Human Landing Sites Study (HLS^2) Newsletter – December 2019

Hello all:

We wanted to send some updates on HLS^2 and Mars-related news for 2019. Key HLS^2 highlights from this newsletter include the progress on subsurface ice and hydrated mineral mapping efforts, announcements of two upcoming Google Hangout briefings, and an announcement of an upcoming Mars GIS survey!

Update on Mapping of Water Deposits to Support Mars Exploration Program Studies

Coming out of the first HLS^2 workshop, there was a strong consensus that knowledge of and access to water feedstocks on Mars is critical to landing site selection. Since then, three water mapping teams have been combining existing data sets to bridge the knowledge gaps around both hydrated mineral and subsurface ice water deposits on Mars. These teams will produce next-generation, GIS-compatible water maps for Mars.

Subsurface Water Ice

The Subsurface Water Ice Mapping (SWIM) project, led by Nathaniel Putzig and Gareth Morgan of the Planetary Science Institute, completed their map of subsurface ice deposits across the northern hemisphere by integrating neutron, thermal and radar data sets gathered by various Mars orbiters (Figure 1). The SWIM team's results show shallow ice (within 0-5 m of the subsurface) extending equatorward as far as 30^{o}N latitude in some places. The SWIM team is now working on an extension to refine their maps and extend their work to other low elevation regions in both the northern and southern hemispheres. The results shown in these maps will need to be validated by ground truthing (e.g. ice exposing crater impacts, ice scarps, etc.) and by future missions potentially carrying a synthetic aperture radar. If you have any comments or questions about these maps please let us know. We want to hear your ideas on how they can be made most useful for work at future human landing site workshops.

Learn more about the SWIM Project here:

SWIM Project website: https://swim.psi.edu/
SWIM HLS^2 Google Hangout: https://www.youtube.com/watch?time_continue=1&v=ARcVaz5rmV4

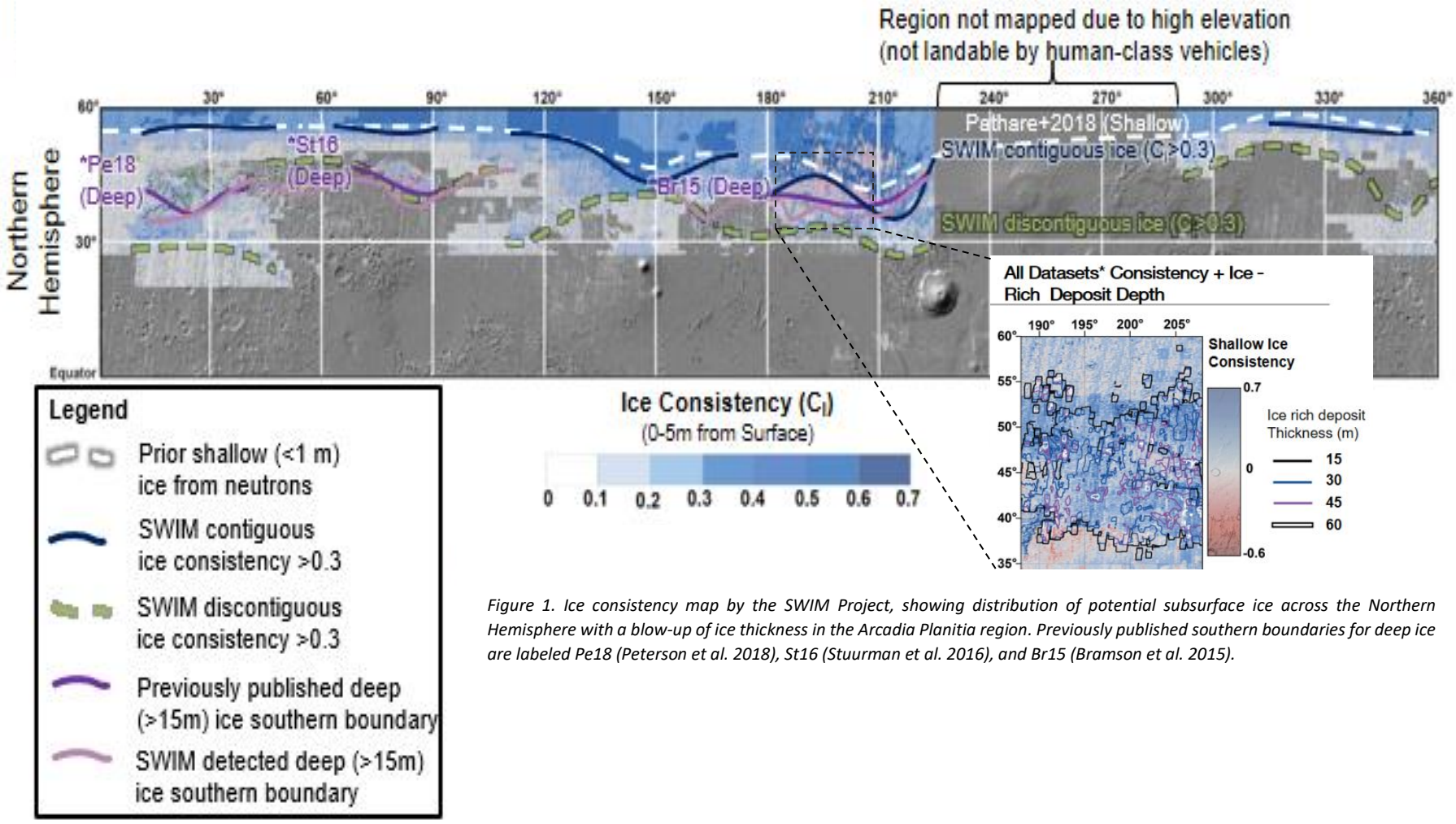

Figure 1. Ice consistency map by the SWIM Project, showing distribution of potential subsurface ice across the Northern Hemisphere with a blow-up of ice thickness in the Arcadia Planitia region. Previously published southern boundaries for deep ice are labeled Pe18 (Peterson et al. 2018), St16 (Stuurman et al. 2016), and Br15 (Bramson et al. 2015).

Hydrated Minerals

Progress continues on developing global maps of hydrated minerals. Using two unique methods and data sets from the Mars Reconnaissance Orbiter (MRO) and Mars Express, John Carter and François Poulet at Université Paris-Sud published the first global map of abundance for water in aqueous minerals (Figure 2). Prior to the work of Carter & Poulet, approximately 1000 sites with aqueous mineral deposits had been identified as pinpoints on a map. Now, several hundred thousand hydrated mineral sites are characterized and mapped, showing their 2D geometry and abundance. These results can help determine regions of interest for future missions and will be incorporated into GIS-friendly datasets.

An additional map is forthcoming from Frank Seelos' team at the Johns Hopkins University Applied Physics Laboratory. Mapping and quantifying hydrated minerals is challenging, and additional validation methods may be necessary to determine the extent and abundance before they can be reliably counted on for Mars in-situ resource utilization (ISRU).

Learn more about hydrated mineral mapping here:
https://www.hou.usra.edu/meetings/lpsc2019/pdf/1177.pdf

Participate in Mars GIS Survey to Meet Your HLS² GIS Needs

At a Jan 2017 stakeholders workshop, attendees identified a Mars GIS (Geographical Information Systems) user survey as one of the highest priorities for GIS/ HLS² communities. Make GIS platforms and tools work best for you. Participate in a Mars GIS user survey. The MarsGIS steering committee is working to develop and distribute a survey to close this gap. Your time and input are extremely valued – the more we know about your needs and wishes, the better the GIS tools will be. Be on the lookout for this upcoming survey before the end of the year.

Announcement of Human Landing Sites Hangouts

We will be continuing our Human Landing Sites Hangouts (HLSH) lecture series on subjects relevant to the HLS² community. Below is the schedule for upcoming briefings. We will be hosting these Hangouts on our YouTube channel (found here):

Title	Speaker(s)
Exploration Zones Briefing: Columbus Crater, Gusev Crater, Oyama	Kennda Lynch, Alex Longo, Briony Horgan
Paving the Road to Mars: Civil Engineering at the Human Landing Site	Rob Mueller, Michelle Munk, Pete Carrato
Hydrated Minerals Mapping Briefing	Sydney Do, Francois Poulet, and Frank Seelos

These interactive lectures will be livestreamed via YouTube, recorded, and made available online. We will soon send you calendar invites for the events. We hope that you will be able to join us.

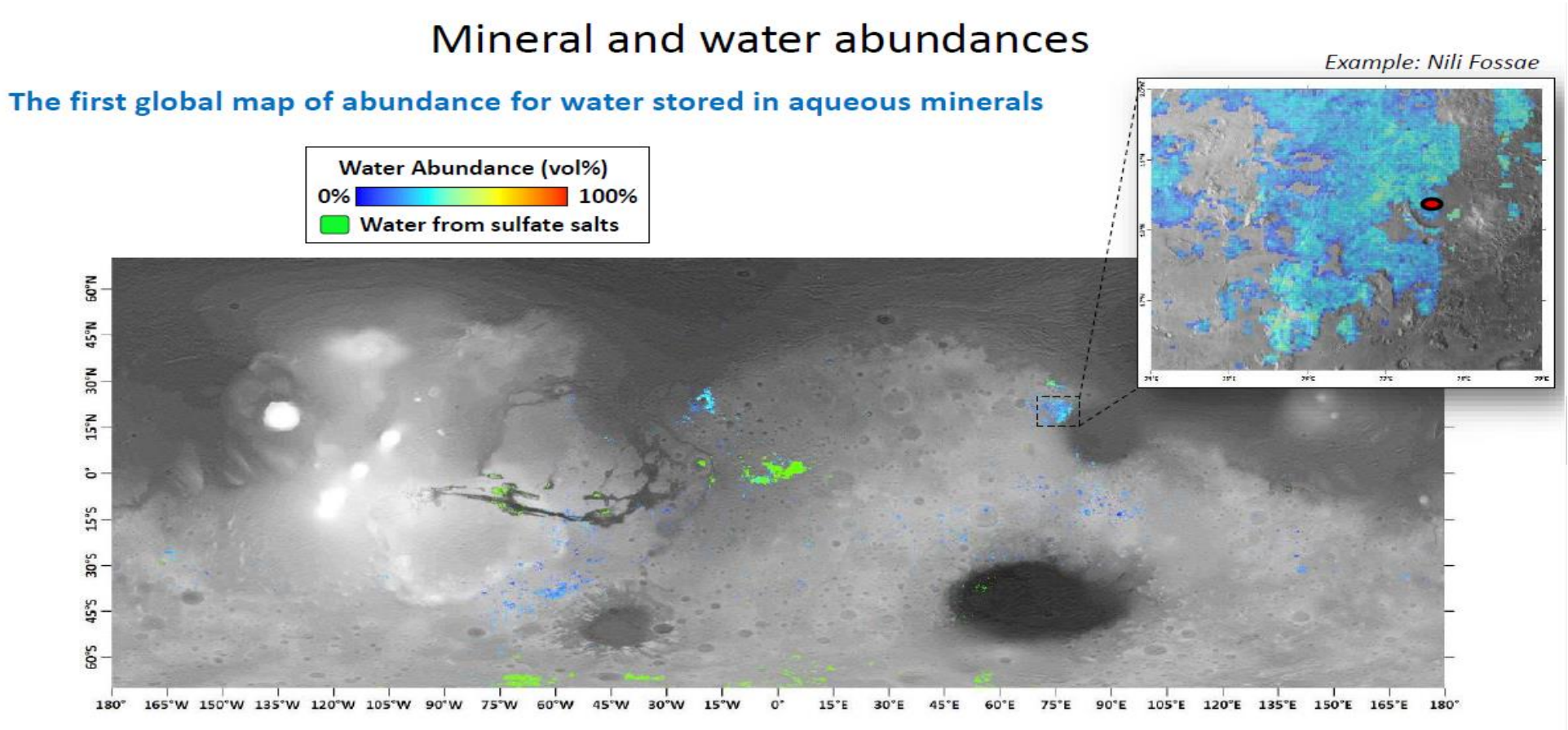

Figure 2. Mars global map of abundance for water in aqueous minerals. NOTE: Uncolored pixels do not necessarily represent regions with zero water abundance. Credit: Carter et al., IAS Paris-Sud University

Other Mars News

TGO Collects Detailed Data on Hydrogen Signatures at Mars

The Trace Gas Orbiter (TGO), a joint effort between ESA and Roscosmos, has produced the highest resolution hydrogen signature map of Mars to date. After gathering data for just 131 days, TGO's Fine Resolution Epithermal Neutron Detector (FREND) improved the spatial resolution of these detections as compared to its predecessor, the High Energy Neutron Detector on Mars Odyssey. This work is valuable for both human and robotic landing site selection, since hydrogen can indicate the presence of water in many forms; including subsurface ice, hydrated minerals, shallow permafrost, and polar ice. Preliminary maps of the distribution of hydrogen in the uppermost meter of the Martian surface are shown in Figure 3. TGO's main science mission began at the end of April 2018, and the map will continue to improve as long as the instrument is operating. Detections made by FREND can help validate the efforts of SWIM and future instruments, such as a potential Synthetic Aperture Radar.

Learn more about TGO scientific findings:
http://www.esa.int/Our_Activities/Human_and_Robotic_Exploration/Exploration/ExoMars/First_results_from_the_ExoMars_Trace_Gas_Orbiter

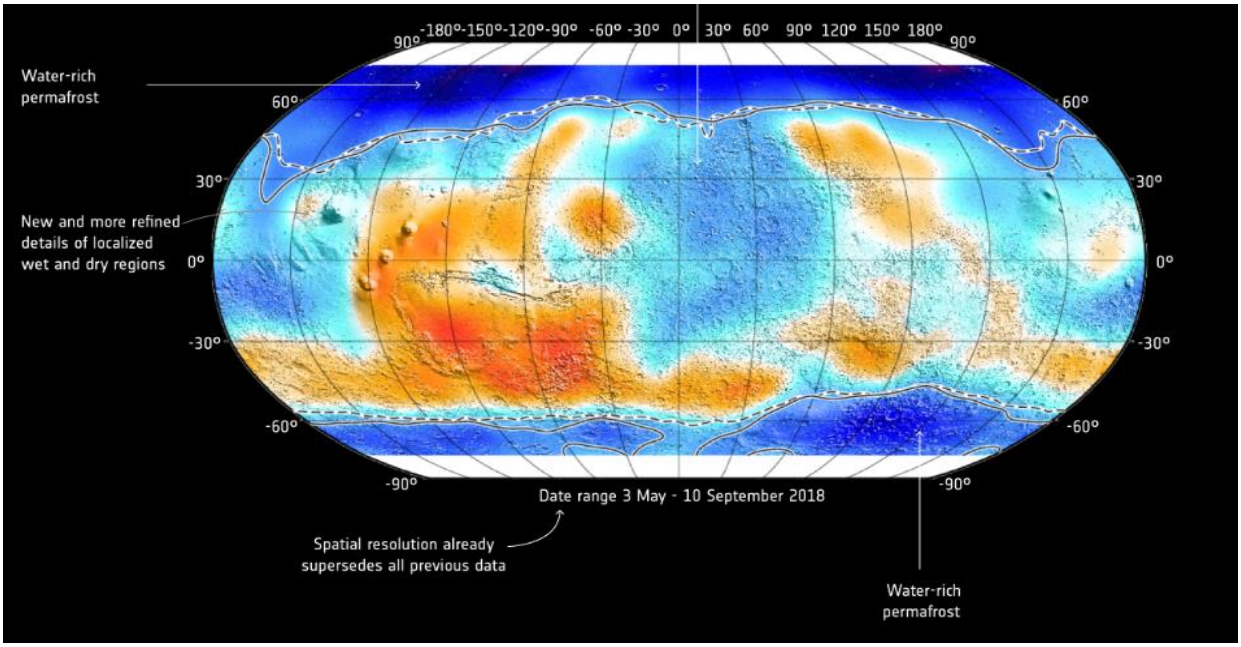

Figure 3. TGO's first map of hydrogen signatures distribution on Mars Credit: ESA; spacecraft: ATG/medialab; data: A-C Vandaele et al (2019)

InSight Update

InSight's Seismic Experiment for Interior Structure (SEIS) is active and providing information about Mars' interior. On April 6th, InSight's SEIS detected the first recorded "Marsquake." In late February, InSight's Heat Flow and Physical Properties Package (HP3), also known as "the Mole," began its process of hammering into the Martian regolith, but got stuck after digging only a small fraction of its intended 5 meters. On July 1st, InSight's robotic arm successfully lifted and moved the Mole's support structure to give its cameras a clear view. Images revealed that a small pit had formed around the Mole, possibly confirming the engineering team's hypothesis that the Mole doesn't have adequate friction from the surrounding regolith to allow it to dig. Teams at NASA's Jet Propulsion Laboratory (JPL) and the German Aerospace Center (DLR) designed and tested a potential solution using mock-ups on Earth. Using the small scoop on the robotic arm to pin the Mole against the side of its hole it made 5 centimeters of forward progress. However, the Mole backed halfway out of its hole during subsequent drilling attempts. The InSight team has resumed drilling as of November, 21 and are exploring further techniques to save the instrument. The Mole's troubles highlight challenges involved with drilling and may impact strategies involved with future ISRU efforts at Mars.

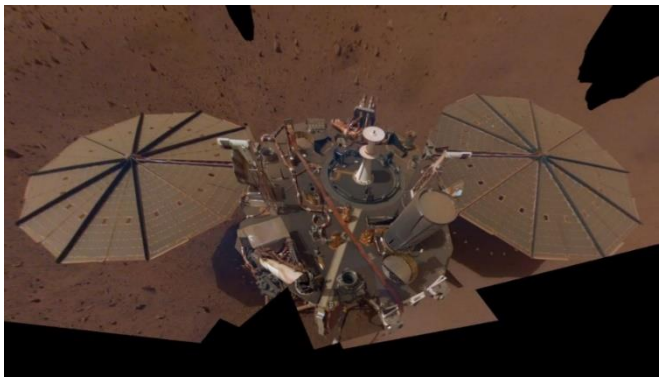

Figure 4. InSight selfie composed of 14 different images:

Learn more about InSight and latest developments: https://mars.nasa.gov/insight/

Farewell to MarCO's "EVE" and "WALL-E"

In May of 2018, NASA launched the first interplanetary CubeSats, MarCO-A and MarCO-B — fondly referred to by their nicknames EVE and WALL-E. The MarCO mission was designed to tag along with the InSight lander and quickly transmit telemetry data from InSight as it progressed through entry, descent, and landing at Mars. Without the MarCO spacecraft, data from InSight would have taken more than an hour to be relayed to Earth. However, EVE and WALL-E relayed the landing data back in just eight minutes. The success of the MarCO mission demonstrates the potential of interplanetary small missions to meet strategic mission goals at Mars.

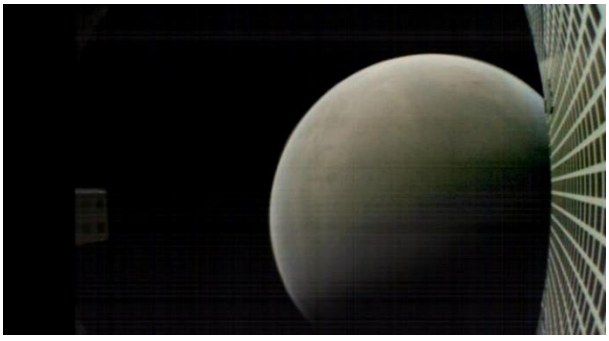

Figure 5. MarCO Image of Mars from about 7,600 kilometers away Credits: NASA/JPL-Caltech

Learn more about MarCO: https://www.jpl.nasa.gov/cubesat/missions/marco.php

Mars 2020 Update

With just over six months to go, the Mars 2020 rover is reaching the final stages of testing and integration. As the rover nears completion, NASA is once again in need of a name for the mission. As the agency has done for every Mars rover since Sojourner (launched in 1996), NASA is hosting a competition for K-12 students living in the U.S. to name the rover. The contest closed on November 1, 2019. The public will have the opportunity to participate in an online poll of the top 9 names in January 2020. Don't miss your opportunity to contribute to the Mars 2020 mission! Learn more about the contest and participate in the online poll at: https://mars.nasa.gov/mars2020/participate/name-the-rover/

Last year, NASA announced that the Mars 2020 mission would fly with a prototype helicopter in tow. The Mars Helicopter Scout will be the first vehicle to attempt to demonstrate the viability of heavier-than-air flight on the Red Planet. The helicopter will conduct several test flights approximately 3 meters above the surface for durations of 30-90 seconds, and distances of a few hundred meters. Aerial assets, such as this helicopter, have the potential to play a vital role in future landing site and ISRU reconnaissance objectives.

See the Mars 2020 helicopter test flight: https://vimeo.com/326662931

Learn more about Mars 2020: https://mars.nasa.gov/mars2020/news/

Figure 6. MARS 2020 rover at JPL's High Bay 1. Credits: NASA/JPL-Caltech

Figure 7. From left-to-right: The Chief Engineer for the Mars Helicopter Program Bob Balaram, the Project Manager for the Mars Helicopter Project MiMi Aung, and NASA Administrator Jim Bridenstine. Photo Credit: Ashly Cullumber / SpaceFlight Insider

iMOST report

In preparation for the forthcoming Mars Sample Return campaign, the International Mars Exploration Working Group (IMEWG) commissioned the International MSR Objectives and Samples Team (iMOST) to advise on the collection, storage, and processing of returned Martian samples. The report was published in the March 2019 issue of the journal *Meteoritics and Planetary Science*: vol. 54, p. 667-671. This work represents the culmination of incredible international collaboration. The research and recommendations

are already serving as key inputs to both the mission planning for the Mars 2020 rover and the emerging Mars Sample Return campaign as a whole.

Read the iMOST report: https://doi.org/10.1111/maps.13242

9th International Conference on Mars

From July 22-25, 2019, Caltech hosted the 9th International Conference on Mars. Leaders in the field on Martian science and exploration gathered to present on crucial discoveries made since the last conference five years ago. Topics covered include the use of terrestrial analogs, ancient Martian water sources, and data needed to get humans to Mars and keep them alive.

Learn more about conference highlights here: https://www.hou.usra.edu/meetings/ninthmars2019/

The following day, on July 26, the Mars Exploration Program Analysis Group (MEPAG) held their 37th face-to-face meeting. Highlights include discussion of the next steps for the Mars Sample Return campaign, updates on Mars 2020 and ESA's Rosalind Franklin rover, and new decadal science priorities for Mars.

Learn more about MEPAG meetings: https://mepag.jpl.nasa.gov/meetings.cfm

Upcoming Meetings/Conferences of Potential Interest to the HLS² Community

1. *American Geophysical Union* (December 9-13, 2019) - AGU
   San Francisco, California
   The Fall Meeting of the AGU will celebrate its centennial.
   Abstract Deadline: Wednesday, 31 July 2019
   Link: https://www2.agu.org/fall-meeting

2. *IEEE Aerospace 2020* (March 7-14, 2020)
   Big Sky, Montana
   The IEEE Aerospace Conference is organized to promote interdisciplinary understanding of aerospace systems, their underlying science and technology, and their application to government and commercial endeavors.
   Link: https://www.aeroconf.org/

3. *Lunar Planetary Science Conference 2020* (March 16-20, 2020) - LPSC
   The Woodlands, Texas
   The LPSC brings together international specialists from around the world to present the latest results of research in planetary science. There will be a special session showcasing new results from the InSight lander on Mars.
   Link: https://www.hou.usra.edu/meetings/lpsc2020/

Other News of Interest:

Moon to Mars Ice and Prospecting Challenge

In June of 2019, nine university teams competed in the 3rd annual Moon to Mars Ice & Prospecting Challenge at NASA Langley Research Center in Hampton, Virginia. As with previous challenges, teams designed and built drills that could penetrate simulated Martian regolith and extract subsurface water ice. This year, for the first time, teams attempted to use feedback from their drills to identify various unknown layers covering the ice and to construct a model of those layers.

This year, West Virginia University took first place overall, with the most water extracted at nearly 7 liters. A big congratulations is in order to all participating teams: collectively, they extracted a record-breaking total of 20.7 liters of water, which is 5 times the total amount from last year's competition!

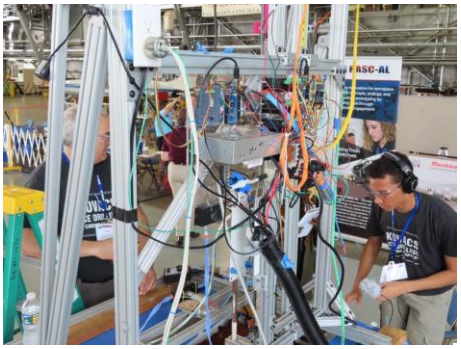

Figure 8. For the first time in the Challenge, all university teams were able to extract water!

Figure 9. West Virginia University students looking over their drill system, MIDAS.

Figure 10. Schematic of layers that teams had to drill through to reach water ice

Additionally, we are excited to announce the Moon to Mars Ice & Prospecting Challenge for 2020. Learn more about the 2020 challenge at: http://specialedition.rascal.nianet.org/

Learn more about the Ice & Prospecting Challenge:

NASA 360 Day 1 Video: https://www.youtube.com/watch?v=WtUU7eYyXME&t=82s
NASA 360 Day 2 Video: https://www.youtube.com/watch?v=fRi2FqNsaWk

Aggregation, Refueling, Refurbishment, and Resupply

In a recently published white paper, "Logistics is a Key Enabler of Sustainable Human Missions to Mars," Do et al. examined options for keeping the crew supplied with food and tools for 1100 day Mars missions. This paper discusses key logistic supply chain challenges by drawing on the experiences of major exploration efforts such as Antarctic expeditions and the International Space Station (ISS). Interplanetary supply lines represent a challenge for which humanity does not yet have an answer.

Full Paper: https://baas.aas.org/community/logistics-is-a-key-enabler-of-sustainable-human-mars-missions/

2019 Humans to Mars Report

Explore Mars released their "Humans to Mars Report 2019" during the Humans to Mars Summit. Highlighted in this report are Mars missions planned for 2020 and the Sixth Workshop on Affording, Achieving and Sustaining Human Mars Exploration (AM VI).

Learn more about Humans to Mars:

Videos of the Summit's talks: https://livestream.com/viewnow/HumanstoMars2019.
Humans to Mars Report 2019: https://www.exploremars.org/the-humans-to-mars-report
AM VI and Previous Reports: https://www.exploremars.org/affording-mars

Figure 11. Mars, Pennsylvania streets during the festivities. Credit: NASA/Bill Ingalls

Martian New Year Celebration in Mars, PA

Mars, Pennsylvania hosted a Mars Exploration Celebration the weekend of May 31 - June 2, 2019. Every 26 Earth months, Mars completes a trip around the sun and enters a new Martian year. This is the third time that Mars, PA has held festivities for the Red Planet New Year. NASA joined town members to share the latest in Martian exploration through fun interactive activities.

Learn more about the Martian New Year Celebration: http://marsnewyear.com/

Visit "Mars on Earth" Through Google Street View

Figure 12. Astronaut Canyon, Devon Island, Earth (left), vs a Tributary Canyon to Ius Chasma, Mars (right). Credit: Pascal Lee and NASA

Devon Island, Canada, in the Lower Arctic, is sometimes referred to as "Mars on Earth" because its harsh conditions make it a great analog to the Red Planet. And now, anyone can explore Devon Island without the purchase of a plane ticket. Dr. Pascal Lee, chairman of the Mars Institute and director of the Haughton-Mars Project, partnered with Katja Minitsenka of Google to collect Street View photos of many regions of interest to Martian researchers. The documentary *Mars on Earth* (2019) shows Google's visit to Devon Island and offers insight into the day-to-day life of those working on the Haughton-Mars Project. Sites like Devon Island offer real opportunities to use analogs to better prepare for Mars. They can inform how we think about choosing Exploration Zones and mission planning operations.

Watch the documentary and see Devon Island on Street View:

Mars on Earth: A Visit to Devon Island, by Google (2019): https://youtu.be/xzyOdH6OlV0
Devon Island Street View: https://g.co/earth/devonisland

We Want to Hear From You:

Please send any feedback, questions, or comments to this email. If you know anyone else who would like to be added to our distribution list, have them contact us at nasa-mars-exploration-zones@mail.nasa.gov.

For additional information, please visit our website:
http://www.nasa.gov/journeytomars/mars-exploration-zones