SHARAD RADARGRAM ANALYSIS TOOL DEVELOPMENT IN JMARS. J. B. Adler[1], S. Anwar[2], S. Dickenshied[2], S. Carter[2] [1]Arizona State University School of Earth and Space Exploration, Tempe, AZ, 85251, USA [2]Mars Space Flight Facility, Arizona State University, Tempe, AZ, 85287, USA (Jacob.B.Adler@asu.edu).

Introduction: JMARS is a free GIS software developed at ASU for mission planning and data analysis [1-2]. New tools in JMARS have been developed for human exploration and In-Situ Resource Utilization (ISRU) mapping [3]. Principal among the resource requirements for NASA's human mission to Mars architecture is the availability of mineable water [4]. The human landing site committee posited that 20,000kg of water would be required to sustain each crewed mission to the surface [4]. As a result of this requirement, many of the proposed human landing sites would rely on extracting water from subsurface ice sheets detected at sites from 40°N and poleward [4-5]. The Mars Water In-Situ Resource Utilization (ISRU) Planning (M-WIP) study concluded that hydrated mineral, buried ice sheet, and regolith resources should each continue to be considered as potential water sources, since 1) we don't know enough about the abundance, heterogeneity, or mineability of these deposits from current orbital assets and 2) water extraction engineering prototypes are not yet able to accurately test the nuances of each regime (due to 1) [6]. Poleward sites (while containing substantial surface or buried ice resources) remain out of bounds for the Mars 2020 rover and sample return (≤30° lat.) [7] and for NASA's human exploration plans in the 2030s (≤50°) [4]. However, glacial landforms and ice influenced morphologies can be found over 40° away from the Martian poles. Additionally, models during periods of polar wander or high obliquity lend credence to morphologic evidence of past glacial activity closer to the modern equator [8]. *It is thus important to study subsurface ice sheets at all latitudes, and the new tools developed in JMARS 2035 [3] can help landing site proposers locate these resource deposits, quantify their extent, and assess extractability.*

Tool Development: Radargrams produced from the SHARAD (SHAllow RADar) instrument onboard the Mars Reconnaissance Orbiter have been used to identify subsurface ice sheets, study polar processes, and map subsurface lava flows [9-11]. SHARAD has a vertical resolution of 15m (free-space) and a horizontal resolution of 0.3-1km (along track). Ground tracks are ~3-6km apart. JMARS allows visualization and analysis of all (16,720) SHARAD radargrams available on the PDS [12]. The JMARS SHARAD layer can toggle display of the data ground tracks, and can be overlaid on any combination of other Mars orbital datasets. Additionally, all radargram images can be viewed in full resolution. A dynamic charting tool graphs pixel depth vs radar strength and can be exported in a number of formats (Fig. 1).

JMARS users also have the ability to annotate radargram images and draw identified "surfaces". These annotations and drawn shapes can be exported either as pixel locations or converted to dielectric constants. By entering either the estimated depth (Δx) or dielectric constant (ε_r), the charting tool can calculate the remaining unknown quantities according to: $v = \Delta x/\Delta t = c/\sqrt{\varepsilon_r}$ since the time delay Δt is measured by SHARAD.

Ground tracks can also be colorized where reflectors are marked and color schemes can be chosen for any number of subsurface reflectors. These annotated segments can be plotted in the charting window alongside any other numeric dataset on our server.

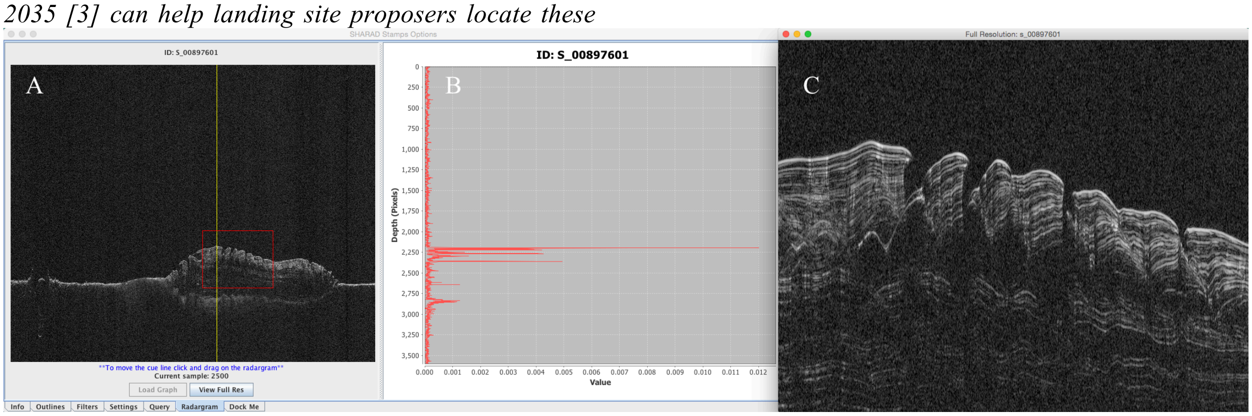

Fig 1. JMARS 2035 Screenshot – The interactive charting tool (A+B) includes a draggable position bar (yellow) and zoom box (red) which can both be dragged across the image to update the chart (B) and full resolution window (C).

Map sampled statistics can be generated along the ground tracks or annotated segments, and these statistics could serve to assess the viability (ease of accessing, drilling, and extracting) of many of the proposed Resource ROI sites being considered for human exploration [4-5]. This capability is useful for the ISRU mining community as JMARS can calculate surface roughness, dustiness, albedo, elevation, temperature, wind speed, thermal inertia, etc. above a resource deposit. Figure 2 shows where the proposed human exploration zones are located relative to the global map of SHARAD ground tracks and the NASA Special Regions map [13]. We see that SHARAD coverage is generally sparser near the equator, but several regions of increased spatial resolution exist (including Deuteronilus Mensae [10]). Exploration zones poleward of L3 (region of suspected buried ice) or in increased radar coverage are prime targets for investigation with these new tools.

Future Work: We are further improving the SHARAD layer by adding the ability to upload a radar cluttergram and overlay the modeled image on the radargram. This will assist with subsurface layer drawing and analysis.

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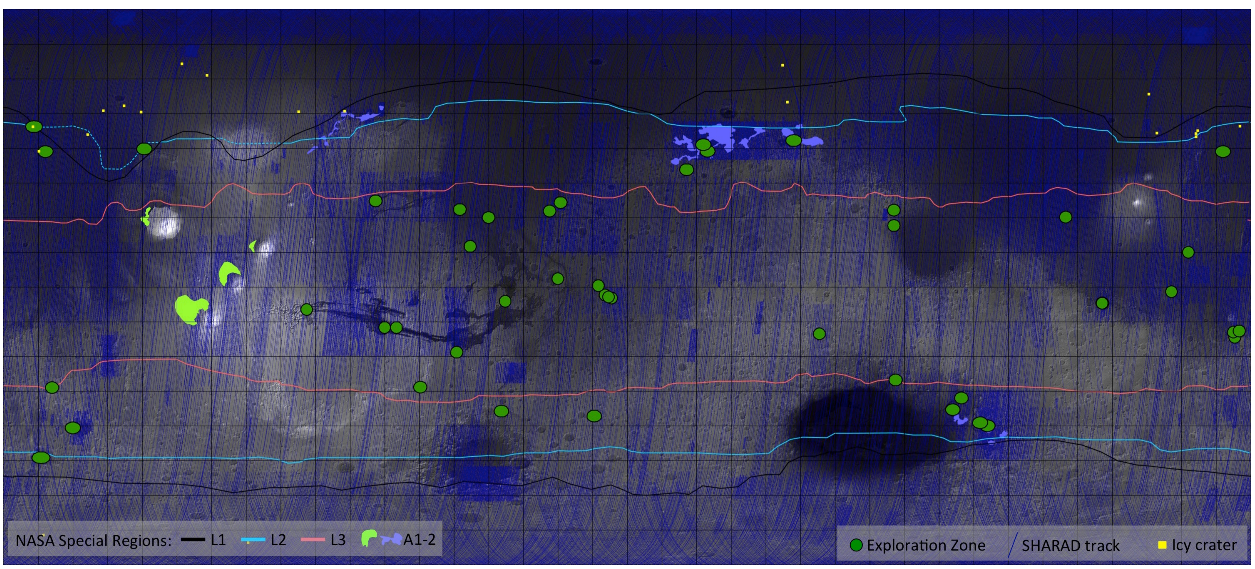

Fig. 2. JMARS 2035 Screenshot - Global map of human exploration zones [4-5], SHARAD ground tracks [9], and NASA Special Regions [13]. L1 – neutron counts = 6; L2 to poles – continuous shallow ice within 0.3m of surface; L2 to L3 – discontinuous shallow ice within 5m of surface; L3 to L3 – no shallow ice within 5m of the surface observed or suspected; A1 and A2 – SHARAD buried ice detections; Icy crater – locations of ice-exposing new impacts [14].