[EE] Evening Poster | B (Biogeosciences) | B-AO Astrobiology & the Origin of Life

[B-AO01]Astrobiology

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Twenty years have passed since when the field of Astrobiology, which aims to unveil the origins, evolution, and habitability of life by integrating multidisciplinary fields, was established. Origins of Life are currently being re-conceptualized via expansion of prebiotic chemistry to systems chemistry and chemical space. Besides their relationship to life's building blocks, it is expected to demonstrate the significant roles of organic molecules in the history of planetary formation. The linkages among the variations in chemical compositions of deep-sea hydrothermal environments, geological settings, and ecological systems were systematically investigated. Cassini, which accomplished in the long-term explorations of the planets bearing liquid, had "Grand Finale" this year. Discoveries of extrasolar planets have been dramatically increased to date.

Originally, Astrobiology does not need a specific science category. We therefore aim to make this session so that Earth and Planetary scientists from all the categories join for discussing 'where we came from and where we are going' and for making novel integrated researches.

For the next stage of Astrobiology, presentations on the instrument development in space explorations, comparative studies of solar system and exoplanets, etc, will be very much welcome.

[BAO01-P01]Formaldehyde formation in asteroid impacts: a new origin of prebiotic sugar precursor

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Ribose, the sole sugar in RNA, is a product of the Formose reaction in which formaldehyde condenses under alkaline conditions. Thus, the accumulation of formaldehyde on the prebiotic Earth is a key step for the formation of biological sugars including ribose. Impacts by extraterrestrial objects were far more frequent on the early Earth than present day. Oceanic impacts of iron-bearing asteroids have been investigated as a generating process of organics, such as amino acids and nucleobases on the prebiotic Earth. However, it remains unclear whether formaldehyde forms in such oceanic impact events. In this study, we investigated the formation of formaldehyde as well as the formation of sugars in an experiment simulating impact-induced reactions by asteroids. A series of shock-recovery experiments was conducted using a single-stage propellant gun. Starting materials containing analogues mineral mixture of meteorite, $NaH^{13}CO_3$, water, and gaseous N_2 were enclosed in a stainless-steel capsule. Water was replaced with ammonia water or aqueous solution of $Ca(OH)_2$ in some experimental conditions. A ^{13}C-enriched carbon source (i.e., $NaH^{13}CO_3$) was chosen for the starting material to distinguish between products and contaminants. A flyer collided to the capsule at a velocity of approximately 0.9 km/s to generate a shock wave. After cleaning all the surface of the recovered capsule, the sample was extracted from the capsule with ultrapure water. Aldehyde analysis and sugar analysis was performed by ultra-performance liquid chromatography tandem mass spectrometry (UHPLC-MS/MS) and gas chromatography mass spectrometry (GC/MS), respectively. Analogue mineral mixtures of meteorites

were also collected after the impact and analyzed by X-ray powder diffraction. As a result of analyzing the mineral mixtures, the formation of siderite was confirmed. As a result of UHPLC-MS/MS and GC/MS, formation of 13C-formaldehyde was confirmed in all experimental conditions, although sugars were below the detection limit. The yield of formaldehyde was greater in experiments using ammonia whereas the yield was not much different in the experiment with $Ca(OH)_2$. Metallic iron in the analogue meteorite minerals were oxidized to Fe^{2+} and formed siderite. Bicarbonate was expected to have been abundant in the prebiotic ocean. Further, CO_2 was a major component of the atmosphere on the prebiotic Earth. Therefore, the formation of formaldehyde from bicarbonate in the present study suggest that the impacts of asteroids to the early ocean is a new substantial source of formaldehyde on the prebiotic Earth.