In situ analyses of cometary dust from Rosetta/COSIMA and cometary dust from terrestrial collections

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Cometary dust particles hold information on the material present at the time of Solar System formation. The Rosetta mission investigated the structure and composition of comet 67P/Churyumov-Gerasimenko (hereafter 67P) between 2014 and 2016. The Rosetta/COSIMA mass spectrometer [1] collected about 35 000 particles that were ejected from the nucleus of 67P, and analysed about 200 of them. The elemental composition of individual particles was measured for major and some minor elements, and some particles were also analysed after a sputtering sequence, giving access to their sub-surface composition. The 67P cometary dust particles are enriched in carbon compared to the meteoritic CI reference value [2], with a slightly higher H/C ratio and a N/C ratio compatible with the CI value, respectively [3,4]. There is a difference between the sub-surface and the surface compositions, with a solar-like composition in the sub-surface, while some elements (like Mg and Fe) are depleted at the surface of the particles. We suggest that this results from pre-accretion irradiation of the building units of 67P dust particle. Such a pattern is indeed observed at the surface of lunar grains [5] and asteroid samples [6] that are submitted to irradiation from the Sun.

Cometary dust is also present in cosmic dust collections on Earth. Chondritic porous anhydrous IDPs collected in the stratosphere and ultracarbonaceous Antarctic micrometeorites (UCAMMs) are probably of cometary origin [e.g. 7]. Irradiated rims were identified in minerals embedded in inorganic matter in UCAMMs, also suggesting pre-accretion irradiation of these minerals [8]. The organic matter in UCAMMs show several phases with distinct elemental and isotopic compositions, suggesting a formation from several reservoirs [9].

[1] Kissel J. et al, (2007) *Space Sci. Rev.* **128**, 823–867. [2] Bardyn A. et al. (2017) *MNRAS* **469**, S712–S722. [3] Fray N. et al. (2017) *MNRAS* **469**, S506–S516. [4] Isnard R. et al. (2018) *Astron. Astrophys.* **630**, A27. [5] Keller L.P. and McKay D.S. (1997) *Geochim. Cosmochim. Acta* **61**, 2331–2341. [6] Noguchi T. et al. (2014) *Meteoritics Planet. Sci.* **49**, 188–214. [7] Engrand et al. (2024) In: Comets III. Univ. Arizona Press, pp 577–619. [8] Engrand C. et al. (2020) *Lunar Planet. Sci. Conf.* **51**, 2008. [9] Rojas J. et al. (2024) *Nature Astron.* **8**, 1553–1561.