



## Note on Formation of Petroleum from Kerogen

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### DESCRIPTION

Petroleum is a complex mixture of hydrocarbons that can be solid, gaseous or liquid and is found naturally on Earth. Although petroleum also refers to natural gas and the viscous or solid form known as bitumen which is found in tar sands. The term is frequently limited to the liquid form, popularly known as crude oil. The most significant of the primary fossil fuels is petroleum which exists in its liquid and gaseous phases. Because of their close ties to one another in nature, liquid and gaseous hydrocarbons are often referred to simply as petroleum instead of petroleum and natural gas. Large amounts of carbon dioxide (CO<sub>2</sub>) are released into the atmosphere during the combustion of all fossil fuels including coal and biomass. Much of the long-wave solar energy that is absorbed by the Earth's surface is prevented from reradiating from the surface and escaping into space by the CO<sub>2</sub> molecules. The lower atmosphere stays warmer than it would because the CO<sub>2</sub> absorbs upward-propagating infrared radiation and reemits some of it downward. Because of this occurrence, Earth's natural greenhouse effect is amplified leading to anthropogenic global warming. There is strong evidence that rising CO<sub>2</sub> and other greenhouse gas concentrations have had a significant role in the rise in Earth's near-surface mean temperature since 1950.

### The developing stage from planktonic remnants to kerogen

Although it is acknowledged that the materials that made up the primordial Earth were the original source of carbon and hydrogen it is generally accepted that these two elements had to go through an organic phase before they could be combined to form the diverse complex molecules known as hydrocarbons. The single-celled planktonic (free-floating) plants and animals including foraminifera, that live in aquatic habitats of marine, brackish or fresh water are most likely the source of the organic material that is the source of the majority of hydrocarbons. It is known that such basic species were widespread well before the Paleozoic Era which started about 541 million years ago.

The single-celled planktonic creatures and plants were quickly buried in fine-grained sediments which preserved their remains. In order to eventually undergo diagenesis a sequence of processes including biological, chemical and physical changes into genuine petroleum, this provided the organic ingredients or so-called protopetroleum. The initial stage of hydrocarbon creation known as the immature stage is characterized by biological activity and chemical rearrangement that transforms organic materials into kerogen. The majority of the hydrocarbons produced in the later phases come from this dark-colored insoluble byproduct of bacterially transformed plant and animal debris. Biogenic methane is the sole hydrocarbon produced in significant amounts during the initial phase. The process of organic materials being broken down by anaerobic microbes includes the formation of biogenic methane gas.

### Mature step from kerogen to petroleum

The mature stage of hydrocarbon creation is caused by deeper burial caused by ongoing sedimentation, rising temperatures and advancing geologic age. During this stage, the whole range of petroleum compounds is formed from kerogen and other precursors by thermal deterioration and cracking. During the mature stage hydrocarbon generation takes place at depths of roughly 760 meter to 4,880 meters and at temperatures between 65°C and 150°C depending on the quantity and kind of organic matter present. The "oil window" is the name given to this unique setting.

The oil window is present at shallower depths in younger strata in regions with higher than average geothermal gradients but it is smaller. Maximum hydrocarbon production occurs between 2,000 meters and 2,900 meters below the surface. Wet gas also referred to as natural gas liquids is the main type of gas that forms below 2,900 meters. Dispersed kerogen makes up around 90% of the organic matter in sedimentary source rocks. Its molecular makeup consists of a variety of leftover materials with sheets of aromatic hydrocarbon rings layered on top of one another along with sulphur, oxygen and nitrogen atoms. There are several different hydrocarbon compounds including typical

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paraffin chains attached to the ends of the rings. Long-term low-temperature heating of kerogen in an oil window of a source rock causes the molecules to break and the connected paraffin chains to liberate. Further heating may lead to the production of soluble bitumen compounds followed by various saturated and unsaturated hydrocarbons, asphaltenes and other of the thousands of hydrocarbon compounds that make up crude oil mixtures. This process may be aided by the catalytic effect of clay minerals in the source rock matrix.

Depending on the geothermal gradient the end of the mature stage of kerogen occurs below 4,800 meters where it condenses in structure and becomes chemically stable. The principal hydrocarbon product in this climate is dry thermal methane gas because crude oil is no longer stable.