

Formation of Source Rocks



Million of Years

Dr. Ali Kahal – 2024 – KSU

Formation of Source Rocks

Petroleum System

A Petroleum System is defined as a natural system comprising an active source rock and all associated oil and gas, along with essential geological elements and processes necessary for the existence of a hydrocarbon accumulation.

Elements

Source Rock

Fine-grained, organic-rich that have the potential to generate petroleum

Migration Route

It is the cracks, faults and pores in the rocks through which oil and gas move.

Reservoir Rock

Subsurface rock and sediment materials characterized by porosity and permeability, to allow the migration and accumulation of petroleum hydrocarbons

Seal Rock

A unit with low permeability that impedes the escape of hydrocarbons from the reservoir rock

Trap

A geological structure where petroleum accumulates within a layer (formation) of sedimentary rock and cannot move out of it

Processes

Generation

Burial of source rock to temperature and pressure regime sufficient to convert organic matter (kerogen) into hydrocarbons

Migration

Migration is the process of the oil and gas moving away from the source rocks

Accumulation

Hydrocarbons migrate into a trap faster than the trap leaks, forming a reservoir

Preservation

Hydrocarbons remain in the reservoir and are not destroyed by biodegradation or overheating

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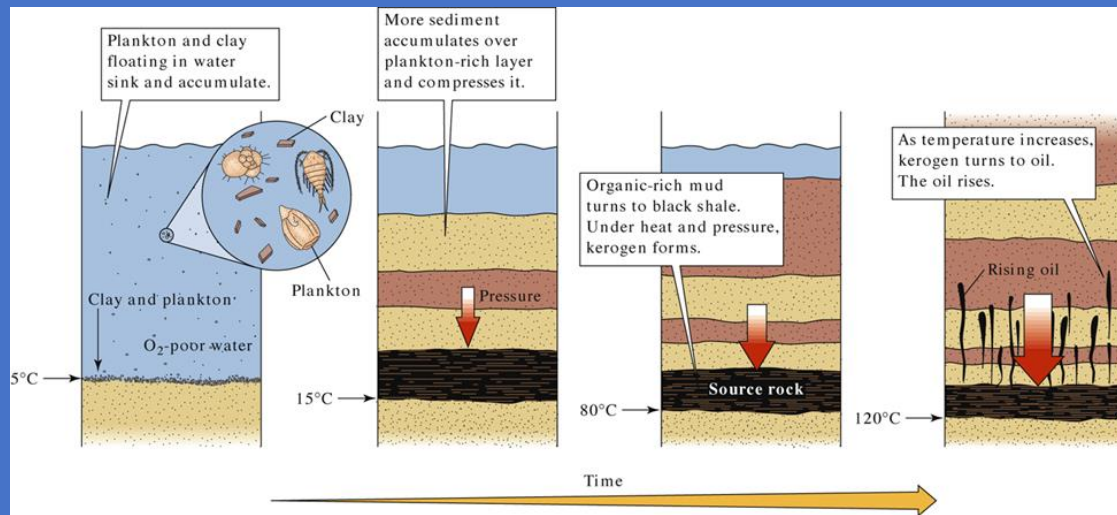
□ Formation of Source Rocks

- All marine organic material is formed near the surface of the ocean, in the photic zone, through photosynthesis.
- Some phytoplankton are broken down chemically and oxidised and some are eaten by zooplankton.
- On the bottom, organic matter will be subjected to breakdown by micro-organisms (bacteria).
- It will also be eaten by burrowing organisms which live in the top portion of the sediments.
- The activity of these organisms contributes to reducing the organic content of the sediments because most of the organic matter is digested when the sediment is eaten.
- Bioturbation also stirs up the sediments, exposing them more to the oxygen-bearing bottom water. However, if the bottom water is stagnant, the lack of oxygen and the toxicity of H₂S will exclude most life forms.
- The resultant lack of bioturbation will thus preserve more organic matter in the sediment together with perfect, undisturbed, lamination.
- Except where the water is completely stagnant, slow sedimentation rates will result in each sediment layer spending longer in the bioturbation and microbiological breakdown zones, and consequently less organic matter will be preserved in the sediment.
- Rapid sedimentation leads to more of the deposited organic matter being preserved but from the outset it will be highly diluted with mineral grains.

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Black Shale

- Regulation of organic carbon and black shale development by multi-sphere interactions
- The formation and preservation of black shale are the result of interplays between biological activity, marine environment and sedimentary evolution.



The Kimmeridge Clay is a Black Shale with up to 50% organic matter. It is the main source rock for the North Sea Oil & Gas Province

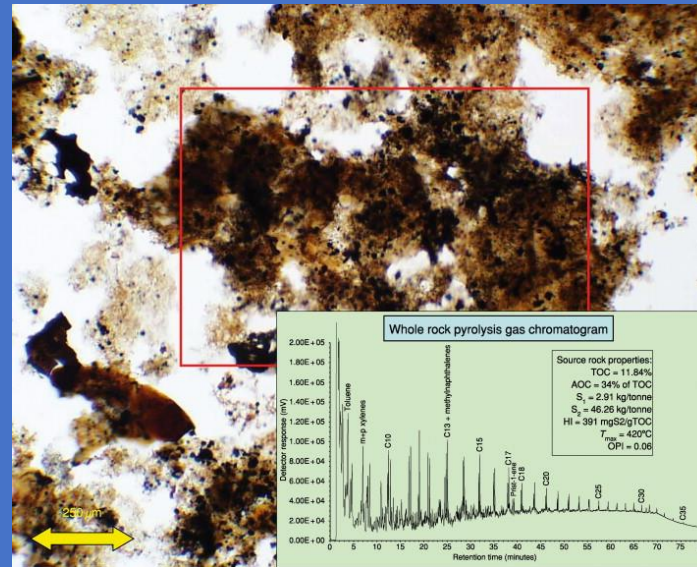
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□ Kerogen

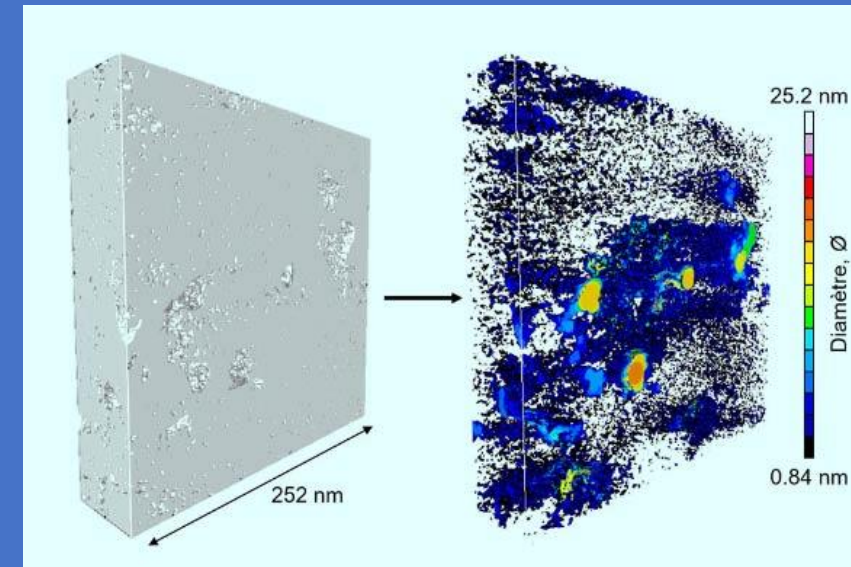
- Kerogen is solid, insoluble organic matter in sedimentary rocks. Consisting of an estimated 1016 tons of carbon, it is the most abundant source of organic compounds on earth. It is insoluble in normal organic solvents and it does not have a specific chemical formula. Upon heating, kerogen converts in part to liquid and gaseous hydrocarbons. Petroleum and natural gas form from kerogen. Kerogen may be classified by its origin: lacustrine (e.g., algal), marine (e.g., planktonic), and terrestrial (pollen and spores).



Kerogen



Kerogen



Electron tomography, a sample of kerogen to determine its internal structure.

Formation of Source Rocks

□ Source Rocks

- Petroleum source rock is defined as the fine-grained sediment with sufficient amount of organic matter, which can generate and release enough hydrocarbons to form a commercial accumulation of oil or gas .
- Source rocks are commonly shales and lime mudstones, which contain significant amount of organic matter .
- A petroleum source rock is defined as any rock that has the capability to generate and expel enough hydrocarbons to form an accumulation of oil or gas.

- Source rocks are classified according to oil generation into three classes as follows:
 - I. Immature source rocks that have not yet generated hydrocarbons.
 - II. Mature source rocks that are in generation phase.
 - III. Post mature source rocks are those which have already generated all crude oil type hydrocarbons.

- The petroleum source rocks are distinguished to potential, possible, and effective, as follows :
 - I. Potential source rocks are immature sedimentary rocks capable of generating and expelling hydrocarbons, if their level of maturity were higher.
 - II. Possible source rocks are sedimentary rocks whose source potential has not yet been evaluated, but which may have generated and expelled hydrocarbons.
 - III. Effective source rocks are sedimentary rocks, which have already generated and expelled hydrocarbons.