

THE EVOLUTION OF NUCLEOBASES UNDER ASTEROIDAL AQUEOUS ALTERATION.Y.Y. HE¹, I. CRIOUE¹, J.-C. VIENNET¹, M. LECASBLE¹, D. BOULESTEIX², A. BUCH², M. GUILLAUMET¹, B. LAURENT¹, A. DUVERGER^{1,3}, S. BERNARD¹, and L. REMUSAT¹

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Asteroids, comets, and their fragments including meteorites, micrometeorites, and interplanetary dust particles (IDPs) could serve as delivery vehicles for organic matter to Earth [1]. Therefore, the organic compounds of chondrites, carbonaceous meteorites, and comets are essential for the decoding of the evolution of organic materials in the early solar system. Among the organic compounds detected in chondrites, nucleobases are of particular interest because they are the building blocks of DNA and RNA of all life on Earth. In addition, purine nucleobases such as guanine and xanthine, and pyrimidine nucleobases such as cytosine, uracil and thymine have been detected in numerous meteorites previously, and the isotopic composition of nucleobases isolated from carbonaceous chondrites support their extraterrestrial origin [2,3]. Generally, aqueous alteration that asteroids experienced on the parent body correlates with variations in the abundances and isomers distributions of nucleobases in meteorites [4]. The more aqueously altered type 1 CI, CM, and CR chondrites showed a decrease in overall abundance and diversity of nucleobases [5]. Extraterrestrial nucleobases could have been formed by abiotic reaction mechanisms in a variety of cosmic environments [1]. However, the distributions of meteoritic nucleobases are the results of both synthetic and subsequent degradation reactions. For instance, meteoritic nucleobases could be formed by the reaction of hydrogen cyanide and ammonia on the parent asteroid, also known as HCN polymerization; for the degradation of nucleobases, guanine could be thermal degraded to xanthine [6], and uracil could be photodegraded and produce dimers [7]. However, there have been few studies that reported the influence of aqueous alteration on the evolution of nucleobases. Therefore, the influence of aqueous alteration on the evolution of nucleobases and the role of minerals during hydrothermal processes remains to be addressed.

A laboratory investigation of the evolution of three nucleobases (*i.e.* guanine, uracil and xanthine) was performed under aqueous alteration conditions typical of carbonaceous chondrites. Nucleobases powder and pure degassed water were mixed and heated at 150 °C for 10 days under an oxygen free atmosphere in titanium Parr© reactors. The released gas, soluble organic molecules, and the residual solids were characterized. We note that decarboxylation occurred during the aqueous alteration of nucleobases, especial for xanthine. The XRD analysis of nucleobase and saponite shows that saponite helps to trap some of the nucleobases under aqueous alteration, which may be due to the strong interactions between guanine and saponite through three H-bonds with edge hydroxyls and water molecules [8]. Barely no guanine was detected in liquid products, however, a high abundance of guanine was detected in the solid residue of guanine and saponite mixtures, which indicates that guanine is one of the most stable nucleobases under aqueous alteration conditions. Thus aqueous alteration may not have significant influence on the evolution of guanine in parent body. This may explain why guanine has the largest abundances in carbonaceous chondrites compared with the other nucleobases [9].

References:

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