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The mechanism that had formed the primitive liposome in the early Earth environment

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The mechanism that makes organization of molecules in the water is investigated. Micro powder of iron (Fe) will adhere to CO_2 in the carbonated water. It will slowly make robust membrane and solid material. The free hydrogen and free carbon caused by oxidation of Fe play an important role in those intermolecular materials.

[Hydrogen ion concentration of water for the organization of molecules]

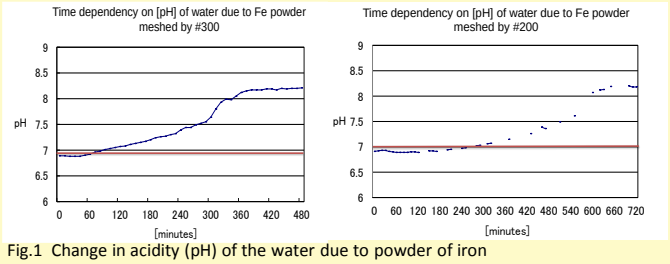


Fig.1 Change in acidity (pH) of the water due to powder of iron

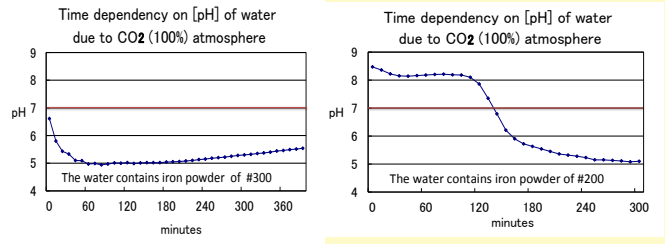


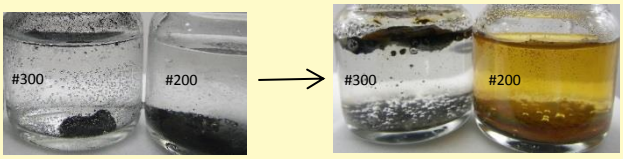
Fig.2 Time change of pH due to dissolved CO_2 gas on the water with iron powder

The pH value rapidly decreased by CO_2 gas. In the case show in left of Fig.2, the pH value increases by the minute powder of Fe that was pulled up by bubble of CO_2.

[The bubble in the carbonated water that was formed around minute powder of Fe]

The activation energy of the solubility on CO_2 is approximately equal to the energy of hydrogen bonds (5Kcal/mol), the same as the activation energy of viscosity of water. And, degree of ionization on the CO_2 is 0.017. Therefore, most of CO_2 in the water is trapped in molecules of water i.e. carbon dioxide hydrate.

Since the electronegativity of carbon atom is larger than that of hydrogen atom, the CO_2 is deposited on the surface of iron powder and a bubble of CO_2 will enlarge.

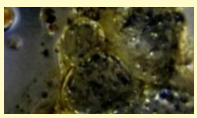


(a) State at immediately after mixing (b) State after 45 hours from the mixing

Fig.3 The size (mesh#300 and #200) effects of iron powder on the phenomena caused by mixing of iron powder in carbonated water

Iron powder of mesh#300 adhered to dry ice, and solids were appeared on the surface of the carbonated water as shown in Fig.3(b) and Fig.4.

If the size of the iron powder is large (right side: #200), significant products on the surface does not occur. But interference color was appeared on the glass wall.



Fe in the carbonated water will be oxidized, and free hydrogen (H) and free carbon (C) will be generated. Those free atoms will contribute to form the intermolecular materials.

Fig.4 The materials those were produced in the carbonated water with iron powder

By comparing Fig.4 with Fig.9, following chemical reactions can be considered between the floating material and meteorite ALH84001, which was flying from Mars.

Pyrrhotite and magnetite are contained in the edges of carbonate in the meteorite. The minerals may be generated from deoxidization of sulfuric acid by iron by as follows.

$$3Fe + H_2SO_4 \rightarrow Fe_2O_3 + FeS + H_2O \quad (1)$$

PAH (polycyclic aromatic hydrocarbons) that are included in the grain of carbonate in the meteorite ALH84001 will be made from acetylene [$nC_2H_2 \rightarrow$ PAH]. At the time when Ca is oxidized by CO_2, the generated free carbon(C) from CO_2 is bonded to the Ca.

It becomes calcium carbide (CaC_2). C_2H_2 is generated CaC_2 by the reaction with water.

$$2CO_2 + 5Ca + 6H_2O \rightarrow 2C_2H_2 + 5Ca(OH)_2 \quad (2)$$

[Analysis on the materials made from carbonated water with minute powder of Fe]

Fourier transform infrared spectroscopy (FT-IR) is used to realize the bonding state of the molecule, because the infrared light is absorbed due to rotation and vibration of a molecule.

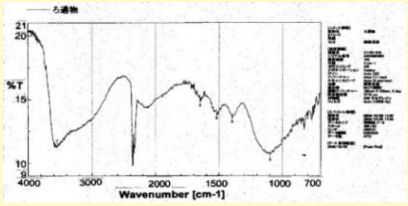


Fig.5 FT-IR on the solid substance collected at the surface of water

As the result, the evidence of organic molecules could not be confirmed.

On the other hand, dried solid of surface of the carbonated water was inspected by energy dispersive X-ray spectrometry (EDS) of scanning electron microscopy (SEM).

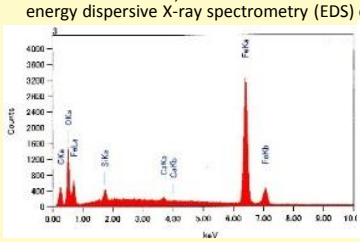


Fig.6. EDS (manufacturing contaminated with Ca, Si)

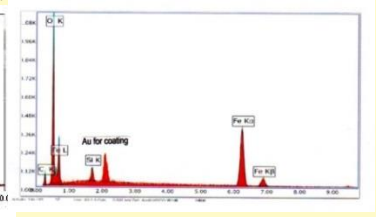


Fig.7. EDS (sample is coated with Au; gold)

In Fig.7, large amount of oxygen are detected on the sample that was covered with Au. The solid material produced in the carbonated water includes H_2O. Since, it is difficult to detect hydrogen ions, it can be concluded that the gas inside of bubble is CO_2.

[The mechanism by which forms a liposome at the reconstruction of a babble]

Since inside of a bubble is gas, it emerges at the surface of water. It will be broken, because the membrane of bubble is subjected to stress from the outside. Some bubbles swallow the suspended solids at surface of the water. It encloses with liquid H_2O and CO_2 gas by the membrane containing fine powder of iron. The liposome has a long life, because it exists inside of the water where is less stressful than in the surface.

[The interfacial reaction of floating materials on the water surface]

Since floating materials on the water surface stays at stressed state, there is a possibility to make chemical reaction by bombard of gas molecules. There is the possibility that the amino acid is generated at the interface of water from the ammonia together with COOH supplied from the carbonated water. Here, ammonia (NH_4OH) will be generated in the membrane that contains hydrogen ions.

[The link of amino acids that is adsorbed on the membrane of a liposome]

In the almost neutral state (pH = 7) of water, COOH of an amino acid will connects with NH_2 of adjacent another amino acid. When a side chain of amino acid is adsorbed on the membrane, the thermal motion of amino acid is suppressed by connection to the membrane. The connection suppresses the degradation of intermolecular bond. The chain of amino acids attached to the membrane is able to become a huge link of molecules, because the membrane consists of huge number of molecules. The link of amino acids has been evolved to improve the survival in its environment.

[Conclusions]

The intermolecular bond exists in the membrane of a bubble, and it has the ability to assemble molecules. CO_2 adhere to minute powder of Fe. A bigger bubble of CO_2 rises up to surface of the water with hanging minute powder of Fe. A liposome is created from a bubble by swallowing the water together with the membrane. The amino acids attached to the membrane will form the first protein by the interfacial reactions.

[References]

[1] S. Karasawa,"Inorganic production of membranes together with iron carbide via oxidization of iron in the water that includes carbon dioxide plentifully", AbSciCon2010, Pre-biotic Evolution: From Chemistry to Life II , League City, Texas, Apr.27, 2010.

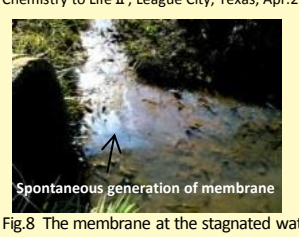


Fig.8 The membrane at the stagnated water

Fig.9 Martian meteorite ALH84001 (by NASA)