**Topics: Organic Matter in Extraterrestrial Materials**

# (ULTRA)HIGH RESOLUTION ORGANIC SPECTROSCOPY ANALYSIS OF SOLUBLE ORGANIC MATTER IN METEORITES

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Observations such as astrochemistry (telescopic observations) and laboratory wet chemical analysis of return objects such as meteorites enables us to understand the origin and evolution of organic matter. The molecular composition and diversity of non-terrestrial organic matter in carbonaceous chondrites can be studied by means of both, targeted [1] and non-targeted [2,3] chemical analytical approaches, leading to new insights/histories on the studies samples. Targeted chemical analyses as followed with mass spectrometry coupled to gas or liquid chromatography are hypothesis-driven and are largely focused on molecules of biological/prebiotic interest; these can be amino acids, sugars, nucleotides, fatty acids. In the non-targeted approach using rather higher resolution type of instrumentations such as nuclear magnetic resonance spectroscopy (NMR) or (ultra)high resolution mass spectrometry (FTICR-MS), all analytes are globally profiled within the limits of the analytical possibilities and without biased or constrained hypothesis in order to gain comprehensive information.

Both approachs enabled insights into the holistic complex compositional space to tens of thousands of different molecular compositions and functional groups having in total millions of diverse structures. Solvent extractions of pristine carbonaceous meteorits could show this in the last decade [2, 3], and suggests that interstellar chemistry is extremely active and rich.

In this presentation we give a state of the art on the chemical description of the soluble organics of meteorites by non-targeted approach. We described to date that heteroatomic organic molecules play an important role in the description of non-terrestrial chemical evolution. The thermally and shock-stressed Chelyabinsk (LL5) [4] showed high number of nitrogen counts within CHNO molecular formulas, especially in the melt region. This match of the organic molecular profile with the petrologic character could be also observed for Novato (L6) [5], Braunschweig (L6) and the latest German fall Stubenberg (LL6) [6]. Recently novel falls such as Hamburg (L4), Renchen (L5-6) and Ejby (H5-6) and the thermals affected CM2 Diepenveen confirmed these findings. The resulted extreme richness in chemical diversity offers information on the meteoritic parent body history and help in expanding our knowledge or astrochemistry towards higher molecular masses and complex molecular structures.

In mass spectrometry all the performed studies involve electrospray ionization (ESI) sources in both negative and positive-ion modes that is known to be appropriate for the ionization of species over a wide mass and polarity range. DESI is a surface analysis that was recently used and which is based on the ESI-process as well [7]. The less polar and oxygen depleted species are not necessarily detected by this method and thus the chemical description of the material can not be the most exhaustive. using an atmospheric pressure photoionisation source (APPI) coupled to a high resolution Fourier transform ion cyclotron resonance mass spectrometer (FT-ICR MS). This method is well known to ionize the less polar to nonpolar species such as the polyaromatic hydrocarbons (PAH) or unsaturated heteroatom compounds. The contribution of APPI, to a better understanding the chemical composition of the meteorite, will be discussed by comparing the elemental compositions achieved by positive- and negative-ion ESI FT-ICR MS. In the light of the forthcoming return missions we feel important to adapt modern analytical tools for a wider observation of chemical classes in minimal amount of sample use.

References:

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