Effects of serpentine on the organic synthesis in impacts of meteorites on the early ocean

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Lunar crater records suggest an intense impact event during 3.8 to 4.0 billion years ago. Impacts of meteorites onto oceans create plumes in which meteoritic minerals, oceanic water and atmosphere react each other. Previous works suggest the formation of amino acids, nucleobases and other simple organic compounds in iron-bearing meteorite onto ammonia-bearing oceans [1, 2]. Serpentine is another common mineral in meteorites, commonly found in aqueous altered carbonaceous chondrites. This study examines the effects of serpentine on the synthesis of amino acids and amines. Impact-induced reactions were simulated by a shock-recovery experiment in which reactants are subjected to a traversal of shock wave. Sample cavity was filled with mixtures of minerals and aqueous solution with overhead gas, simulating meteorites, oceanic water, and atmosphere, respectively. Two compositions of material mixtures were used. The first one (S1) consisted of forsterite, Fe, Fe_3O_4, Ni, and solid carbon, whereas the second sample (S2) used serpentine instead of forsterite in S1. These starting materials were enclosed in a tightly sealed metallic container and subjected to the impact of a metallic flyer at ~0.9 km/s. Products were extracted by water from the container and then analysed by an ultrahigh performance liquid chromatograph connected to a tandem mass spectrometer. Glycine, the smallest amino acid, and three kinds of simple amines (methylamine, ethylamine, propylamine) were formed in this shock-recovery experiment. The yields of glycine and amines in the experiment using serpentine (S2) were 10 times greater than that of S1. This result suggests that serpentine in meteorite plays an important role in organic synthesis in its oceanic impacts and implies a contribution by carbonaceous chondrites to the formation of life's building blocks on the prebiotic Earth.

[1] Furukawa *et al*. (2009) *Nature Geoscience* **2,** 62-66. [2] Furukawa *et al*. (2015) *EPSL* **429,** 216-222.