The chemical composition of impact craters on Titan

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We investigate nine Titan impact craters using Visual and Infrared Mapping Spectrometer (VIMS) data and a radiative transfer code (RT) [e.g. 1] in addition to emissivity data, in order to constrain the spectral behavior and composition of the craters. Past studies have looked at the chemical composition of impact craters either by using qualitative comparisons between craters [e.g. 2;3] or by combining all craters into a single unit [4], rather than separating them by geographic location or degradation state. Here, we use a radiative transfer model to first estimate the atmospheric contribution to the data, then extract the surface albedos of the impact crater subunits, and finally constrain their composition by using a library of candidate Titan materials. Following the general characterization of the impact craters, we study two impact crater subunits, the ‘crater floor’, which refers to the bottom of a crater, and the ‘ejecta blanket’, which is the material thrown out of the crater during an impact event. The results show that Titan’s mid-latitude plain craters: Afekan, Soi, and Forseti, in addition to Sinlap and Menrva are enriched in an OH-bearing constituent (likely water-ice) in an organic based mixture, while the equatorial dune craters: Selk, Ksa, Guabonito, and Santorini, appear to be purely composed of organic material (mainly unknown dune dark material). This follows the pattern seen in [4], where midlatitude alluvial fans, undifferentiated plains, and labyrinths were found to consist of a tholin-like and water-ice mixture, while the equatorial undifferentiated plains, hummocky terrains, dunes, and variable plains were found to consist of a dark material and tholin-like mixture in their very top layers. These observations also agree with the evolution scenario proposed by [3], wherein the impact cratering process produces a mixture of organic material and water ice, which is later “cleaned” through fluvial erosion in the midlatitude plains; a cleaning process that does not appear to operate in the equatorial dunes, which seem to be quickly covered by a thin layer of sand sediment. This scenario agrees with other
works that suggest that atmospheric deposition is similar in the low-latitudes and midlatitudes on Titan, but with more rain falling onto the higher latitudes causing additional processing of materials in those regions [e.g., 5]. In either case, it appears that active processes are working to shape the surface of Titan, and it remains a dynamic world in the present day.