NUCLEAR GEYSER MODEL OF THE BIRTHPLACE OF LIFE. T. Ebisuzaki[1] and S. Maruyama[2], [1]RIKEN (2-1 Hirosa Wako Saitama 351-0198 Japan, ebisu@postman.riken.jp), [2]Earth-Life Science Institute, Tokyo Institute of Technology (2-12-1-IE-1, Ookayama, Meguro-ku, Tokyo 152-8550 Japan).

Natural Nuclear Reactor of Oklo: A natural nuclear chain reaction was predicted by Kuroda [1] 20 years before the remnants of the natural reactor were discovered [2,3]. The ancient natural reactor of Oklo was active with about 100 kW about 2 Gyr ago [4]. The isotope analysis reveals that its activity is periodical of about 3 hours with 0.5 hr. active phase and 2.5 hr. dormant phase. The period is similar to the typical geyser operation. This similarity suggests the following reaction operation: 1) the reactor system is soaked by water, which moderates high velocity neutrons to the system critical to activate chain reaction. 2) As the water is converted to steam, the decreasing thermal neutron flux to make the system subcritical. 3) The reactor cools down in 2.5 hr. and the water returns to the reaction zone.

Birth Place of Life: According to the analysis by Adam [5], natural nuclear reactors were much common in number and much larger in scale in Hadean era (4.6-4.0 Gyrs ago), since ^{235}U, the fuel of the reactor was much abundant 30 times compared to the present.

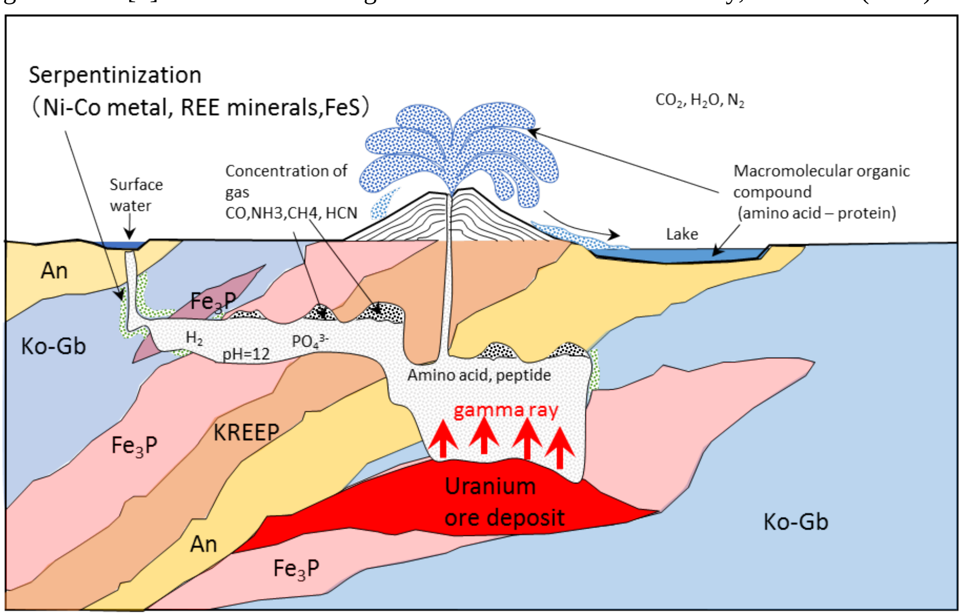
A natural nuclear reactor supplies ideal environment for the birthplace of life. First, it supplies energy in the form of ionizing radiation to produce radicals which can activate stable chemicals such as H_2O, CO_2, CH_4, and N_2 in water and air. In fact, a detectable amount of acetonitrile is produced in the mixture of gas mixture with CH_4 and N_2 and crashed uranium containing minerals (Monazite and Metatorbernite). Draganic et al. [6] demonstrated that gamma bombardment of aqueous acetonitrile produced high molecular weight organic oligomers as well as peptides fragments. The hydrolysate products are reported to contain amino acids (aspartic acid, theorine), carbohydrates (glyceraldehyde, glucose, and ribose), and carboxylic acids (succinic, maleic, fumaric, maleic, and pyruvic acids).

Second, phosphate (PO_4) is available in natural nuclear reactors, since most of the uranium containing minerals are rich in phosphate, essential parts of biological systems to produce ATP, nucleotide, and lipid molecules. For example, monazite is a phosphate mineral with the major component of $CePO_4$ or $LePO_4$. Furthermore, the monazite becomes metamict to release dissolved phosphates steadily in high radiation environment [7, 8].

Third, it offers an almost closed space (underground cave or equivalents) to store the building block chemicals and condense them to reach the critical concentration of the condensation reaction to produce polymers in underground.

Fourth, the geyser set up offers periodical variation in temperature and humidity, which is believed to be essential to produce large biological polymers.

In the presentation, we will discuss the network of the chemical reactions in a natural nuclear reactor and the primordial metabolism of the first biological systems.



[1] Kuroda, P.K. (1956) J. Chem. Phys. 25, 781. [2] Neuilly, M. et al. (1972) C. R. Acad. Sci. Paris, 275, 1847. [3] Bodu, R.E. et al. C. R. Acad. Sci. Paris, 275, D1731. [4] Meshik et al. (2004) Physical Review Letters, 93, 182302-1-4. [5] Adam, Z. 2007, Actinides and Life's Orgins, Astrobiology, 7, 852-872. [6] Draganic, I.G.et al. (1980). J. Mol. Evol. 15, 261–275. [7] Balan, E. (2001) Am. Mineral. 86, 1025–1033. [8] Meldrum, A. (1998) Geochim. Cosmochim. Acta 62, 2509–2520.