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The role of collisional compaction in solar system minor bodies

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During the early stages of solar system formation the consolidation of chondritic asteroids and comets took place. The structure and chemical composition of these minor bodies contain important clues on the different impact histories that they underwent depending on their particular formation regions. Recent laboratory studies and observational data compiled from comets, meteorites and meteoroids (Blum et al., 2006) suggest that the porosity of these bodies should have decreased with time depending of the degree of collisions, aqueous alteration and heating. For typical rocky targets strength and gravity are the main properties that are defining the formation of impact crater and subsequently the mineralogy of the shocked materials. However, little is known on the influence of porosity on the impact process although the crushing of pore space is an efficient mechanism for absorbing shock waves, also increasing the post-shock temperatures (Wünnemann et al., 2006).

The mineralogy and textures of the different groups of carbonaceus chondrites can provide additional clues on these key processes. For example, important differences in the aqueous alteration suffered by CM carbonaceous chondrites suggest that this was not a process affecting entirely their parent body. Most CM carbonaceous chondrites are breccias whose forming minerals were affected by water in order to form clay minerals, sulfides, carbonates, and other hydrated phases (Rubin et al., 2007). Likely collisional heating played a role mobilizing water in those outer regions exposed to impacts. Not only shock compaction participated in decreasing the microporosity of these bodies, because precipitation of hydrated phases also participated by filling the voids (Trigo-Rodríguez et al., 2006). In this simplified picture, those bodies that have remained for almost their entire history in distant regions of the solar system, like e.g. Kuiper belt comet 81P/Wild 2, have prevented compaction and devolatilization by being exposed to relatively low collisional rates and from impactors typically exhibiting more modest relative velocities. Recent studies on the chemical composition and meteoroids structure obtained by Stardust Preliminary Examination Team suggest that this comet is one the most pristine objects studied so far (Brownlee et al., 2006). Chemical and isotopic compositional similarities with carbonaceous chondrites suggest that the main differences among comets and (small) chondritic asteroids would be different collisional histories. This picture is also consistent with the apparent absence of hydrated minerals in the recovered cometary grains of 81P/Wild 2, but abundance of water in cometary materials would induce extensive aqueous alteration in comets subjected to higher degrees of collisional or/and radiative heating. Consequently, collisional compaction of highly-porous volatile-rich progenitors would have lead to devolatilization and subsequent consolidation of present day chondritic asteroids. This would be the main reason that these primitive asteroids exhibit relatively low porosity and higher degrees of aqueous alteration than pristine comets. In this framework, future missions like e.g. Rosetta to other comets can provide additional clues on the role of collisional compaction in the evolution of the different cometary families. In any case, additional studies of the tensile strength and porosity of primitive solar system bodies can be obtained from the study of the fragmentation of meteoroids in the atmosphere (Trigo-Rodríguez and Llorca, 2006). First results suggest that short period comets exposed to solar heating and collisions have altered their primeval properties. Future advances in this topic can provide clues on the role of comets as a source of water and organic materials to the Earth (Notesco et al., 2003, Levasseur-Regourd et al., 2006)

REFERENCES

Blum J., R. Schräpler, B.J.R. Davidson and J.M. Trigo-Rodríguez (2006). Ap. J. 652, 1768-1781.

Brownlee D. et al. (2006) Science 314, 1711-1716.

Levasseur-Regourd A.C., J. Lasue, and E. Desvoivres (2006) Orig. Life Evol. Biosph. 36, 507-514.

Notesco G., A. Bar-Nun and T. Owen (2003) Icarus 162, 183-189.

Rubin A.E., J.M. Trigo-Rodríguez, H. Huber, and J. T. Wasson (2007) Geochim. et Cosmoch. Acta 71, 2361-2382.

Trigo-Rodríguez J.M., Rubin A.E. and J.T. Wasson (2006) Geochim. et Cosmoch. Acta 70, 1271-1290.

Trigo-Rodríguez J.M. and J. Llorca (2006) Mon. Not. Royal Astron. Soc. 372, 655-660.

Wünneman K., G. S. Collins and H.J. Melosh (2006) Icarus 180, 514-527.