

MICROPALAEONTOLOGY

IN

HYDROCARBON EXPLORATION

B.SC. SEM-3
GE-3
DEPT. OF GEOLOGY
DSPMU, RANCHI

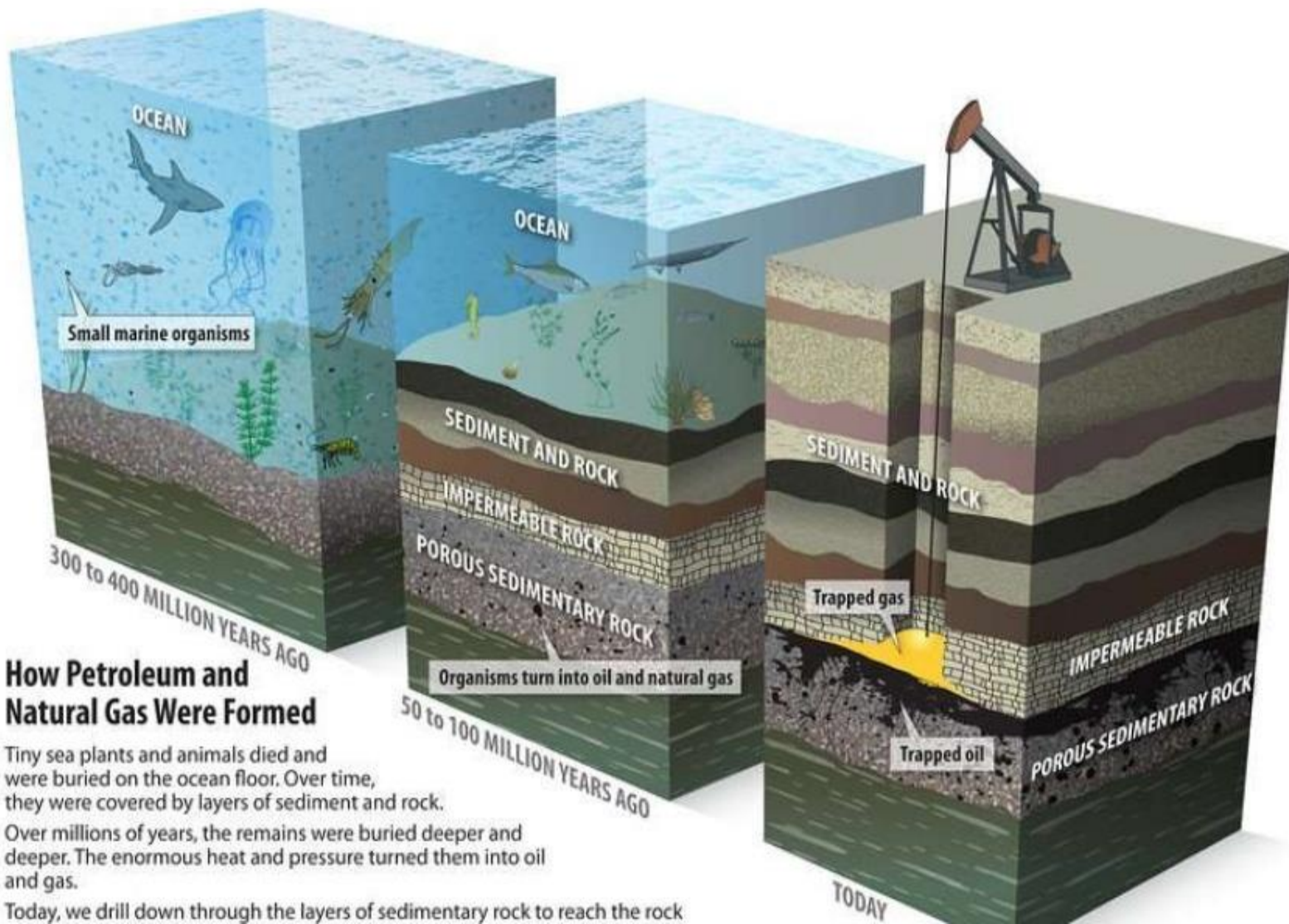
Petroleum formation

- ❖ M.V. Lomonosov laid down the fundamentals of the organic theory of origin of oil. He was the first to suggest the hypothesis of formation of coal from peat through its coalification caused by increasing pressures and temp.
- ❖ Through this theory, it is generally accepted that the living material from which petroleum was formed consisted of millions of foraminifera, diatoms and radiolaria etc.
- ❖ Petroleum formation occurs by various hydrocarbons combining with certain minerals such as sulphur under extreme pressure.

Cont.....

- ❖ When small sea plants and animals die they will sink; they will then lie on the sea bed where they will decompose and mix with sand and silt.
- ❖ These sediments prevented the dead bodies from rotting away completely and thus they subject these remnants to the action of anaerobic bacteria.
- ❖ This bacterial action leads to the final transformation of the fatty contents of these organisms into minute droplets of petroleum.

Formation of Petroleum and Natural Gas

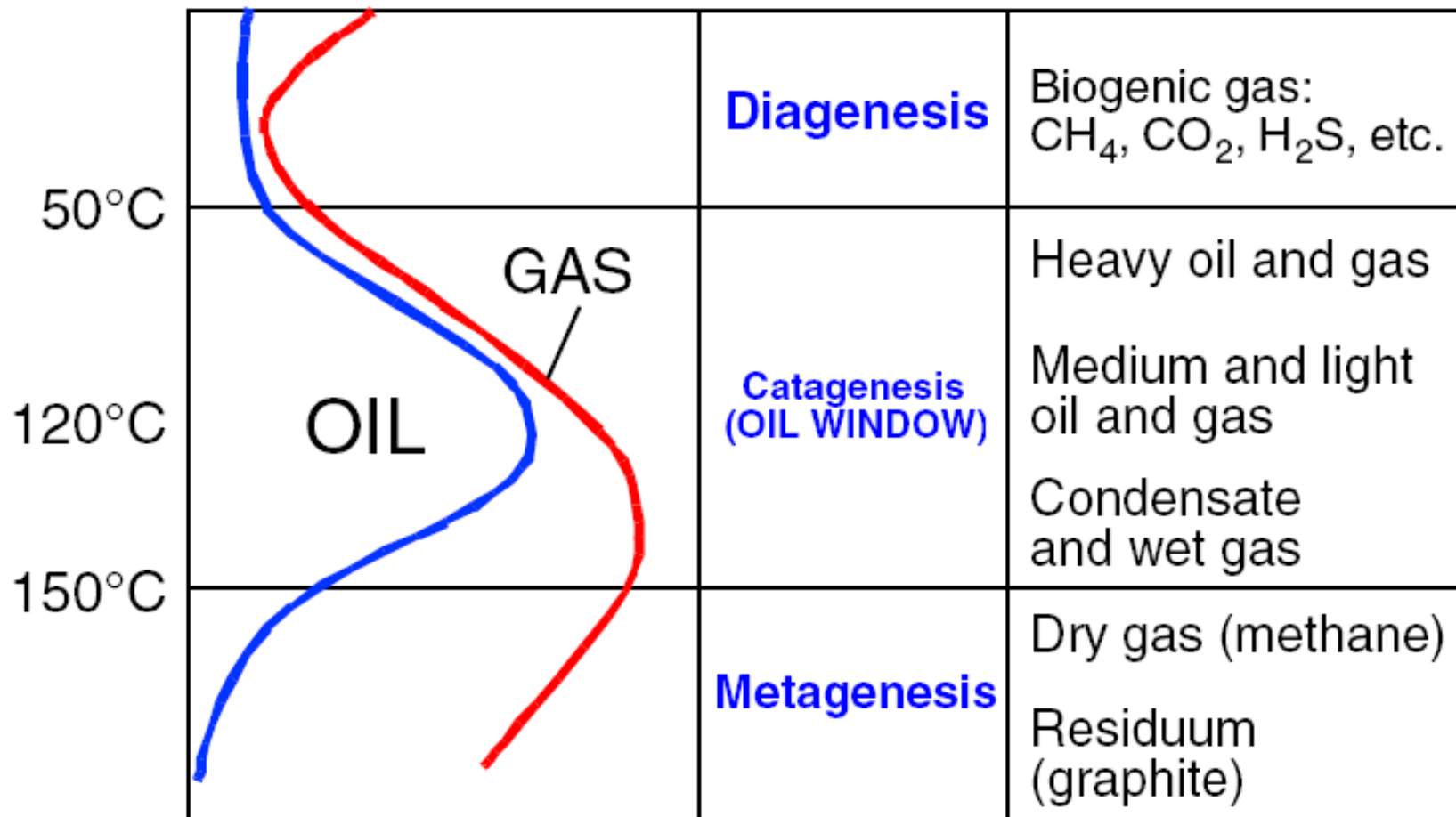


How Petroleum and Natural Gas Were Formed

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



The oil window

Environmental significance

Most of the microfauna can be of great help in visualising the environment (Provenance) at the time of their deposition. Examples are:

- 1. Lacustrine environment:** diatoms, sponge spicules and also rare occurrence of foraminifera.
- 2. Littoral environment:** we encounter sessile foraminifera and ostracods.
- 3. Lagoonal environment:** spores and pollens, conodonts, arenaceous and porcellaneous foraminifera.

Introduction to microfossil

Microfossil comprise the remains of once living bacteria, protists, plants and animals and in some cases fragments of larger organisms. eg:conodonts.

Some of the important microfossil involved in oil exploration are

Diatoms: unicellular algae which are characterised by an external skeleton comprising two valves, one overlapping the other like the lid of a pill box.



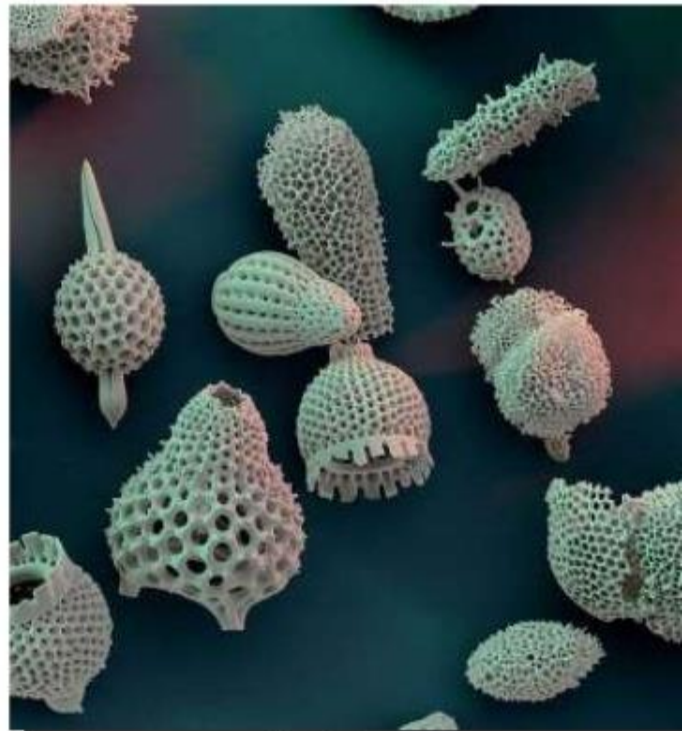
Coccolithophores: they are unicellular and predominantly autotrophic nanoplankton (commonly 5-60 micrometers in size). The cell is surrounded by protective armour of tiny calcareous scales called coccoliths.



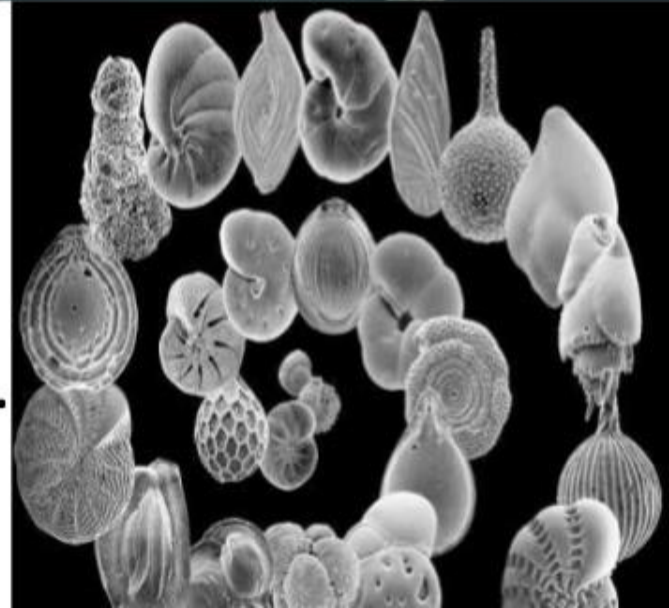
Conodonts: tooth-like fossils typically less than a millimeter long.



Radiolaria: they are marine protozoans. The fossil forms are made of opaline silica. The more advanced forms of radiolaria have lattice skeletons with complex geometry.

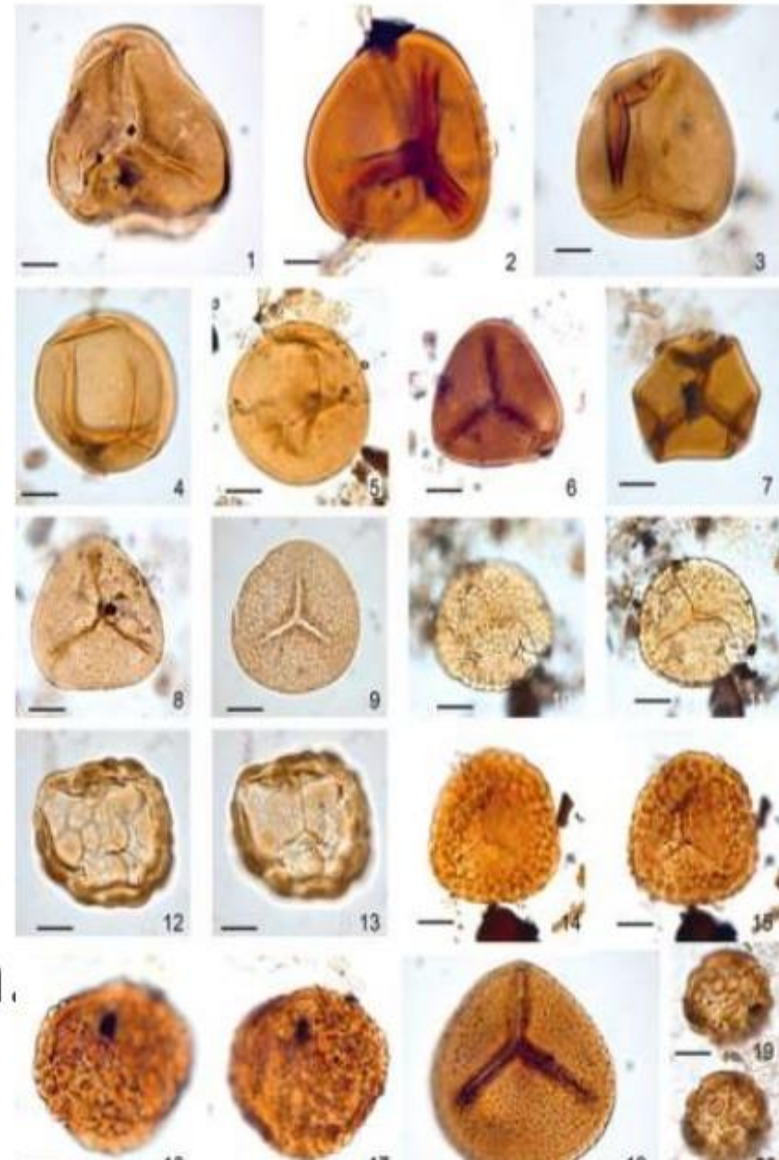


Foraminifera: protozoans with a test consisting of one or more chambers each interconnected by an opening (foramen) or several openings (foramina).



Spores and pollens: they are produced in large numbers and can be carried over long distances by wind or water before they settle down and get deposited.

Source for Hydrocarbon also navigates for exploration.

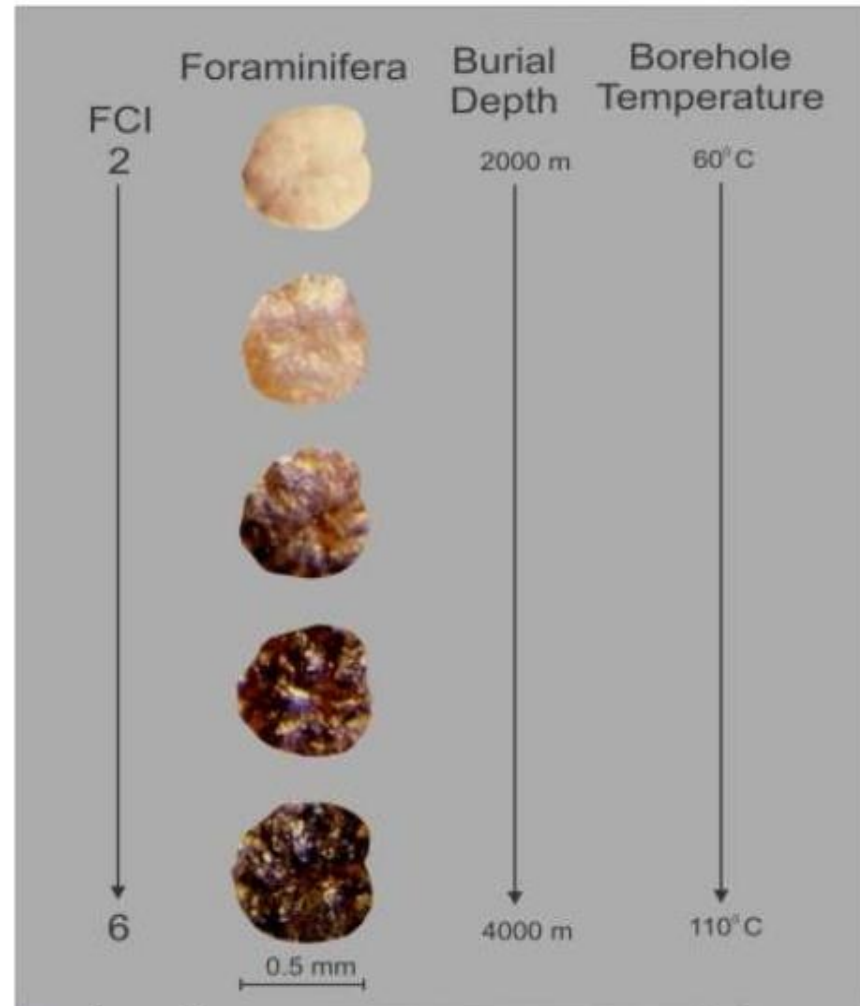


Role of microfossil in fossil fuel exploration













- ❖ Microfossils have many application to Petroleum Geology.
- ❖ Three microfossil which are of particular importance to hydrocarbon exploration are: Foraminifera, Calcareous Nannofossils and Palynomorphs.

Foraminifera

- ❖ Foraminifera have many uses in [petroleum exploration](#) and are used to interpret the ages and paleoenvironments of sedimentary strata in oil wells.
- ❖ Agglutinated fossil Foraminifera buried deeply in sedimentary basins can be used to estimate thermal maturity, which is a key factor for petroleum generation.
- ❖ The [Foraminiferal Colouration Index](#) (FCI) is used to quantify colour changes and estimate burial temperature. FCI data is particularly useful in the early stages of petroleum generation ($\approx 100^{\circ}\text{C}$)



Conodont Alteration Index (CAI)

CAI 1	CAI 1.5	CAI 2	CAI 3	CAI 4	CAI 5
					
					
Immature To Peak Oil	Peak Oil	Peak Oil to Condensate	Condensate to Dry Gas	Dry Gas to Metamorphic	Metamorphic

Late Ordovician conodont elements showing experimentally induced color alteration (from Epstein, et al., 1977).

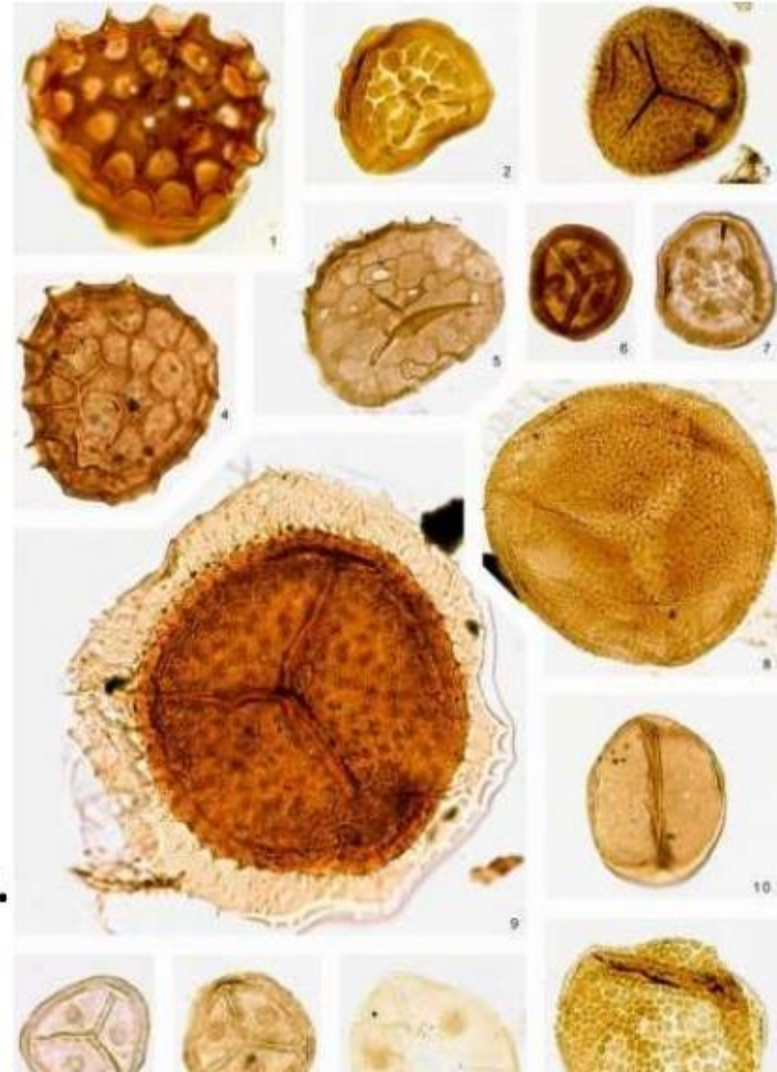
Calcareous nannofossils

- ❖ These are extremely small objects (less than 25 microns) produced by planktonic unicellular algae
- ❖ Coccolithophores, planktonic golden brown algae that are very abundant in the world's oceans.
- ❖ The calcareous plates accumulate on the ocean floor, become buried beneath later layers, and are



Palynomorphs

- ❖ Spores and Pollens are transported by wind and water and can travel long distances before final deposition.
- ❖ Organic chemicals comprising Palynomorphs get darker with increased heat.
- ❖ Helps to assess the temp. to which a rock sequence was heated during burial and thus it is useful in predicting whether oil or gas may have formed in the area under study.



Conclusion

- ❖ Ooze is a pelagic deep-sea sediment of which at least 30% is composed of the skeletal remains of microscopic floating organisms.
- ❖ The different types of fossils fuels are Coal, Oil and natural gas and even CBM gas.
- ❖ Some of the important microfossils involved in oil exploration are Diatoms, Coccolithophores, Radiolaria, Foraminifera, Conodonts and Palynomorphs.
- ❖ The Foraminiferal Colouration Index(FCI) is used to quantify colour changes and estimate burial temperature.
- ❖ Sediment maturation is checked for hydrocarbon investigation before any exploration.

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- ❖ Oil exploration & production companies are in Asia, Africa, America, Australia, Oceania & Europe. In India the companies include Gujarat State Petroleum Corporation, Oil and Natural Gas Corporation, Oil India etc.
- ❖ ONGC is currently exploring Coal Bed Methane in Singrauli, Madhya Pradesh and north of Godavari valley in Andhra Pradesh.

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