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LECTURE - 2

→ Paleoclimatology – The study of past climates. This is most often done by examining the physical, chemical or biological properties of a sequence of sediments. In various parts of the world, marine sediments, lake sediments, peat bogs, corals, ice cores, speleothems (stalagmites & stalagtites) and tree rings are studied. For more ancient times, fossils found in sedimentary rocks can indicate what past environments were like.

→ Ice cores – These are long cylinders of ice that are drilled out of glaciers and permanent polar ice sheets, where ice builds up year after year without melting. Most cores come from Antarctica, Greenland, or high ~~altitudes~~ altitudes in the Andes and Himalayas (i.e. Undisturbed Regions).

→ Snow crystals compact until they form a solid ice matrix, trapping tiny air bubbles. These bubbles contain gases from our atmosphere long ago. A sample representing a specific period is crushed into small pieces to allow gas to escape. The gases are separated by gas chromatography. CO_2 concentration is measured by infrared spectroscopy or mass spectroscopy.

→ Isotopic ratios from ice cores ~~are~~ are used as proxy data for measuring past temperatures.

→ Elements with same atomic number but different atomic mass are isotopes. Approx, one in every 500 water molecules contain heavier isotope of oxygen; an even smaller fraction of molecules contain heavier isotope of hydrogen (deuterium).

→ We take these isotopic ratios. Eg: O(18u)/O(16u). Now, heavier molecules have lower vapour pressure, which means they evaporate less readily than regular water molecules. Hence, in colder temperatures, ratio is less than in hotter temperatures. This principle allows isotope ratios from ancient ice to be used as proxy for temperature data.

→ Methane sources - some can be traced back to non-biological sources, including volcanic eruptions and serpentinization reactions on the ocean floor. However, 90-95% methane on Earth has biological origin.

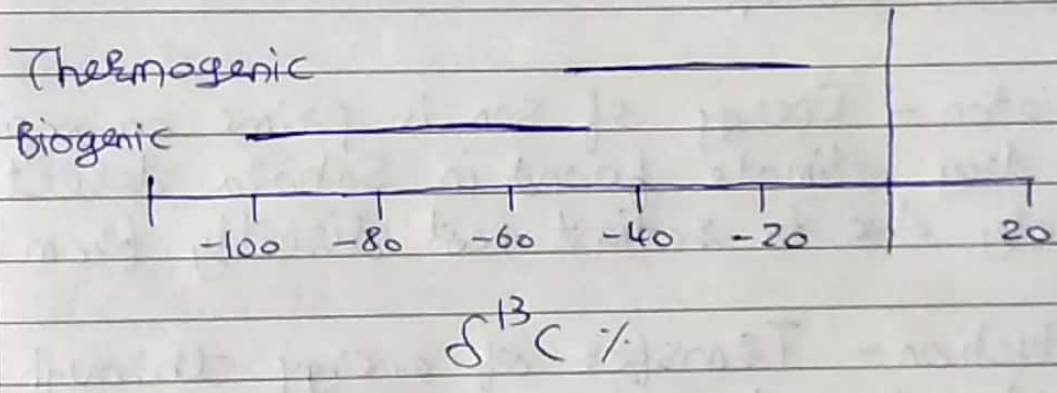
→ Two main types of biological methane - Thermogenic & Biogenic.
Thermogenic methane is produced deep in the ground from buried remains of organisms, which gradually become fossil fuels after being exposed to heat & pressure for centuries (biggas)
Biogenic methane is produced by methanogens, methane producing micro-organisms that are usually found in anaerobic environments.

→ Using, carbon isotopic ratios, it is determined whether methane is thermogenic or biogenic.

$R_{standard} = \frac{^{13}C}{^{12}C}$ (standard ratio)

R_{sample} = Isotopic ratio calculated experimentally.

$$\delta^{13}C = \left(\frac{R_{sample} - R_{standard}}{R_{standard}}\right) \times 1000$$



→ There are three types of energy transfer that play a role in kinetic processes.

① Convection – Transfer of energy by the movement of molecules in fluids (liquids or gases that flow). Lizards feel convection as a cool breeze.

② Radiation – Transfer of energy by electromagnetic waves. Lizards feel radiation from rays of visible and ultraviolet light coming from sun.

③ Conduction – Transfer of energy through direct contact and collisions between neighbouring molecules.

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lizard feels heat energy transferring directly from the warm rock to his underbelly, increasing the average kinetic energy of the particles that make up his body.

→ Examples:

Convection- Wind & Ocean currents are both media for the convection of energy. The Gulf Stream plays a large role in warming Northern Europe.

Radiation - Energy of Sun is prime example. Hot, dry climate found in Sahara desert is largely due to radiant heat directly from sun.

Conduction - Transfer of energy through soil. Particles in soil collide with each other directly, transferring kinetic energy.

→ Greenhouse model -
A greenhouse maintains a comfortable temperature by absorbing radiant energy from sun, emitting infrared energy (heat) and preventing loss of heat through convection. However, Earth's atmosphere does not trap heat by stopping convection like a greenhouse, rather 'greenhouse gases' in our atmosphere absorb outgoing energy & reradiate it back towards Earth, transferring energy into nitrogen, oxygen, increasing their kinetic energy.

→ Blanket model:
The atmosphere acts like a blanket and hence keeps the Earth warm by preventing convection of heat energy.

→ Characteristics of the gases that affect their behaviour – atomic mass, constituent atoms, distribution of positive & negative charge, strength of their bonds.

→ How is an atmospheric CFC molecule affected by

(a) UV radiation: A bond in the CFC molecule breaks apart.

(b) IR radiation: Causes stretching and bending of the bonds in CFC.

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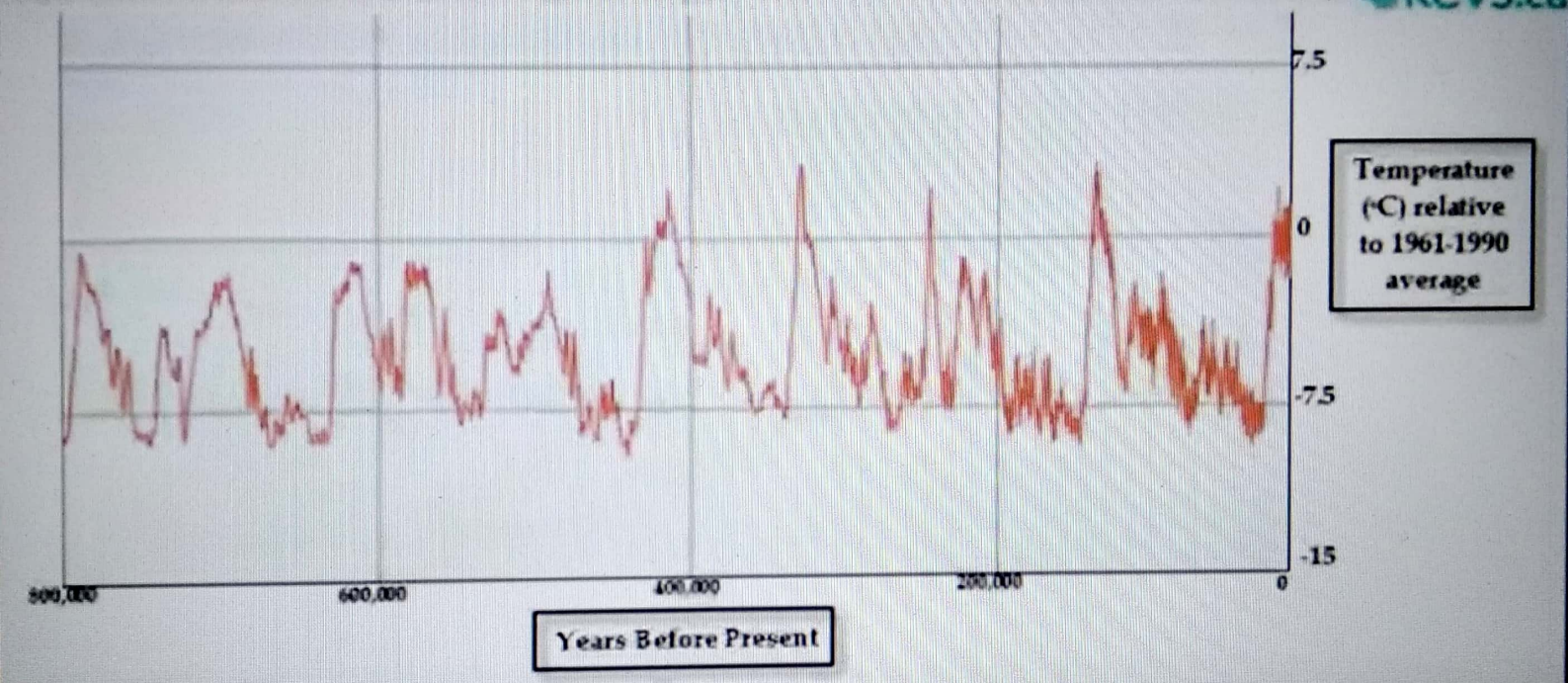

The cooler periods on this graph correspond to ice ages or glacial periods, when much of the northern hemisphere was covered by thick sheets of ice. The warmer regions of the graph indicate interglacial periods.

Although the planet's climate has always fluctuated, the rate of change has become more dramatic since the Industrial Revolution. This suggests that recent changes have anthropogenic origins.