ANTARCTIC MICROMETEORITES, CONSTRAINTS ON INTERPLANETARY ORGANICS FOR HAYABUSA 2 AND OSIRIS-REX.

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Within the coming years, both Hayabusa 2 and OSIRIS-REx space missions will open a new window on our knowledge of the composition of carbonaceous asteroids. The comparison of samples from asteroids Ryugu and Bennu to the known interplanetary material will provide crucial constraints on the origin and evolution of both high and low temperature phases in the Solar System. A key issue will be the comparison of the organic compound of these dark asteroids with that of carbonaceous chondrites, carbon-rich interplanetary dust particles and cometary samples from 81P/Wild2 [1] or in-situ analyses of particles from comet 67P/Churyumov-Gerasimenko [2, 3]. The comparison of Hayabusa 2 and OSIRIS-REx samples with carbon-rich interplanetary dust will provide a unique tool to study the different kinds of asteroidal organic matter and their possible links with cometary organics.

On short time scales, the extraterrestrial input on Earth is dominated by the mass provided by particles in the 20-500 μm size range, (i.e. micrometeorites) [4]. Large collections of Antarctic MicroMeteorites (AMMs) have been extracted from blue ice fields of Adélie Land [5] and near Yamato mountains [6], in the South Pole Station Water Well [7] and at Dome Fuji [8] or in the transantarctic mountains [9]. Thanks to the support of IPEV and PNRA, we achieved several AMM collections from snow at the vicinity of CONCORDIA Station located at Dome C (73°S, 123°E) in the central regions of the Antarctic continent [10]. We recovered thousands of AMMs from melting and filtering ultra-clean snow extracted from trenches. The AMMs from central Antarctic snow are well preserved from terrestrial weathering and exhibit fragile particles [10, 11] resembling to the chondritic porous IDPs from stratospheric collections [12, 13]. The cleanliness of such collections also allows identifying rare particles with high carbon content, i.e. Ultra-Carbonaceous Antarctic Micrometeorites (UCAMMs) [14]. The UCAMM carbonaceous component consists in a highly disordered organic matter exhibiting extreme deuterium excesses [15] and N/C ratios higher than those reported in IOM from carbonaceous chondrites [16-18]. UCAMMs have no counterpart in meteorite collections and the identification of their potential parent body is challenging. The UCAMMs have similarities with the so-called CHON particles identified in comet 1P/Halley by the Vega and Giotto space probes [19], and with C-rich IDPs identified in stratospheric collections [20]. The isotopic compositions of light elements (H, C and N) were recently measured with the NanoSIMS using polyatomic ions using a high mass resolution (HMR) protocol [21] and a dedicated series of standards to infer the D/H instrumental mass fractionation [22]. STXM-XANES and TEM data reveal that UCAMMs contains several components exhibiting different concentrations of minerals and a wide range of hydrogen and nitrogen isotopic compositions [23, 24]. The main carbonaceous component of UCAMM has large D/H ratio variations, while a minor component exhibit depletion in ^{15}N and higher mineral content. Both the bulk elemental and isotopic compositions of UCAMMs indicate that these samples most probably originate from the solar system outer regions, i.e. the cometary reservoir [15, 18]. Their high nitrogen concentration and high heterogeneous isotopic composition can be accounted for by assuming that the precursors of their organic matter result from the irradiation by galactic cosmic rays of N-rich ices at the sub-surface of a parent body orbiting at large heliocentric distances [18, 25].

The comparison of UCAMMs, and micrometeorites in general, with the future samples from Hayabusa 2 and OSIRIS-REx will provide new constraints on the association of primitive organic matter and minerals in the early solar system. I will review these recent results and emphasize why both the experimental developments that we used to analyze UCAMMs and ion irradiation experiments are of interest for a better understanding of Hayabusa 2 and OSIRIS-REx samples.

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