Storage and release of volatiles in small bodies

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Small bodies in our solar system are considered left-overs from the era of planet formation that contain significant reservoirs of organics and volatiles [1,2]. The small bodies encompass multiple groups of diverse objects, such as comets, asteroids, Centaurs, Trojans, etc. At this stage, groups are loosely defined by their orbital and physical properties. For example, Jupiter family comets are objects with a specific dynamical relation to Jupiter (Tisserand parameter below 3) that show sublimation activity. Asteroids are found between Jupiter and Mars, and their circular orbits have a Tisserand parameter larger than 3. Traditionally, comets are considered volatile-rich and asteroids "dry". We now know that these separations are not as simple. There are several objects in the Main Belt that show repeated evidence of sublimation activity, such as 133P/Elst-Pizzarro and 238P/Read [3]. Many of these objects seem to be dynamically stable in the main belt, ruling out that they are cometary interlopers. Not all asteroids that grow a tail or dusty coma are sublimating; disruptions such as rotational fragmentation and impacts can loft material from the surface [4,5]. On the other side of the spectrum, the Rosetta results suggest that comets might contain much less ice than previously assumed, with estimated refractory-to-ice mass ratios in the nucleus between 0.2 and 7 [6]. The discovery of objects on comet-like trajectories that show no evidence of activity ("Manx comets", [7]) suggests that there are either asteroidal, purely rocky objects in the Oort cloud, or that comets can effectively devolatize thermally accessible ices and survive intact. To interpret the information that small bodies can provide us on the conditions of the disk from which they formed, to better understand their role in the delivery of volatiles and organic molecules to the inner solar system, and to assess what resources they can provide it is critical to understand how small bodies evolve through, and because of, activity. It is imperative that we acquire a complete picture of the nuclei of comets in different evolutionary stages through robotic planetary missions. In this contribution, I will argue that for this, we will first need to establish firm criteria in how to select objects that represent their full life cycle.

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