1. BIOGENETIC THEORY

Most geologists view crude oil and natural gas as the product of compression and heating of ancient organic materials over geological time. Oil is formed from the preserved remains of prehistoric zooplankton and algae which have been settled to the sea (or lake) bottom in large quantities under anoxic conditions. Terrestrial plants, on the other hand, tend to form coal. Over geological time this organic matter, mixed with mud, is buried under heavy layers of sediment. The resulting high levels of heat and pressure cause the organic matter to chemically change during diagenesis, first into a waxy material known as kerogen which is found in various oil shales around the world, and then with more heat into liquid and gaseous hydrocarbons in a process known as catagenesis. Geologists often refer to an “oil window” which is the temperature range that oil forms in—below the minimum temperature oil remains trapped in the form of kerogen, and above the maximum temperature the oil is converted to natural gas through the process of thermal cracking. Though this happens at different depths in different locations around the world, a ‘typical’ depth for the oil window might be 4–6 km. Note that even if oil is formed at extreme depths, it may be trapped at much shallower depths where it was not formed (the Athabasca Oil Sands is one example). Because most hydrocarbons are lighter than rock or water, these often migrate upward through adjacent rock layers until they either reach the surface or become trapped beneath impermeable rocks, within porous rocks called reservoirs. However, the process is not straightforward since it is influenced by underground water flows, and oil may migrate hundreds of kilometres horizontally or even short distances downward before becoming trapped in a reservoir. Concentration of hydrocarbons in a trap forms an oil field, from which the liquid can be extracted by drilling and pumping. Three conditions must be present for oil reservoirs to form: first, a source rock rich in organic material buried deep enough for subterranean heat to cook it into oil; second, a porous and permeable reservoir rock for it to accumulate in; and last a cap rock (seal) or other mechanisms that prevents it from escaping to the surface. Within these reservoirs fluids will typically organize themselves like a three-layer cake with a layer of water below the oil layer and a layer of gas above it, although the different layers vary in size between reservoirs. The vast majority of oil that has been produced by the earth has long ago escaped to the surface and been biodegraded by oil-eating bacteria. Oil companies are looking for the small fraction that has been trapped by this rare combination of circumstances. Oil sands are reservoirs of partially biodegraded oil still in the process of escaping, but contain so much migrating oil that, although most of it has escaped, vast amounts are still present – more than can be found in conventional oil reservoirs. On the other hand, oil shales are source rocks that have never been buried deep enough to convert their trapped kerogen into oil. The reactions that produce oil and natural gas are often modeled as first order breakdown reactions, where kerogen is broken down to oil and natural gas by a set of parallel reactions, and oil eventually breaks down to natural gas by another set of reactions. The first set was originally patented in 1694 under British Crown Patent No. 330 covering,

The latter set is regularly used in petrochemical plants and oil refineries.

ABIOTIC ORIGIN

There is an alternative theory about the formation of oil and gas deposits that could change estimates of potential future oil reserves. According to this theory, oil is not a fossil fuel at all, but was formed deep in the Earth’s crust from inorganic materials. The theory was first proposed in the 1950s by Russian and Ukranian scientists. Based on the theory, successful exploratory drilling has been undertaken in the Caspian Sea region, Western Siberia, and the Dneiper-Donets Basin.The prevailing explanation for the formation of oil and gas deposits is that they are the remains of plant and animal life that died millions of years ago and were compressed by heat and pressure over the years. Russian and Ukranian geologists argue that formation of oil deposits requires the high pressures only found in the deep mantle and that the hydrocarbon contents in sediments do not exhibit sufficient organic material to supply the enormous amounts of petroleum found in supergiant oil fields.

The abyssal, abiotic theory of oil formation continues to receive attention due to the work of retired Cornell astronomy professor Thomas Gold, known for several theories that were initially dismissed but eventually proven true, including the existence of neutron stars. He has also been wrong, however; he was a proponent of the “steady state” theory of the universe, which has since been discarded for the “Big Bang” theory. Gold’s theory of oil formation, which he expounded in a book entitled *The Deep Hot Biosphere*, is that hydrogen and carbon, under high temperatures and pressures found in the mantle during the formation of the Earth, form hydrocarbon molecules which have gradually leaked up to the surface through cracks in rocks. The organic materials which are found in petroleum deposits are easily explained by the metabolism of bacteria which have been found in extreme environments similar to Earth’s mantle. These hyperthermophiles, or bacteria which thrive in extreme environments, have been found in hydrothermal vents, at the bottom of volcanoes, and in places where scientists formerly believed life was not possible. Gold argues that the mantle contains vast numbers of these bacteria. The abiogenic origin of petroleum deposits would explain some phenomena that are not currently understood, such as why petroleum deposits almost always contain biologically inert helium. Based on his theory, Gold persuaded the Swedish State Power Board to drill for oil in a rock that had been fractured by an ancient meteorite. It was a good test of his theory because the rock was not sedimentary and would not contain remains of plant or marine life. The drilling was successful, although not enough oil was found to make the field commercially viable. The abiotic theory, if true, could affect estimates of how much oil remains in the Earth’s crust.

The abiogenic origin theory of oil formation is rejected by most geologists, who argue that the composition of hydrocarbons found in commercial oil fields have a low content of 13C isotopes, similar to that found in marine and terrestrial plants; whereas hydrocarbons from abiotic origins such as methane have a higher content of 13C isotopes.

1b. 1. The biogenic theory states that petroleum originates from remains of biological matter, while the abiogenic theory claims that petroleum derives from non- biological processes.

2. The biogenic theory states that oil was fossil fuel at first while the abiogenic theory states that oil was fossil fuel at first

2.



2b. Light Crude oil is liquid petroleum that has low density and that flows freely at room temperature. It has low viscosity, low specific gravity and high API gravity due to the presence of a high proportion of light hydrocarbon fractions. It generally has a low wax content as well. On the other hand, heavy crude oil or extra heavy crude oil is any type of crude oil which does not flow easily. It is referred to as “heavy” because its density or specific gravity is higher than that of light crude oil. Heavy crude oil has been defined as any liquid petroleum with an API gravity less than 20°. Extra heavy oil is defined with API gravity below 10.0 °API (API gravity, is a measure of how heavy or light a petroleum liquid is compared to water. If its API gravity is greater than 10, it is lighter and floats on water; if less than 10, it is heavier and sinks. Light crude oil receives a higher price than heavy crude oil on commodity markets because it produces a higher percentage of gasoline and diesel fuel when converted into products by an oil refinery. Heavy crude oil has more negative impact on the environment than its light counterpart since its refinement requires the use of more advanced techniques an the use of contaminants.

2c. Bituminous coal or black coal is a relatively soft coal containing a tarlike substance called bitumen or asphalt. It is of higher quality than lignite coal but of poorer quality than anthracite. Formation is usually the result of high pressure being exerted on lignite. Its coloration can be black or sometimes dark brown; often there are well-defined bands of bright and dull material within the seams. These distinctive sequences, which are classified according to either "dull, bright-banded" or "bright, dull-banded", is how bituminous coals are stratigraphically identified.

Bituminous coal is an organic sedimentary rock formed by diagenetic and sub metamorphic compression of peat bog material. Its primary constituents are macerals, vitrinite, and liptinite. The carbon content of bituminous coal is around 60–80%; the rest is composed of water, air, hydrogen, and sulfur, which have not been driven off from the macerals. Bank density is approximately 1,346 kilograms per cubic metre (84.0 lb/cu ft). Bulk density typically runs to 833 kilograms per cubic metre (52.0 lb/cu ft). The heat content of bituminous coal ranges from 24 to 35 megajoules per kilogram (21 to 30 million British thermal units per short ton) on a moist, mineral-matter-free basis.

Within the coal mining industry, this type of coal is known for releasing the largest amounts of firedamp, a dangerous mixture of gases that can cause underground explosions. Extraction of bituminous coal demands the highest safety procedures involving attentive gas monitoring, good ventilation and vigilant site management.