THE SCIENCE VALUE OF ICE RESOURCE MAPPING: MARS SUBSURFACE WATER ICE MAPPING (SWIM).

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Summary: The majority of mission architectures currently considered to transport humans to Mars involve some form of "living off the land". Water ice, which is essential for life support and can be used to generate fuel is the most valuable of Mars' resources. The Mars Subsurface Water Ice Mapping project (SWIM) has been tasked with providing the community with GIS ready maps of non-polar ice deposits - see Putzig et al [this conference] for more details and SWIM.psi.edu for the products themselves. Beyond landing site selection and mission planning, the SWIM maps contain a treasure trove of information for scientific analysis. At Mars 9 we will present the scientific projects to come out of the SWIM project and encourage members of the community to incorporate the maps within their research projects.

The SWIM Project: is unique in that it integrates all appropriate orbital datasets to provide a holistic assessment of accessible Martian ice reserves. By employing a team with a diverse background of relevant expertise and by leveraging new data processing techniques, the SWIM Project has generated the most up-to-date maps of Martian water ice distribution. To search for and assess the presence of shallow ice across our study regions, the SWIM project uses the following techniques and datasets: neutron-detected hydrogen (MONS), thermal behavior (both TES and THEMIS), multi-scale geomorphology (HiRISE, CTX, HRSC, and MOLA), and radar surface and subsurface echoes (SHARAD). To extract the maximum amount of information from the datasets, we employ newly developed techniques, including: surface radar reflectivity [1], and refined thermal modeling [2] along with more traditional approaches to geomorphological mapping [3] and interpretation of discrete radar-detected subsurface interfaces [4].

To enable a quantitative assessment of how consistent (or inconsistent) the various remote sensing datasets are with the presence of shallow (<5 m) and deep (>5 m) ice across our study regions, we introduced the **SWIM Equation**:

$$C_I = (C_N + C_T + C_G + C_{RS} + C_{RD}) / 5$$

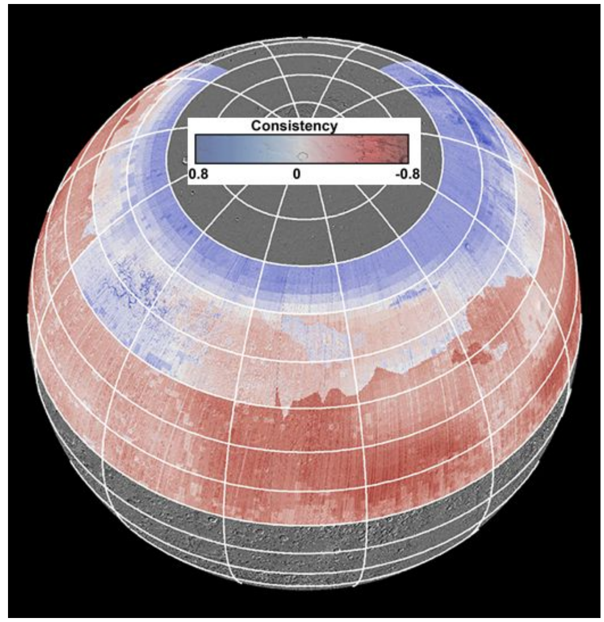

FIGURE 1. *SWIM Ice consistency Map of the Northern Hemisphere of Mars (LPSC edition of the map).*

Ice consistency values C_X range between -1 and +1, where -1 means that the data are inconsistent with the presence of ice, 0 means that the data give no indications of the presence or absence of ice, and +1 means that the data are consistent with the presence of ice (figure. 1). Putzig et al will present a detailed overview of the methodologies behind swim.

Science Value of Resource Mapping Products: In regards to sending humans to Mars, where ice will be a commodity, mission planners primary concern will be: the location of ice; the amount of ice (in terms of concentration and volume) and the depth to the ice - the thickness of the overburden. These three considerations have defined the SWIM study and consequently, the project has generated an unprecedented view of the martian northern hemisphere non-polar ice reservoir (figure 1).

Quantifying and constraining the martian non-polar ice reservoir is of course scientifically valuable, but is limited in that it only informs us about the present situation. Ultimately, we want to know how and when the ice was deposited, the processes governing the flux of volatiles and the relationship between polar and non-polar ice reserves. Indeed, for a thorough exploration of the pressing questions concerning martian ice see the upcoming ICE-SAG report. The

SWIM map products provide a valuable scientific resource with which to tackle the questions outlined by ICE-SAG.

At Mars 9: we will frame the SWIM products within the context of the ICE-SAG findings and present our initial scientific analysis. We will explore three main scientific focuses:

(1) *the heterogeneity present within the mapped ice deposits*. Due to broad range of data sets employed to create our ice consistency maps, it is possible to subdivide the apparent ice-rich areas into multiple units. For example, deposits that have radar detectable bases, such as lobate debris aprons, can be clearly delineated.

The SWIM project has significantly increased the mapping of deposits within the northern plains. For example, the original mapping work of Bramson et al [5] has been significantly extended and the new map has found the deposits to stretch further to the south than previously appreciated (figure 2). Such detailed delineation provides more constraints with which to interpret the formation of a given unit.

(2) *Age/stratigraphy of the mapped ice deposits*. Applying new crater size frequency distribution surveys and leveraging previous surveys we will present a chronological framework to accompany the ice consistency maps. From previous studies we know the glacial ice present within the LDA/LVF was deposited >100 Ma [e.g. 6]. In contrast ice associated with mantling deposits may be orders of magnitude younger. Based on the unit delineation discussed above, we will present their relative ages associated with our maps.

(3) *Science unrelated to ice*. The generation of the consistency maps can produce "false positives" within individual datasets. False positives refer to the positive identification of surface/nearsurface properties that are consistent with ice, but are in fact related to non-ice conditions. For example, the radar surface power map uses nearsurface density measurements as a proxy for ice. As a result, dry. low density materials such as thick dust deposits become mapped out. Many of the false positives contain valuable scientific information which can be leveraged for a myriad of projects. We will present our most promising non-ice mapping products and associated interpretation.

To Learn More: For more information on the SWIM project, GIS-ready map products, and news of the latest releases, visit https://swim.psi.edu and follow us on Twitter @RedPlanetSWIM.

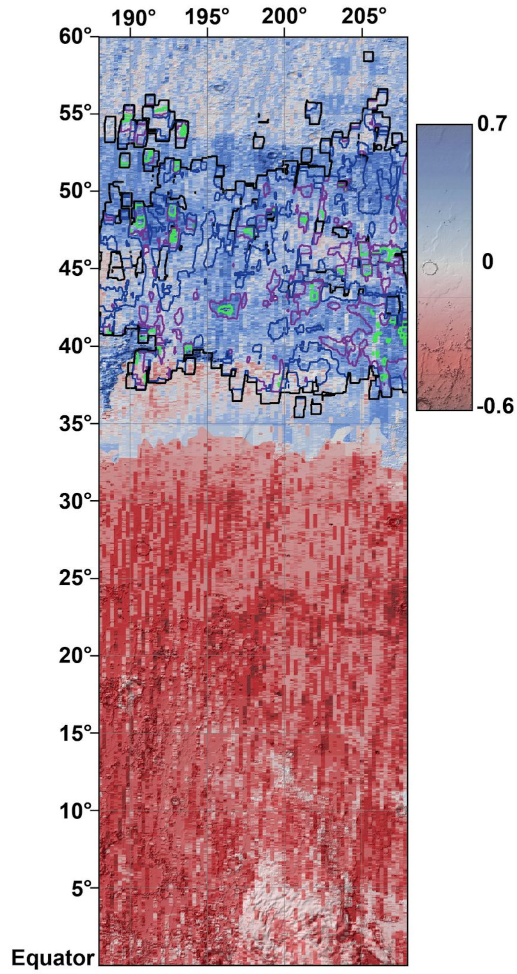

Figure 2. SWIM consistency map of Arcadia Planitia. *The Extent and depth of icy units are highlighted by the depth contours (15 m intervals, Black = 15 - Green = 60m)*

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