Meteorites-asteroid connection and some lessons from hayabusa2

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The connection between meteorites and asteroids has been constructed through their optical properties, i.e. how they reflect light in the visible and infrared range. Not all compounds have absorption in this spectral range, and without having meteorites, our understanding of the nature of asteroids would be very different. Conversely, meteorites are by definition rocks, that fell on Earth, and were exposed to terrestrial conditions. With the Hayabusa and Hayabusa2 mission, uniquely fresh material in provenance from known asteroidal bodies could be studied, and important lessons were learned on how terrestrial residence can perturb optical properties, and our understanding of meteorite asteroid connections.

Over the last decade, at IPAG, reflectance spectra of many different classes of meteorites were measured in IR reflectance and absorption. Many of these studies were coupled to Raman spectra of organic matter to assess the connection between thermal metamorphism and IR absorptions. Generally, the reflectance spectra (0.4-2.6) of chondritic meteorite is controlled by iron: the presence of Fe-metal (producing a red slope), Fe-oxides (with a magnetite "bump" at 0.7 µm or a 1-µm band) the presence of Fe-bearing olivine and pyroxene and sometimes Fe-bearing spinel, and lastly the presence of Fe^{2+}-Fe^{3+} phyllosilicates. The mineralogy of meteorites is the consequence of three steps; 1) accretion, 2) asteroidal processes (thermal and aqueous alteration), and last 3) terrestrial alteration. We will show examples of how step 2) and 3) can modify the original mineralogy –and reflectance spectra --- of extra-terrestrial samples, based on analysis of meteorites (OC, CI, CV, CM and CR) and returned asteroid samples.

First, in the case of OC meteorites our recent work has shown that thermal metamorphism can have a strong impact on the presence or absence of olivine and pyroxene signatures [1]. We also showed that terrestrial weathering can change the interpretation of the possible parent bodies of CR chondrites [2], and that heavily altered CR chondrites are almost indistinguishable spectrally from CM chondrites [3]. We will also show how, interaction with the terrestrial atmosphere can quickly impact absorption in the 3-µm region [4-5]. Last, we will show how redox state in the uniquely pristine Ryugu samples are much more reduced than other CI-chondrites [6].

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