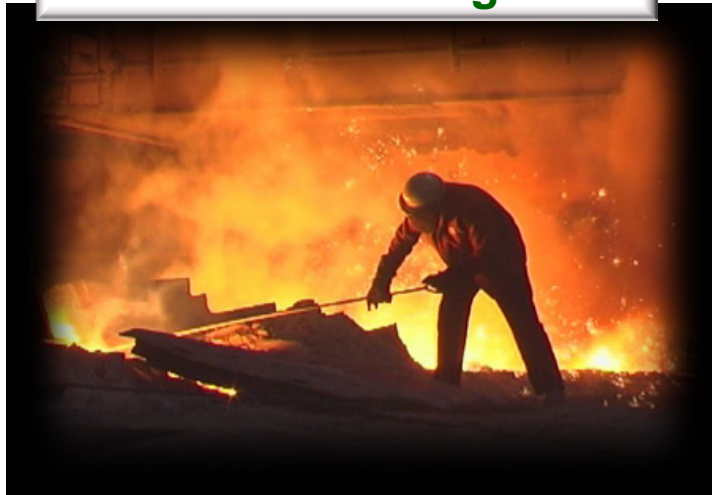
- Anthracite is formed when bituminous coal is subject to temperatures of between 150°C and 200°C .
- Anthracite is a type of metamorphic rock.
- It is harder and shinier than ordinary coal.
- Anthracite contains between 92 and 98% carbon. It produces hardly any smoke and can burn for days (unlike ordinary coal which burns out in hours).
- Anthracite is too expensive for power stations and is preferred for domestic heating and cooking because it is clean burning.

COKE (FUEL)

Coke



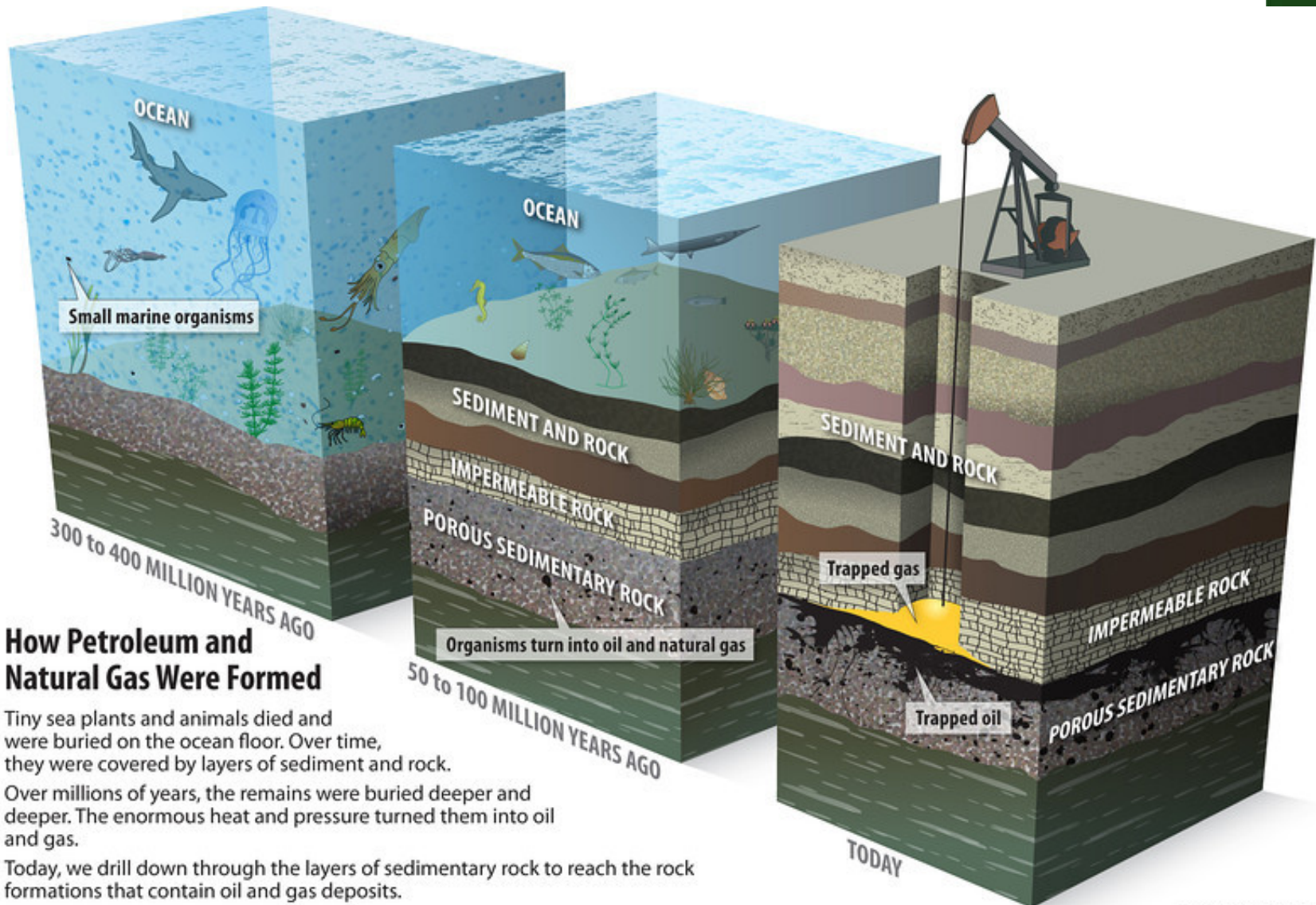
Iron Smelting



FOSSIL FUEL FACTS

- Coke is formed by heating low Sulphur bituminous coal in the absence of air at a temperature as high as 2000°C
- Coke burns cleanly at high temperatures
- Coke is specially useful in furnaces in the iron industry where it is used to reduce iron ore (Fe_2O_3) into iron.
- $2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2$

OIL AND GAS FORMATION



How Petroleum and Natural Gas Were Formed

Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of sediment and rock.

Over millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.

Today, we drill down through the layers of sedimentary rock to reach the rock formations that contain oil and gas deposits.

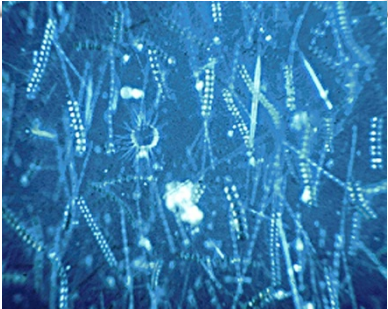
Note: not to scale

OIL AND GAS

The Ocean



Plankton



Diatoms



FOSSIL FUEL FACTS

- Oil is formed from fossilized plankton.
- A drop of Ocean water contain thousands upon thousands of tiny creatures called plankton which include:
 - Protists (e.g. copepods and algae including diatoms).
 - Larvae of jellyfish, starfish, sea-cucumbers and other animals.
- These tiny creatures die and form a thick sludge on the bottom of the ocean.
- Diatoms- can form a thick clay called diatomite which is used in toothpaste.
- The dead plankton sludge is buried and heated to form oil and gas.

DRILLING FOR OIL AND GAS

Drilling on land



Oil pump



FOSSIL FUEL FACTS

- Huge drilling rigs that can drill through thousands of metres of sediments are needed to drill for oil.
- The drill rigs can be found on land or on floating platforms at sea.
- Once the drillers have found oil they pump it out with special pumps



A floating oil platform

CRUDE OIL

An oil gusher



FOSSIL FUEL FACTS

- Oil pumped straight out of the ground is called **crude oil**.
- Crude oil is a smelly mixture of tar, oil, benzene and other substances including sulphur.
- When an oil drill strikes oil the crude oil may come gushing out, this is called a blowout and can be very dangerous.

NATURAL GAS



METHANE



OIL REFINERY

Oil refinery

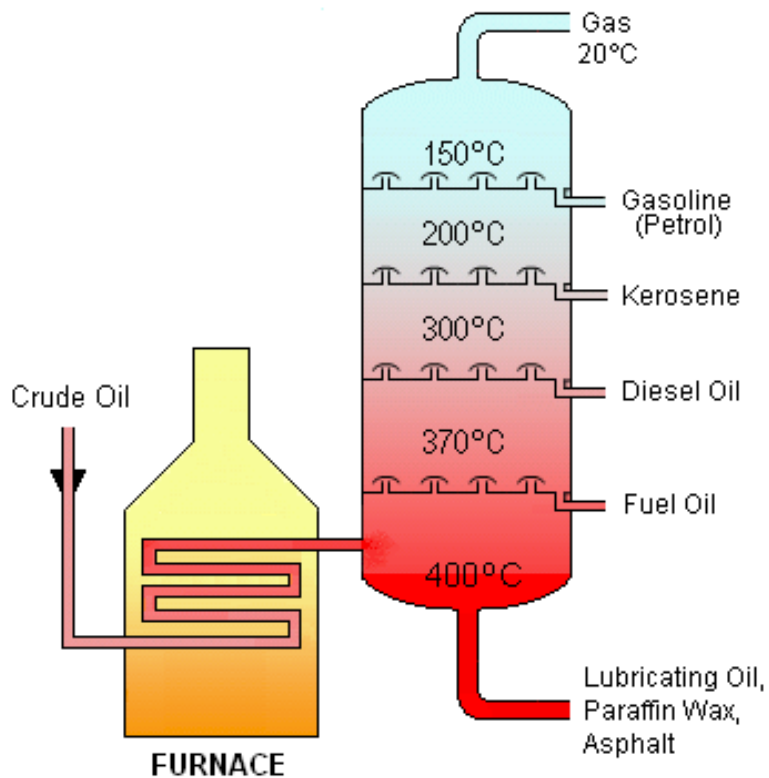


FOSSIL FUEL FACTS

- An oil refinery is a huge factory where crude oil is converted into other products like:
 - Tar (Bitumen)
 - Wax
 - Diesel
 - Petrol
 - Motor car oil
 - Gas
- The crude oil here comes from the Engen refinery in Durban

OIL REFINERY

Fractional Distillation



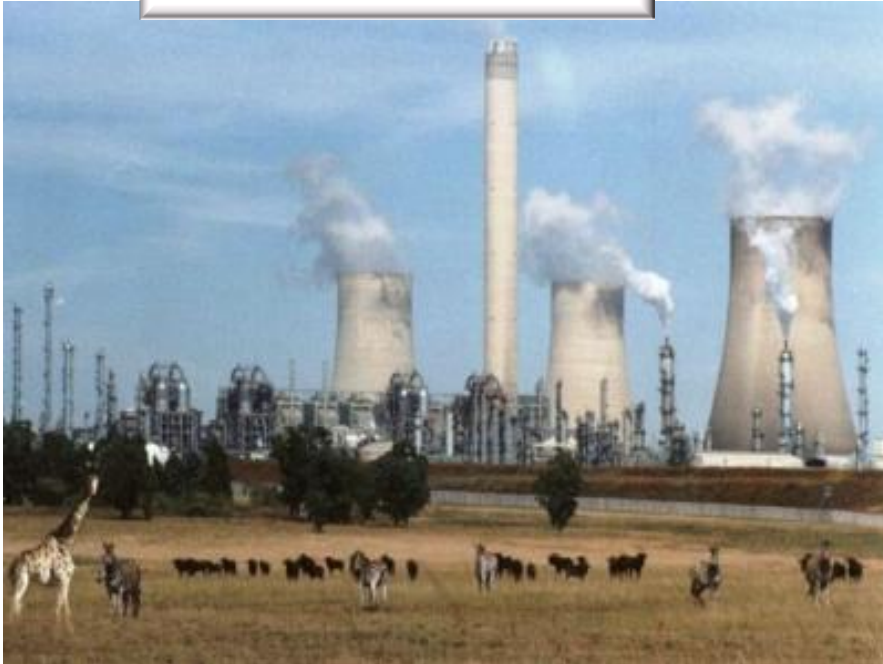
FOSSIL FUEL FACTS

● In an oil refinery a huge fractional distillation column is used to separate the crude oil into different parts:

- At lower temperatures (20°C) gas (LPG) separates.
- At 150°C petrol forms.
- Next at 200°C paraffin (kerosene) separates.
- At 300°C Diesel forms.
- At 370°C motor car oil separates.
- At 400°C Wax and road tar separate out.
- The products of crude oil can be turned in many types of chemicals and plastics.

SASOL

Sasol Plant



FOSSIL FUEL FACTS

- Since 1955 Sasol has had a factory that can turn coal into oil.
- Coal is heated with oxygen and steam under pressure to make carbon monoxide, hydrogen and methane gas.
- The gases are passed over an iron based catalyst to create:
 - LPG (Liquid Petroleum Gas), petrol, diesel, paraffin, motor car oil, waxes, alcohol and acetone
- Sasol can also turn natural gas into fuels
- Using natural gas and coal as a starting point Sasol produces over 300 types of chemical and
- many types of plastic.

IDENTIFY THE HYDROCARBONS

⦿ A

⦿ B

⦿ C

⦿ D


⦿ E

⦿ F

⦿ G

⦿ H

NON-RENEWABLE RESOURCES



NONRENEWABLE AND RENEWABLE RESOURCES

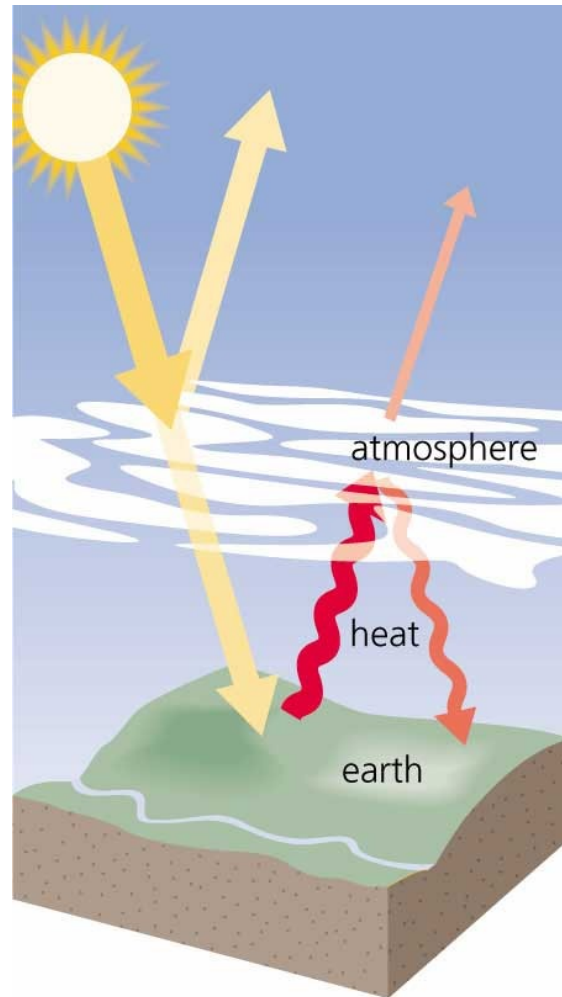
FOSSIL FUEL FACTS

- Fossil fuels are non-renewable resources.
- They took millions of years to form and once we have used them up they will be gone.

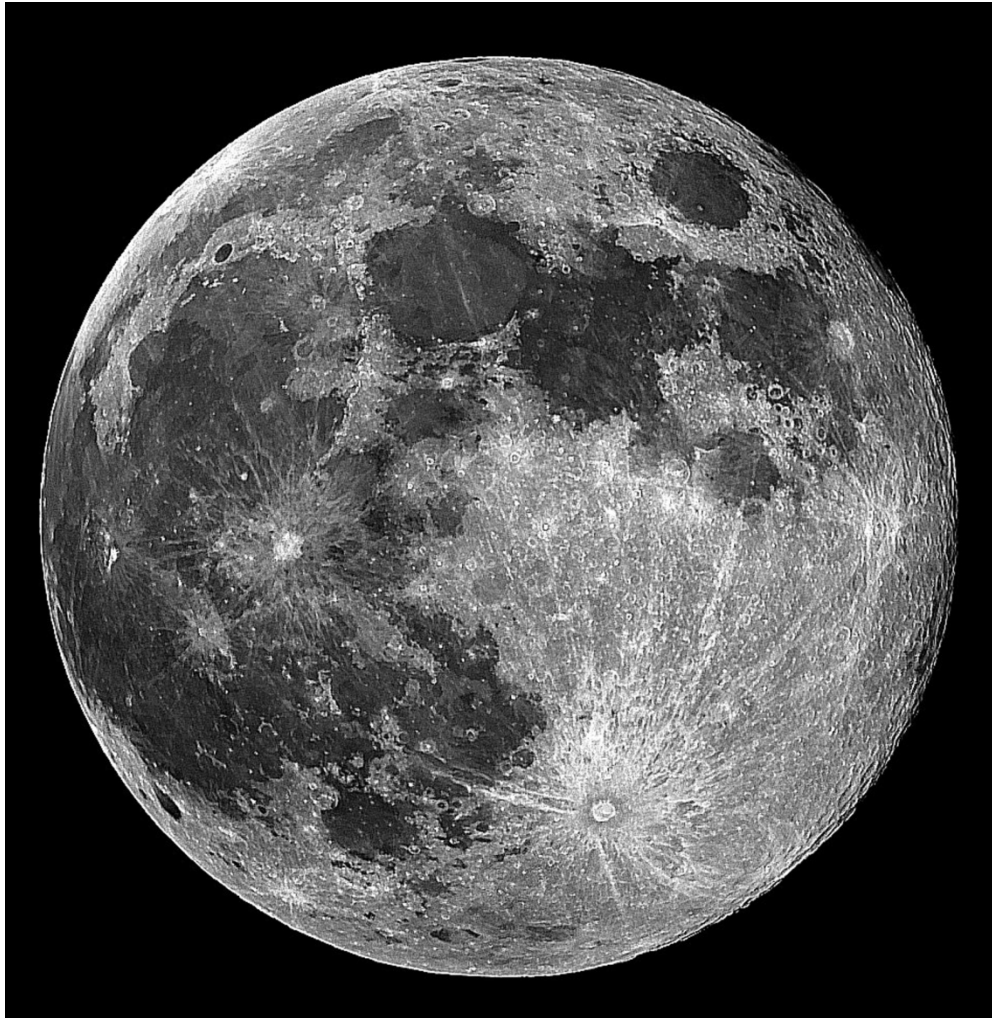
It has been estimated that we have 35 years of oil left, 37 years of gas left and 105 years of coal.

Calculating how long it will take to use up reserves of fossil fuel is complex because new reserves are being found as are new ways of extracting it

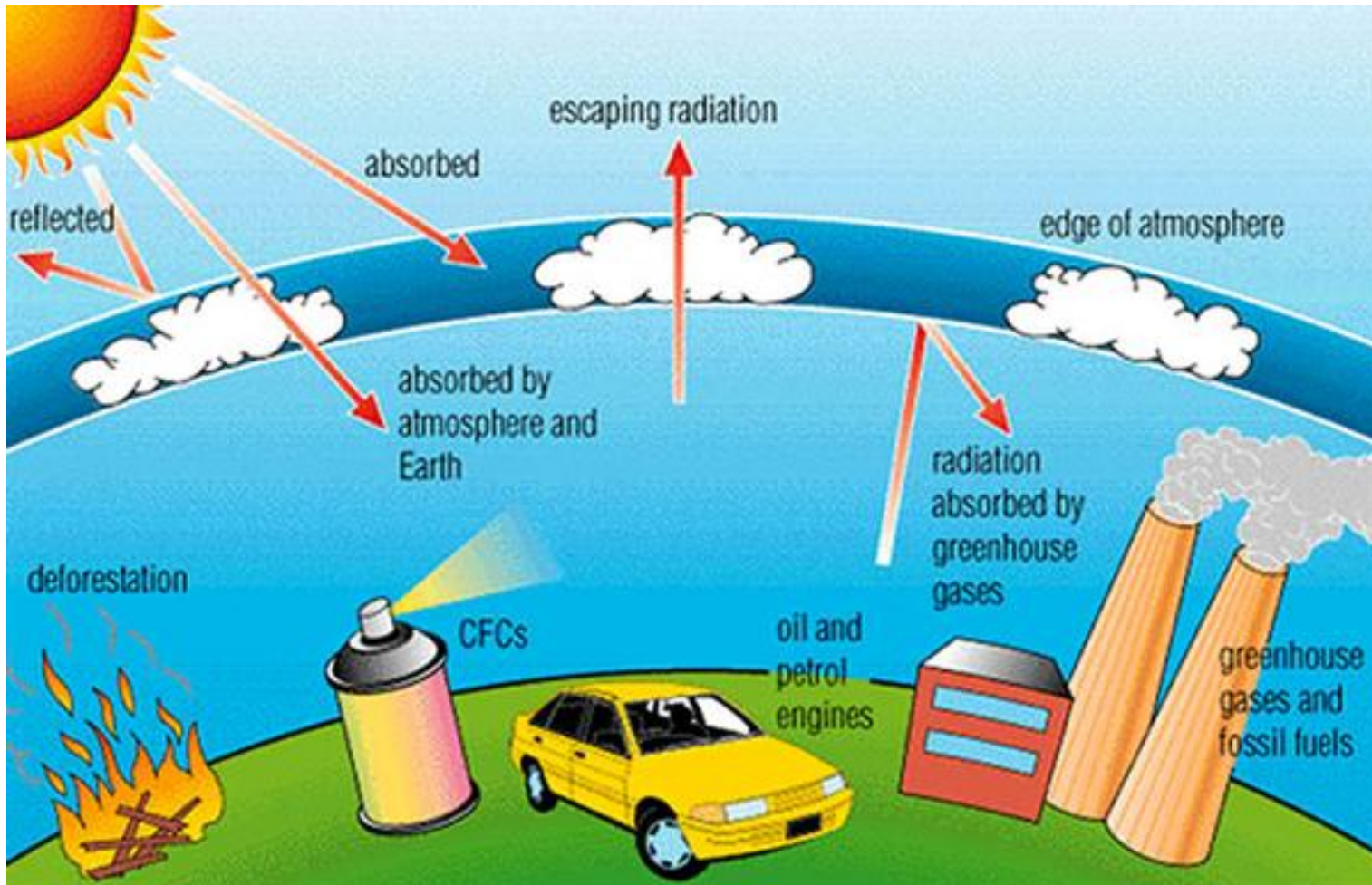
THE GREENHOUSE EFFECT



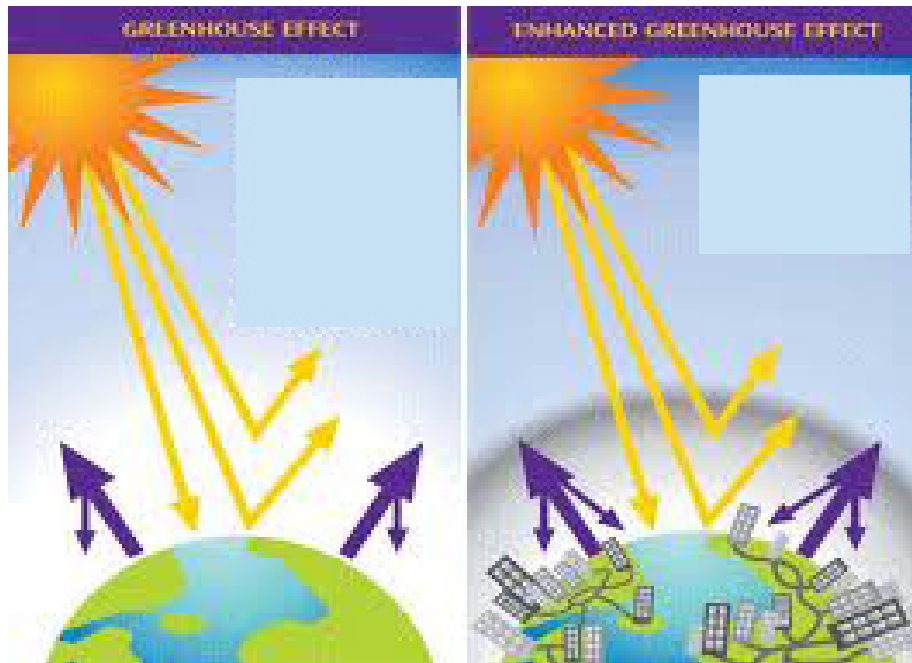
THE MOON



EFFECT OF METHANE AND CO₂



FOSSIL FUELS AND THE ENVIRONMENT



FOSSIL FUEL FACTS

- In 2006 humans produced **29,195.42** million metric tons of carbon dioxide from use of fossil fuels.
- It took millions of years for nature to take carbon dioxide out of the air and to store it in the Earth in the form of fossil fuels.
- Humans are releasing it back into the air in only a few hundred years.
- Increased concentrations of carbon dioxide together with other gases like methane are responsible for enhancing global warming.
- Burning of fossil fuels produces many other pollutants.

BEFORE GLOBAL WARMING

CO₂

CO₂

15.5 °C

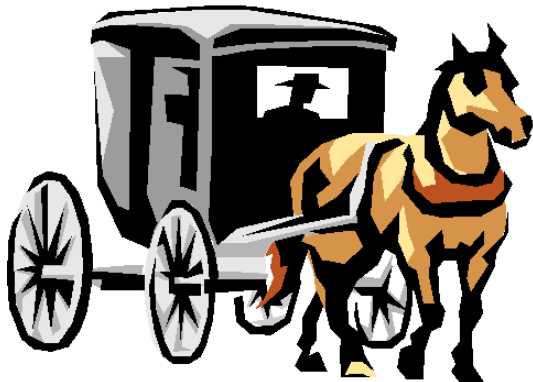
CO₂

Cool

CO₂

CO₂

CO₂



WITH GLOBAL WARMING

CO₂

CO₂

CO₂

CO₂

CO₂

CO₂

CO₂

CO₂

CO₂

CO₂

16.5 °C

CO₂

Warm

CO₂

CO₂

CO₂

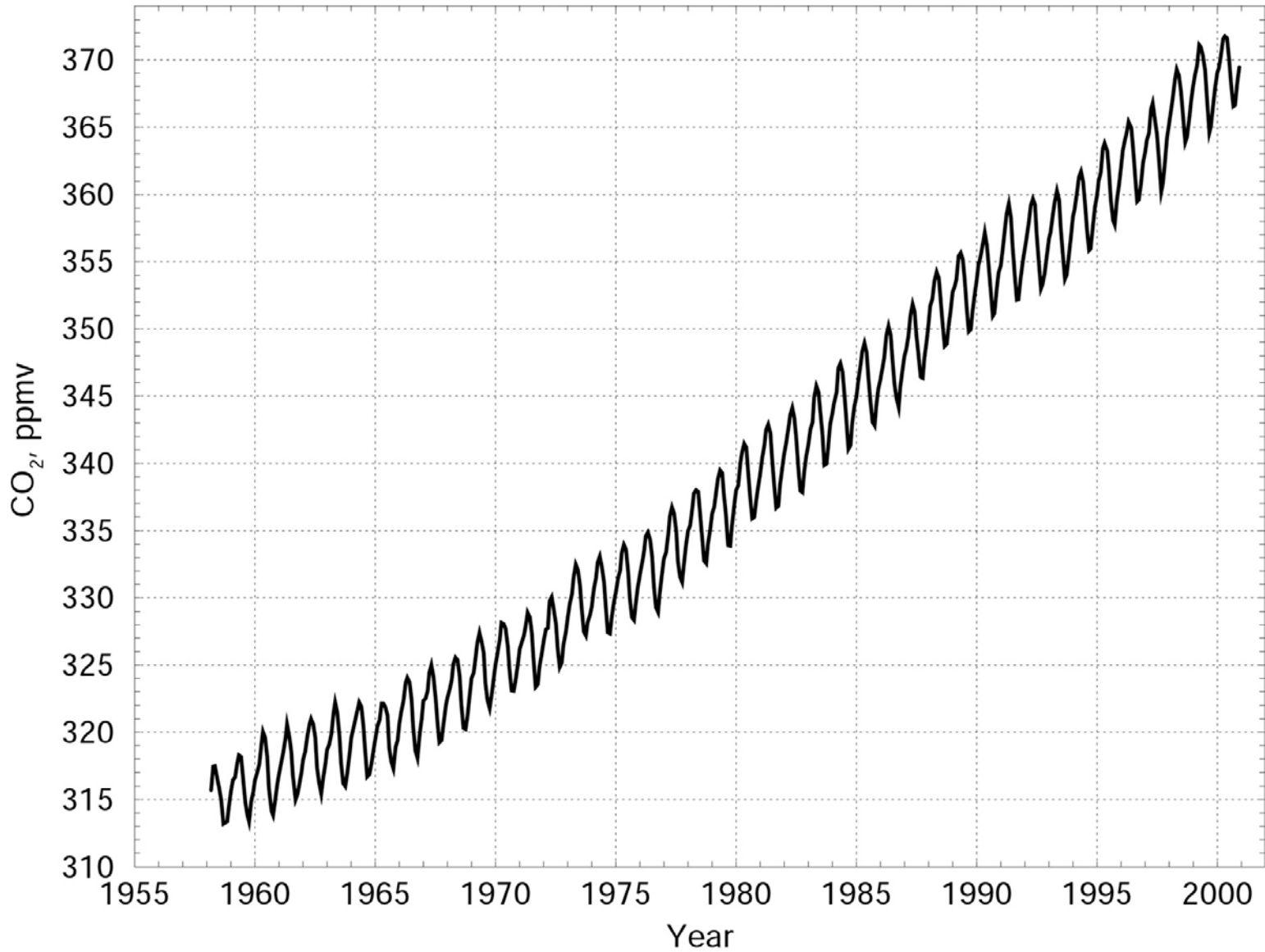
CO₂

CO₂

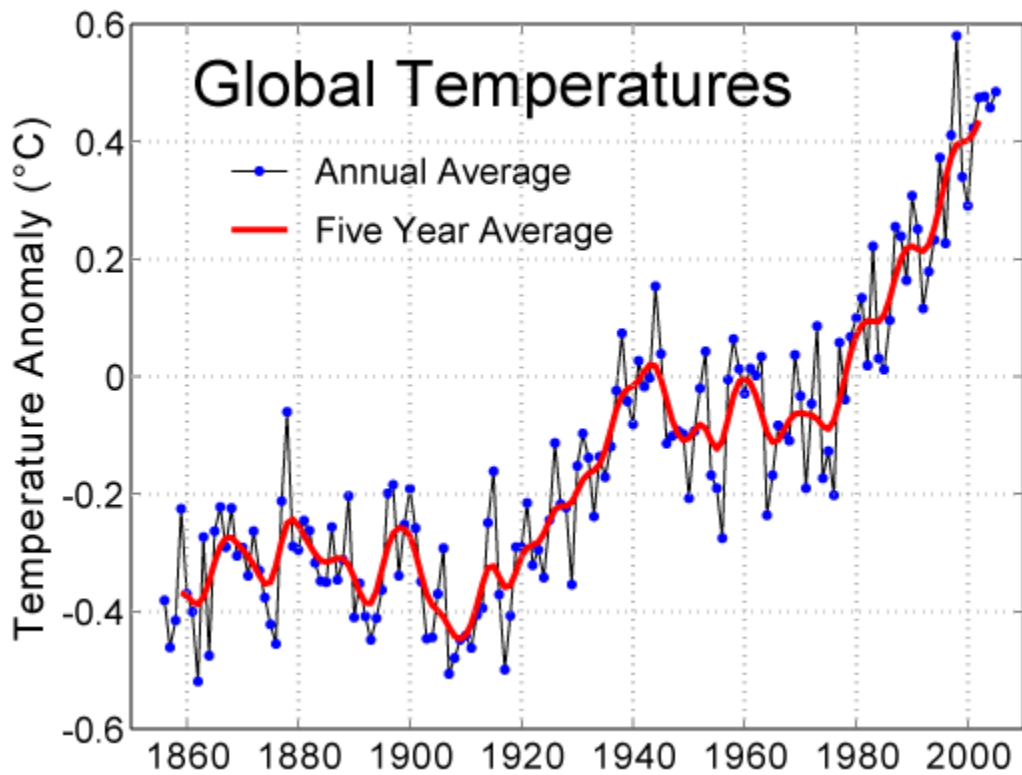
CO₂



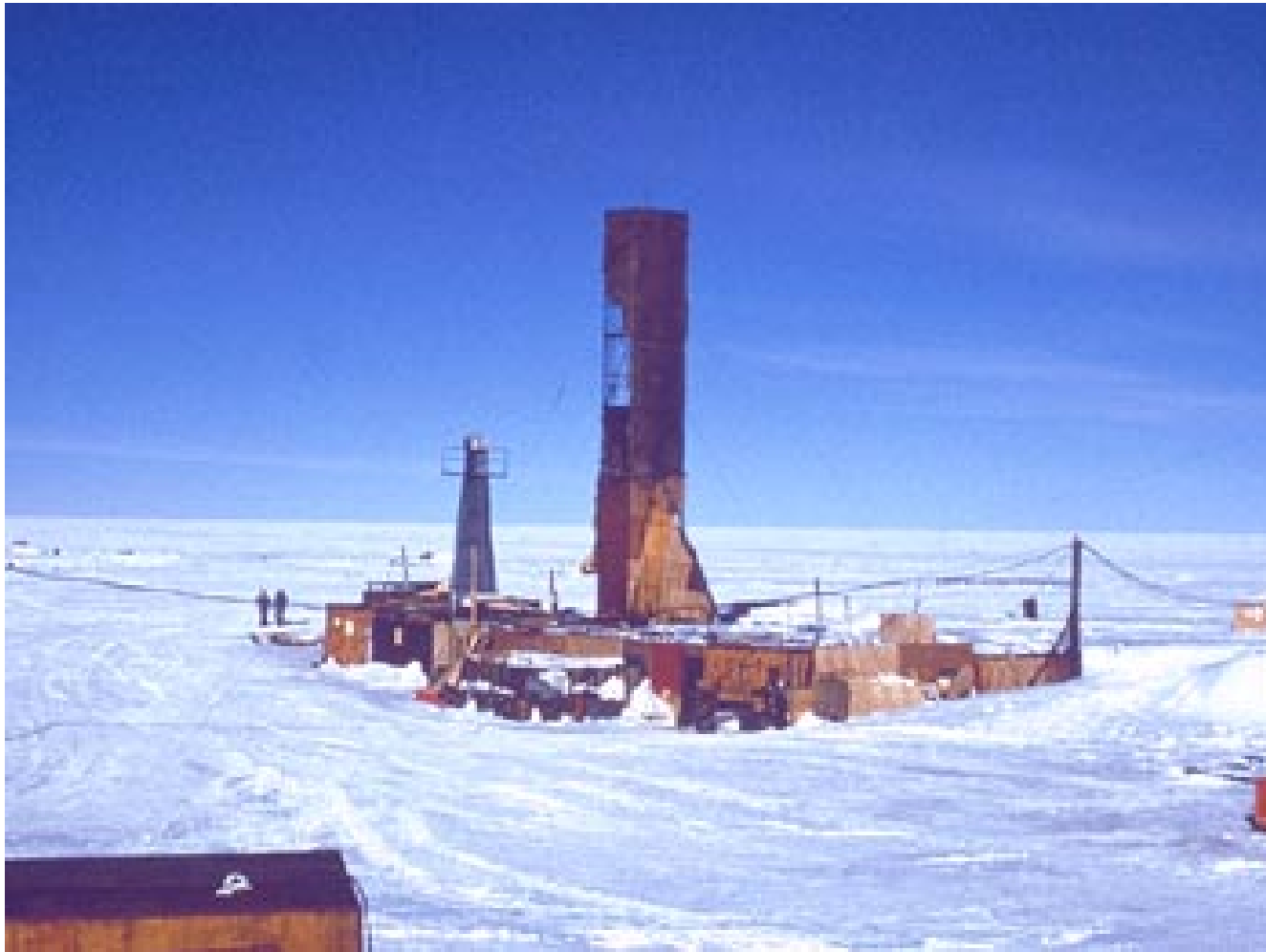
Carbon Dioxide at Mauna Loa, Hawaii



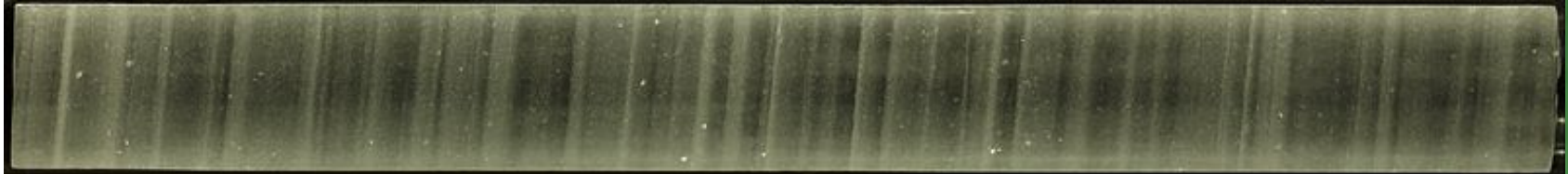
INCREASE IN TEMPERATURE



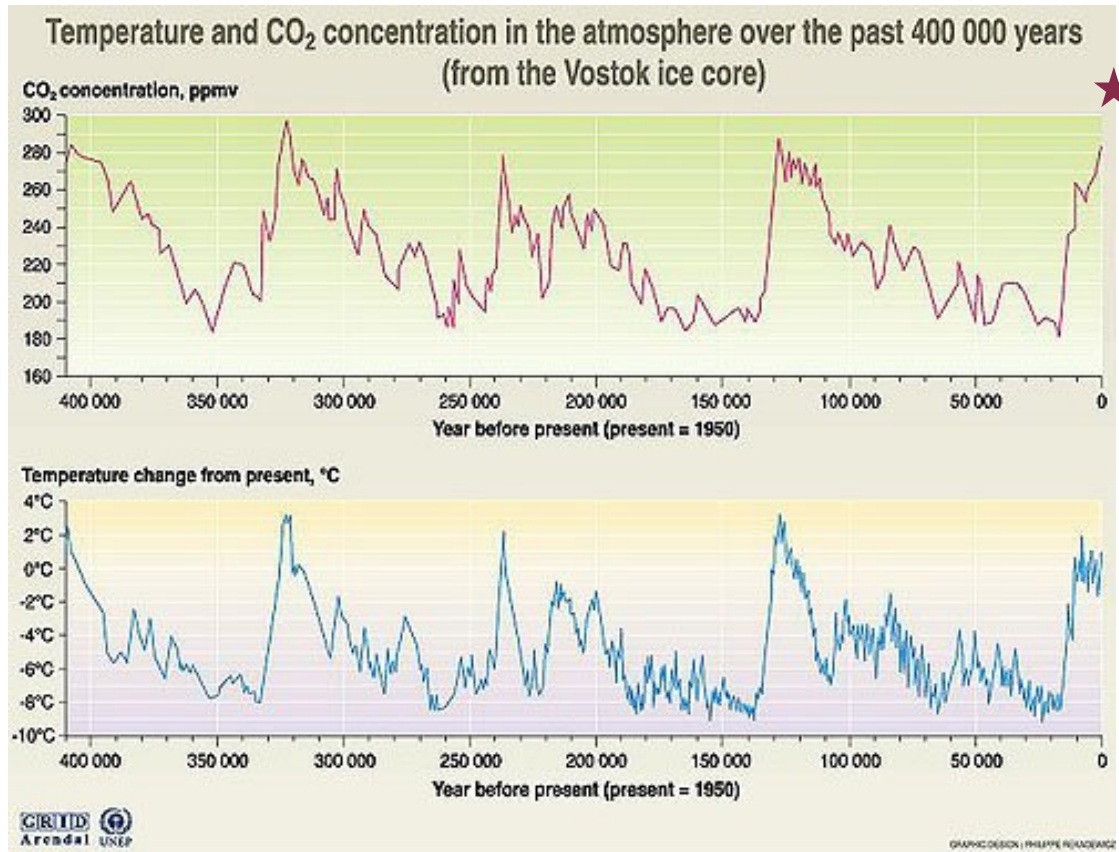
DRILLING IN THE ICE



VOSTOK ICE CORE



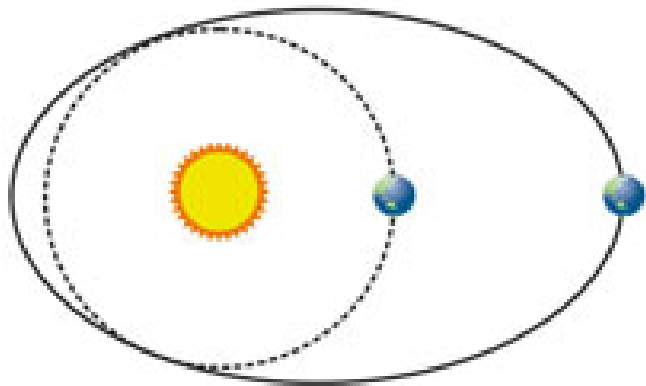
CO2 AND TEMP 400 000 YEARS



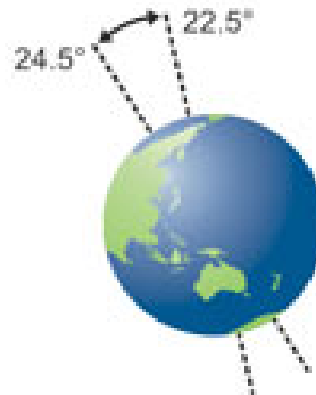
Source: J.R. Petit, J. Jouzel, et al. Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica, *Nature* 399 (3 June), pp 429-436, 1999.

MELANKOVITCH CYCLES

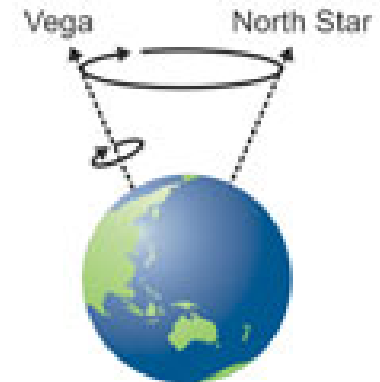
Milankovitch Cycles



Eccentricity

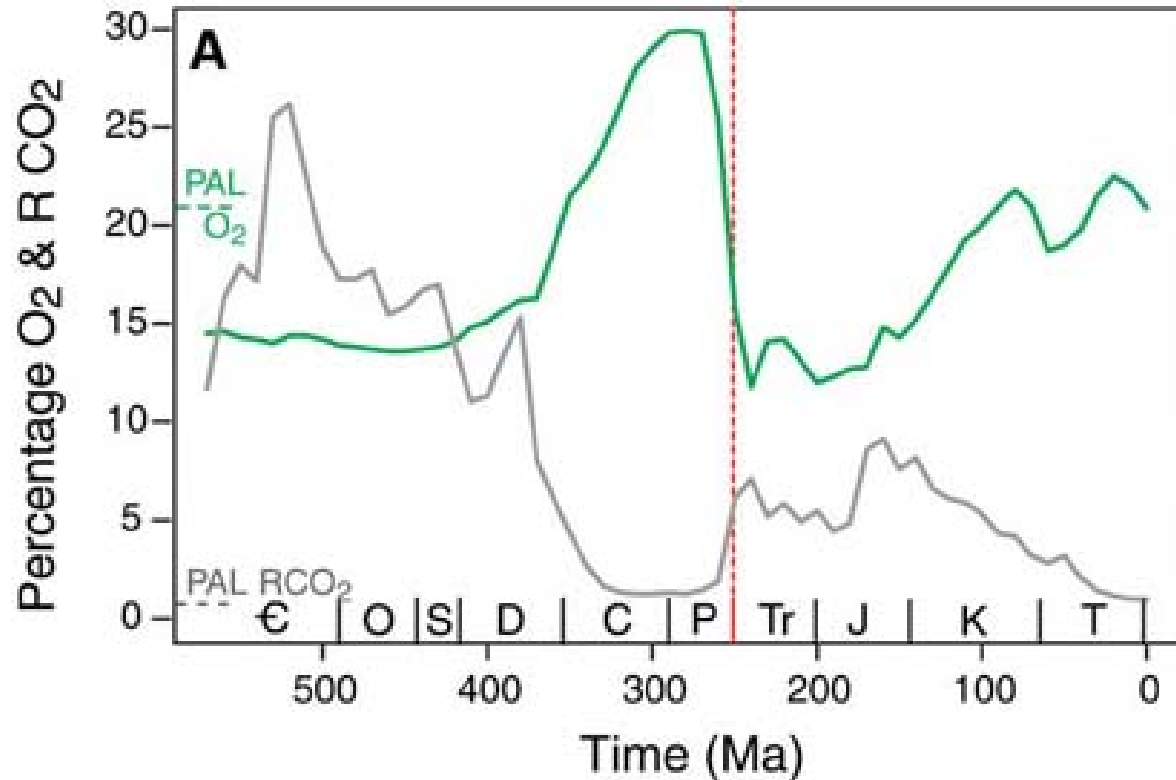


Obliquity



Precession

% OF O₂ AND CO₂ OVER TIME



EFFECTS OF CLIMATE CHANGE

Melting Ice
Caps
High Sea levels
More extreme
weather:

- Hurricanes
- Droughts
- Storms



Sustainable/small carbon footprint

Practical

Not Practical

Not sustainable/ big carbon footprint





anward
WARM YOUR LIFE

















