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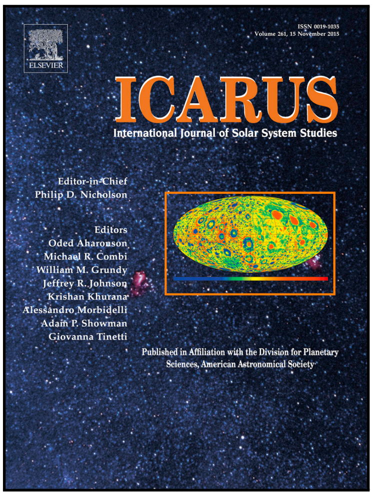

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Abstract

We present our research on compositional mapping of the Martian South Polar Residual Cap (SPRC), especially the detection of organic signatures within the dust content of the ice, based on hyperspectral data analysis. The SPRC is the main region of interest for this investigation, because of the unique CO_2 ice sublimation features that cover the surface. These flat floored, circular depressions are highly dynamic, and we infer frequently expose dust particles previously trapped within the ice during the wintertime. Here we identify suitable regions for potential dust exposure on the SPRC, and utilise data from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) on board NASA's Mars Reconnaissance Orbiter (MRO) satellite to examine infrared spectra of dark regions assumed to be composed mainly of dust particles to establish their mineral composition, to eliminate the effects of ices on sub-pixel dusty features, and to look for signatures indicative of Polycyclic Aromatic Hydrocarbons (PAHs). Spectral mapping has identified compositional differences between depression rims and the majority of the SPRC and CRISM spectra have been corrected to minimise the influence of CO_2 ice. Whilst no conclusive evidence for PAHs has been found within the detectability limits of the CRISM instrument, depression rims are shown to have higher water content than regions of featureless ice, and there are possible indications of magnesium carbonate within the dark, dusty regions.

1. Introduction

Mars has long been the subject of scientific exploration, with a focus on investigations of conditions on ancient Mars, evidence of life, and the search for habitable environments (Fairén et al., 2010). During the last few decades, the polar regions have emerged as regions with increased scientific interest. Mars' polar regions, both in the northern and southern hemispheres, have residual caps that survive throughout each hemisphere's respective summer; the North Polar Residual Cap (NPRC) registers as predominately water ice, while the longer, colder winter in the southern hemisphere due to the orbit obliquity means that the South Polar Residual Cap is largely composed of CO_2 ice (Titus et al., 2003; Byrne, 2009) which overlays, and is surrounded by, water ice layers known as Polar Layered Deposits (PLD; Paige et al., 1990; Piqueux et al., 2008).

While the Martian climate may have been more 'Earth-like' in the past, with warmer, wetter conditions and an active magnetosphere (Fassett and Head, 2010), conditions on present day Mars are much less habitable. The attenuation of Mars' magnetosphere led to a loss of atmosphere through solar wind interactions, leaving the average temperatures and atmospheric surface pressures much lower than on the Earth (Johnson et al., 1996; Kass and Yung, 1995; Melosh and Vickery, 1989). Liquid water generally cannot exist on the surface of Mars due to low atmospheric temperatures and pressures and both water and CO_2 ice sublimate directly from the solid to vapour phase (Blackburn et al., 2010). The lack of a significant atmosphere on present-day Mars means that the surface is exposed to high levels of UV radiation, which would have a deleterious effect on any biological material on the planetary surface (Cockell et al., 2000);

However, the annual, seasonal sublimation and deposition of CO_2 ice on the SPRC leads to an unique surface feature known broadly as 'Swiss Cheese Terrain' (SCT), characterised by flat floored, circular depressions that can intersect to form intricate patterns reminiscent of Emmental Swiss Cheese (Malin et al., 2001). The SCT features are of particular interest as their seasonal sublimation cycles expose material previously shielded within the SPRC (Jian et al., 2009). More specifically, it would be of great interest to examine evidence of one particular class of organic molecules, Polycyclic Aromatic Hydrocarbons (PAHs), that may have been afforded protection from harmful radiation within the SPRC (Dartnell et al., 2012). While any dust trapped within the SPRC may have undergone past exposure during the geological history of Mars, there are potential mechanisms for present day sources of PAHs. In addition, as the evolution of the SPRC is still not