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Understanding planetesimal alteration conditions through amino acid heterogeneity in meteorites and Hayabusa2 return samples.

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Carbonaceous chondrites (CC) and C-type asteroid return samples contain amino acids (AA), which are essential for an origin of life on the early Earth and can provide important information concerning planetesimal alteration processes [1-3]. Current analytical techniques allow for the analysis of several mg-sized samples and can thus enable an investigation of AA heterogeneity within single meteorite specimens [3]. Furthermore, significant differences between the AA abundances of a returned Hayabusa2 particle from touchdown site (TD) 1 and TD 2 indicated that the amino acid abundances in Ryugu were heterogenous over a scale of ~870 m [2]. However, it remained unclear whether heterogeneity was present over smaller distances and if it was unique to Ryugu or common to other asteroidal fragments, such as carbonaceous chondrites. Here the results of an investigation into the mm-scale amino acid heterogeneity within carbonaceous chondrites are reported and compared to the results obtained from the analysis of the Hayabusa2 return samples [4]. The results indicate that CCs are heterogenous in terms of their AA at the mm-scale. Certain AA ratios were also found to be heterogenous over the mm-scale and between different carbonaceous chondrites. Accordingly, in this talk the potential reasons for the heterogeneity will also be discussed and evaluated, including differences in the nature of aqueous alteration, thermal processing and the inherent heterogeneity within the protosolar nebular/protoplanetary disk. Such findings help to further constrain the effects of planetesimal alteration on organic matter and evaluate the accretionary relationship between different groups of CC and Ryugu. Furthermore, the study also highlights important requirements that future sample return missions, which aim to obtain organic-bearing extraterrestrial materials, should take into account.

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