THEORIES FOR THE ORIGIN OF OIL

By Mike Westlund

A. Biological Method--Plant and Animal Sources

Almost all geologists today believe that oil (petroleum) was made biologically, that is from plant and animal fossils. Hence, the name fossil fuels was coined. Large mats of floating vegetation, swamps, and shallow seas were covered with sediments. Over millions of years the accumulating sediments of sand, silt, clay, shells, and gravel were changed to sedimentary rock. The dead vegetation and animals, which was preserved by the lack of oxygen, was slowly changed to oil shale by bacteria and the weight of the sediments. Then over millions of years, the increasing heat and pressure from the accumulating sediments changed the oil shale into petroleum. Plants have never been turned into oil in the laboratory because the geologists say the process takes millions of years.

http://en.wikipedia.org/wiki/abiogenic_petroleum_origin

Everything not documented in this article comes from the above website.

http://whyfiles.org/100oil/2.html (Picture of oil pool under sedimentary rock)

http://www.leeric.lsu.edu/bgbb/3/origin.html (Diagrams of biotic origin)

B. Abiotic Method-- Bacterial Action on Non-biotic Sources

Deep in the crust or in the mantel of the earth, bacteria may make oil abiotically, that is from sources that were never alive. One suspect is archaea, a microorganism in a different kingdom than bacteria. Archaea are found growing in Yellowstone National Park hot springs at 100^{o}C or at boiling. For food, Archaea use hydrogen that has been leached by water out of igneous rocks such as basalt. Archaea combine the hydrogen with carbon dioxide to make methane (natural gas). Methane is the simplest hydrocarbon, a compound of carbon and hydrogen. Other microorganisms or natural processes may join methane molecules together to get a long chain hydrocarbons or oil

1. Hydrogen plus carbon dioxide with the help of archaea yield methane plus water.

2. $H_2 + CO_2 \xrightarrow{\text{archaea}} CH_4 + H_2O$

See chemical equation explanation in Part C.

. http://en.wikipedia.org/wiki/Archaea

www.pnl.gov/slme/exobiology.html

http://www.windows.ucar.edu/tour/link=/earth/Life/archaea.html (pictures)

C. Chemical Equations-- An Explanation

Statement 1 above is a chemical equation showing that the 2 compounds on the left combine to make the 2 compounds on the right. Equation 2 above is the same chemical equation using symbols or abbreviations instead of words. A chemist uses abbreviations for the elements. For example, 1 atom of carbon equals “C.” The smallest part of the element carbon that still is carbon is one atom of carbon.

The elements, from which all matter is composed, are made of 92 different naturally occurring atoms. Compounds are made of 2 or more different elements combined chemically. For example, a carbon dioxide molecule equals 1 carbon atom and 2 oxygen atoms or CO_2. A molecule is the smallest part of a compound that still is that compound. The formula for water is always H_2O because the smallest part of the compound water is a water molecule made up of 2 atoms of hydrogen and 1 atom of oxygen. To form compounds, elements give up their physical and chemical properties to become a compound with different properties. For example, hydrogen and oxygen gases, which are very reactive even explosive, react together to become a stable liquid compound which we call water.

D. Abiotic Method--Chemical Action

1. Producing Methane

Synthetic oil has been produced in the laboratory since 1923 by processes similar to the serpentinite process. This process is believed to be the method by which oil is made from rocks like olivine, miles deep within the crust or even in the mantel. Olivine is a very abundant igneous mineral and is always found with basalts, carbonates, metal catalysts and other rocks needed to supply factors for the serpentinite process. In this process, olivine is turned into the metamorphic rock serpentinite and the mineral magnetite. Metamorphosis is accomplished by adding water, carbon dioxide, and heat from the mantel or a heat vent. The carbon dioxide could be there from creation or be from carbonate rocks. Carbon dioxide dissolved in water becomes carbonic acid just like in soda pop. The water, carbonic acid, transition metal catalysts, and heat at around 500^oC change the olivine to serpentinite, magnetite, and methane.

$$\text{Olivine + water + carbonic acid} \xrightarrow[500^oC]{\text{catalysts}} \text{serpentinite + magnetite + methane}$$

$$(Fe,Mg)_2SiO_4 + H_2O + H_2CO_3 \xrightarrow[500^oC]{\text{catalysts}} \text{serpentinite} + Fe_3O_4 + CH_4 + H_2O$$

Serpentinite is so abundant in California that it has become the state rock. Normally, metamorphic rock is dense and harder than the parent rock, but serpentinite has so much water added that not only is the structure changed but the rock is 40% less dense or bigger.

http://en.wikipedia.org/wiki/olivine (pictures)
http://en.wikipedia.org/wiki/serpentinite (pictures)
http://en.wikipedia.org/wiki/Black_smoker (pictures) (Note that the chemicals mentioned in the diagram are from sources other than scientists researching the production of abiotic oils).
http://en.wikipedia.org/wiki/Magnetite
http://en.wikipedia.org/wiki/Hematite

See more pictures under G-1 Laboratory Exercises web links.

2. Producing Complex Hydrocarbons

Methane can be upgraded to more complex hydrocarbons (hydrogen and carbon containing compounds) by joining methanes together and taking out extra hydrogen atoms. Experiments in the laboratory show that methane compressed to 30 to 40 Kbar yields hydrocarbons having properties similar to petroleum. Also rocks like basalts that contain the mineral olivine are abundant in transition metal catalysts like iron, nickel and chromium that may aid in producing complex hydrocarbons. A catalyst speeds up a reaction or helps the reaction take place, but it usually does not take part in the reaction and get used up. Metamorphic magnetite is an iron containing magnetite mineral which is a major catalyst in the production of methane to ethane. Magnetite is changed to hematite which is also present in serpentines.

$$\text{Methane + magnetite + water} \xrightarrow[\text{Compression}]{\text{Heat}} \text{ethane + hematite + carbonic acid}$$

$$CH_4 + Fe_3O_4 + H_2O \rightarrow C_2H_6 + Fe_2O_3 + H_2CO_3$$

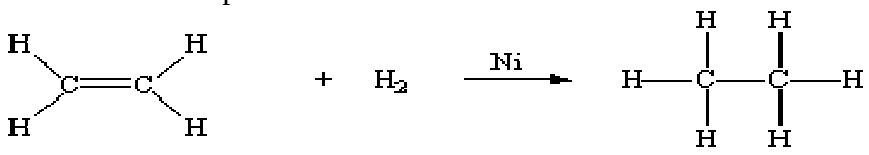
Notice that the 2 methanes have lost 2 hydrogens when they combine to make ethane. The hydrogens are picked up by a carbonate (CO_3) and form carbonic acid. The extra acid speeds up the metamorphosis of olives to serpentine. The hot gaseous hydrocarbons migrate to the surface via gas pressure and the centripetal force from the earth rotating. The hydrocarbons condense to form liquid pools and are trapped beneath sedimentary rock close to the surface of the earth.

E. Additional Evidence for the forming of Abiotic Oil

1. There is methane and other simple hydrocarbons on other moons, planets, and comets in our solar system and on the meteors that fall to the earth. The hydrocarbons in these objects must have formed without any biotic source.
2. The trace metal catalysts needed for the serpentinite process deep in the earth are found near the surface in the oil thought to be made by biotic processes. It may have migrated to the surface with the oil.
3. The White Tiger oil in Vietnam is taken from wells drilled a mile down into the granite crustal rock. Biotic theory hypothesizes that the White Tiger deposits are from sediments thrust deep within the earth.
4. Volcanoes bring out methane from deep in the earth.
5. Under slightly different conditions, the metamorphosis of olivine can form talc-carbonate schists and magnesite stringer, Since these are

present in serpentine rock, the methane producing process must also be active.

6. The biotic oil has too much hydrogen to have been made biotically. Plants have polyunsaturated fats that are unsaturated with respect to hydrogen. Chemists have had no success making oil in the laboratory with plant materials, but animal waste, which is saturated has been turned into petroleum.



A hydrocarbon with a double bond and unsaturated with respect to hydrogen like plant oils

A hydrocarbon saturated with hydrogen like petroleum or animal fats

http://www.elmhurst.edu/~chm/vchembook/500hydrocarbons.html
http://chemed.chem.purdue.edu/genchem/topicreview/bp/1organic/organic.html

7. The amount of oil often increases in reserves even after much drilling. It must be seeping in from very deep down deep in the earth. Biotic theory would again say that the new oil is seeping up from other biotic oil which has already been made a little deeper down in the earth. http://edition.cnn.com/2006/BUSINESS/09/05/chevron.reut/index.html?section=edition_business New Gulf of Mexico discovery by Chevron 4 miles below the ocean floor increases USA oil reserves by 50%. 9-05-06 Picture of oil drilling platform

F. Additional Problems with the Production of Abiotic Oil.

1. How can there be enough fine cracks in the rocks or pore space deep within the earth to allow for oil to be made abiotically and then to seep to the surface?
2. How do you get so much carbon dioxide deep within the earth for the serpentinite reaction? Answer- Serpentine is there in abundance so it either was created in the beginning as serpentine or carbon dioxide must be present for the serpentine to form.
3. Drilling deep within the crust is difficult, expensive, and there does not appear to be any clues as to where to drill to find oil. The serpentinite process should be very active at tectonic plate boundaries, but drilling deep there has produced no economically beneficial source of oil. For abiotic oil, a driller looks for a dome of limestone rock, drills through the highest point, and hopes to find oil collected under the earth. http://whyfiles.org/100oil/2.html (Picture of oil pool under sedimentary rock
4.

5. Much water is needed for the serpentine process and the subsequent joining of the methane molecules. Where does all this water come from deep within the crust that has supposedly produced all the inland, non oceanic wells? There also is limited evidence that major serpentine belts underlie the continental sedimentary basins which hosts oil.
6. In conventional biogenic theory, oil buried too deep is turned into natural gas at temperatures between 120^{o}C to 220^{o}C. As one goes deeper, even natural gas would be destroyed by the higher temperatures above 220^{o}C. . This is the opposite of abiotic oil theory.

G. Laboratory Exercises

1. Testing 3 Types of Rocks

Compare the 3 types of rock mentioned in abiotic oil production with respect to their physical and chemical properties. Draw any conclusions as to what may be characteristic of each of the groups of rock: igneous, metamorphic, sedimentary. Examples of common tests are the following: streak test with white plate, hardness test with glass plate, carbon dioxide production with muriatic acid, color, mineral structure, grain size, etc.

Igneous	Metamorphic	Sedimentary
Olivine (mineral)	Magnetite (mineral)	Limestone
Basalt	Serpentine	Dolomite
		Aggregate
		Sandstone

http://www.windows.ucar.edu/tour/link=/earth/geology/geology.html&edu=elem
http://www.windows.ucar.edu/tour/link=/earth/geology/nonsilicates2.html&edu=elem
http://www.windows.ucar.edu/tour/link=/earth/geology/mineral_id1.html&edu=elem
http://www.gc.maricopa.edu/earthsci/imagearchive/interest.htm

2. Testing Elements and Compounds

Label whether the sample is an element or a compound. Then write the name, abbreviation for the element, and the formula for the compound.

Compounds	Elements
NaCl-table salt	iron-tool
H_2O-water	aluminum-foil
Petroleum-$C_n + H_{2n+2}$	carbon-graphite
Or $C_3 H_8$	from pencil
Or H-H-H	
H-C-C-C-H	
H-H-H	

3. Testing acid, base, or neutral
Water
Vinegar
Baking soda
Ammonia

Use ph hydrion paper or litmus paper
Add vinegar to baking soda to neutralize to water and carbon dioxide
$HC_2H_3O_2 + NaHCO_3 \rightarrow NaC_2H_3O_2 + H_2O$
Acid base a salt water

4. Testing the ph of dissolved carbon dioxide. Carbon dioxide dissolved in water becomes carbonic acid just like in soda pop.
   Test 1- Blow air into water with a straw for about 5 min. and test with ph or litmus paper.
   Test 2-Blow air with a straw into limewater [$Ca(OH)_2$ or calcium hydroxide] and test with ph paper. Limewater will go from cloudy to clear and back to cloudy again as the ph decreases.