

Prevalence and nature of heating processes in CM and C2-ungrouped chondrites as revealed by insoluble organic matter. Impact on VNIR reflectance spectra.

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Chondrites are exhumed from their parent bodies by impacts, which at the same time can result in heating and mechanical modification (compaction, deformation, fracturing, etc.). However, whether impacts are responsible for the occurrence of heated C2s remains controversial since radiogenic and solar heating have also been invoked to explain them. Here [1] we report a Raman and infrared study of the composition and structure of Insoluble Organic Matter (IOM) in a series of 39 CM and C2-ungrouped chondrites. These parameters are tracers of the extent and nature of thermal metamorphism a meteorite has experienced and reflect the degree to which the thermally driven and irreversible carbonization of IOM has proceeded. We propose a carbon-based classification of heated C2 chondrites that reveals a high occurrence frequency of thermally processed C2 chondrites (> 36 %). This classification is in agreement with the mineralogical classification scheme of [2]. Strongly heated C2 chondrites (PCA 02012, PCA 91008, Y 86720) display an IOM structural evolution that is dissimilar to that of type 3 chondrites that experienced long duration radiogenic thermal metamorphism. These differences almost certainly reflect kinetic constraints on IOM modification during short duration heating events. QUE 93005 is a weakly heated chondrite that experienced a retrograde aqueous alteration. Its very aliphatic-rich IOM points to a parent body hydrogenation through interactions with water. The closed-system conditions required by this mechanism could be satisfied by a *kinetic confinement* during a very short duration impact. MET 01072, a heavily compacted and uni-axially deformed chondrite, did not experience post-accretional heating. In this case, the deformation features probably reflect a low-velocity impact. In contrast, the weakly metamorphosed chondrite EET 96029 experienced one or several low pressure impacts that triggered mild heating and partial dehydration without deformation features. The study of a series of lithologies from the Tagish Lake C2-ungrouped chondrite confirms the coexistence of various degrees of post-accretional alteration, the most altered lithologies having experienced a moderate degree of heating. Overall, the high prevalence of heating in C2 chondrites, the evidence of short-duration heating in the most heated C2s and the ability of low velocity collisions to trigger heating favor impacts (against solar heating), as the dominant heating mechanism. Finally, our set of data does not support the action of a low temperature oxidation process that would control the aliphatic abundance in unheated primitive C2s.

As a second step, we will report VNIR reflectance spectra of several of those CM and C2-ungrouped chondrites. The effect of heating processes on the reflectance and spectral properties will be presented and implications for the Hayabusa 2 mission will be discussed [3,4].

References

- [1] Quirico E. et al. 2018. *Geochimica Cosmochimica Acta* In press. [2] Nakamura T. 2014. *J. Mineral. Petrol. Sci.* 100:260. [3] Garenne et al. 2016. *Icarus* 264:172 [4] Beck et al. *Icarus* 313:124