Composition of cometary volatiles: Implications for the delivery of atmospheric species and for solar system dynamics

B. MARTY*[1], K. ALTWEGG[2]. G. AVICE[1], A. MORBIDELLI[3], AND THE ROSINA TEAM

[1] CRPG-CNRS, Université de Lorraine, Nancy, France
[2] Physikalisches Institut, University of Bern, Switzerland
[3] Observatoire de la Côte d'Azur, Nice, France
(*correspondence:bmarty@crpg.cnrs-nancy.fr)

The composition of volatile elements in the outer solar system is still badly known. A better knowledge of the elemental and isotopic compositions of major volatiles - hydrogen, carbon, nitrogen - and of noble gases will shed light on important planetary issues such as the origin (solar system versus interstellar) of ices, of the isotopic enrichments in D, ^{15}N and ^{17,18}O relative to the protosolar nebula composition, and the possible contribution of icy bodies to planetary atmospheres (e.g., Titan, Earth, Venus, Mars, the lunar surface). Ionization experiments of gaseous mixtures [1,2] suggest that elemental and isotopic fractionations of noble gases, nitrogen and oxygen originated in the disk illuminated by the young Sun or nearby stars, and do not require ISM contributions, but they do not exclude it either.

The ROSINA mass spectrometer system on board of the ROSETTA spacecraft is currently analysing volatile elements degassed by Comet 67P/Churyumov-Gerasimenko. Elevated D/H ratios together with high amounts of noble gases permit to set stringent constraints on the delivery of water and organics onto planetary surfaces [3]. Terrestrial volatiles appear to be dominated by asteroidal sources, with the exception of atmospheric noble gases which are instead consistent with a cometary origin. Based on the ^{36}Ar content of the terrestrial atmosphere, comets could have delivered organics in quantities comparable to the modern biosphere. The specific composition of the Martian atmosphere is commonly thought to have been shaped by escape fractionation processes. However, mass balance considerations suggest that cometary contributions to the thin Martian atmosphere should also be considered. According to current models of solar system dynamics [4],the cometary delivery of atmospheric noble gases to the inner solar system might have been delayed by several hundreds of Ma,

[1] Chakraborthy et al. (2014), *PNAS* 111:14704–14709. [2] Kuga et al. (2015) *PNAS* doi/10.1073/pnas.1502796112. [3] Marty et al., *EPSL*, in the press. [4] Morbidelli et al. (2012) *EPSL* 355, 144-151.