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Multi-instrument data analysis for interpretation of the Martian North polar layered deposits

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The Martian polar caps have engendered substantial study due to their spiral morphology, layered structure and the seasonal variability in thickness of the uppermost H_2O and CO_2 ice layers.
We demonstrate a multi-instrument study of exposed and buried north polar layers using data from ESA's Mars Express (MEx) and NASA's Mars Reconnaissance Orbiter (MRO) missions.
We perform analysis of high resolution images from MRO's HiRISE, which provide textural and morphological information about surface features larger than ∼0.3m, with NIR hyperspectral data from MRO CRISM, which allows study of surface mineralogy at a maximum resolution of 18 m/pixel. Stereo-derived topography is provided by MEx's HRSC. Together with these surficial observations we interpret radargrams from MRO SHARAD to obtain information about layered structures at a horizontal resolution between 0.3 and 3 kilometers and a free-space vertical resolution of 15 meters (vertical resolution depends on the dielectric properties of the medium). This combination of datasets allows us to attempt to correlate polar layering, made visible by dielectric interfaces between beds, with surface mineralogies and structures outcropping at specific stratigraphic levels. We analyse two opposite areas of the north polar cap with the intention to characterise in multiple datasets each geologic unit identified in the north polar cap's stratigraphy (mapped by e.g. [1]).
We selected deposits observed in Chasma Boreale and Olympia Cavi because these areas allow us to observe and map strata at opposing sides of the north polar cap.
Using the CRISM Analysis Tool and spectral summary parameters [2] we map the spectral characteristics of the two areas that show H_2O and CO_2 ice layering exposed on polar scarps. Through spatial-registration in a GIS with HRSC topography and HiRISE imagery we assess the mineralogical and morphological characteristics of exposed layers.
In order to constrain the cross section between the two selected localities we choose SHARAD radargrams that most closely align with the transect between the sites. We interpret sub-horizontal features to be due to dielectric interfaces involving the deposits analysed.
Our interpretation of radargrams in the context of compositional and structural constraints, from areas where pertinent beds outcrop, illustrates how joint analysis of surface and sub-surface data can benefit geological interpretation of planetary surfaces and subsurfaces. This technique applied to Mars' north polar layered deposits may offer additional constraint on morphology of internal layering resulting from seasonal deposition/sublimation cycles over varying obliquity [3].
References: [1] Tanaka et al. (2008), Icarus, 196, p. 318-358, doi:10.1016/j.icarus.2008.01.021. [2] Viviano-Beck et al. (2014), J. Geophys. Res. Planets, 119, p. 1403-1431, doi:10.1002/2014JE004627..[3] Putzig et al. (2009), Icarus, 204, p. 443-457, doi:10.1016/j.icarus.2009.07.034.