Assessing the roles of comets in delivering volatile elements to Earth

BERNARD MARTY[1], KATHRIN ALTWEGG[2], MARTIN RUBIN[2] AND THE ROSINA TEAM

[1]CRPG-CNRS, Université de Lorraine, Vandoeuvre les Nancy France. bmarty@crpg.cnrs-nancy.fr
[2]Physikalisches Institut, University of Bern, Sidlerstr. 5, CH-3012 Bern, Switzerland.

Comets are volatile-rich objects and are presumably among the most pristine solar system materials. Their abundant volatile species, mainly in the form of ices, are intimately mixed with refractory silicate-rich phases and organics, the origins of which - either in the protosolar disk or the molecular cloud/interstellar medium - are actively debated. The origin of cometary matter and the potential contribution of comets to inner planet atmospheres are long-standing problems that were central in the definition of the ESA Rosetta mission exploring Comet 67P/Churyumov-Gerasimenko (67P/C-G).

The Double Focusing Mass Spectrometer ROSINA (DFMS) [1] on-board of the Rosetta spacecraft has been analyzing the elemental and isotopic composition of gases released by 67P/C-G during several months. These analyses have shown, among other results, that (i) the studied comet is rich in deuterium, with a D/H ratio three times the oceans' value [2], (ii) the trapping/formation temperature of ice was low around 30 K and the cometary matter has never been heated up above this temperature [3], and (iii) cometary ice contains molecular oxygen that correlates well with H_2O, thus suggesting that ice grains were irradiated for long before comet assembly [4]. All together, these results demonstrate that 67P/C-G has preserved pristine, possibly presolar, material.

Noble gases are key tracers for the origin(s) and processing of volatile elements in the nascent solar system and in planetary atmospheres. The analysis of argon in Comet 67P/C-G has shown that comets are rich in noble gases [5], suggesting that a significant fraction of these elements in the terrestrial atmosphere could be cometary [6]. The ROSINA DFMS has detected during a dedicated period in May 2016 not only argon, but also xenon. In this talk we will present the results with special emphasis on Xe, and discuss the implications for solar system formation scenarios, as well as for the origin of volatile species on inner planets.

[1] H. Balsiger *et al. Space Sci. Rev.* **128,** 745–801 (2007). [2] K. Altwegg *et al., Science* **347,** 6220, e1261952 (2015). [3] M. Rubin *et al. Science* **348**, 232-235. [4] Bieler *et al. Nature* **526**, 678-681. [5] H. Balsiger *et al. Sci. Adv.* **1**, 8, e1500377 (2015). [6] B. Marty et al. *EPSL.* **441,** 91 (2016).

This abstract is too long to be accepted for publication. Please revise it so that it fits into the column on one page.