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

Hello all:

We wanted to send some updates on HLS^2 and Mars news in 2018. Key HLS^2 highlights from this newsletter include: An update on the Mars Water Mapping projects, both for subsurface ice and hydrated minerals. An announcement of two upcoming Google Hangout briefings. And, a call for intern applicants. All the best in 2019!

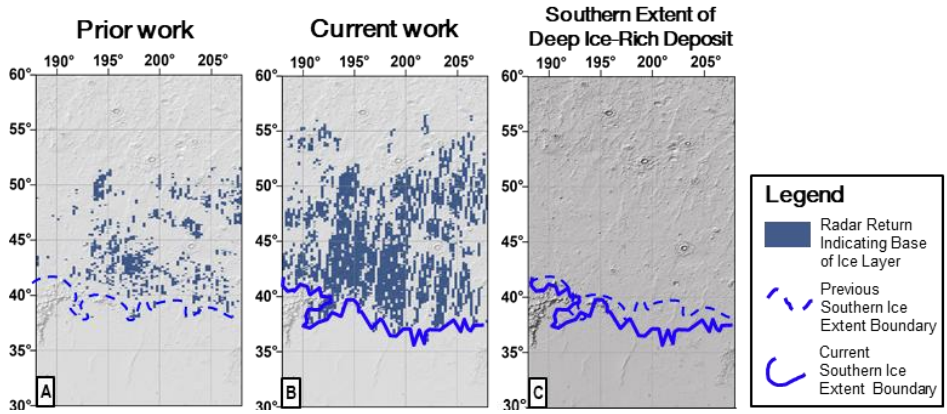
Update on Mapping of Water Deposits to Support Mars Exploration Program Studies

Coming out of the first HLS^2 workshop there was a strong consensus that landing site selection is highly dependent on knowledge of and access to water feedstocks on Mars. The water mapping RFP issued in June 2017 attempts to combine existing data sets in creative ways to bridge the knowledge gaps around both hydrated mineral and subsurface ice water deposits on Mars. Over the last year, the four selected teams have made significant progress towards building next-generation maps. Both tasks will deliver GIS compatible maps of Mars water feedstocks.

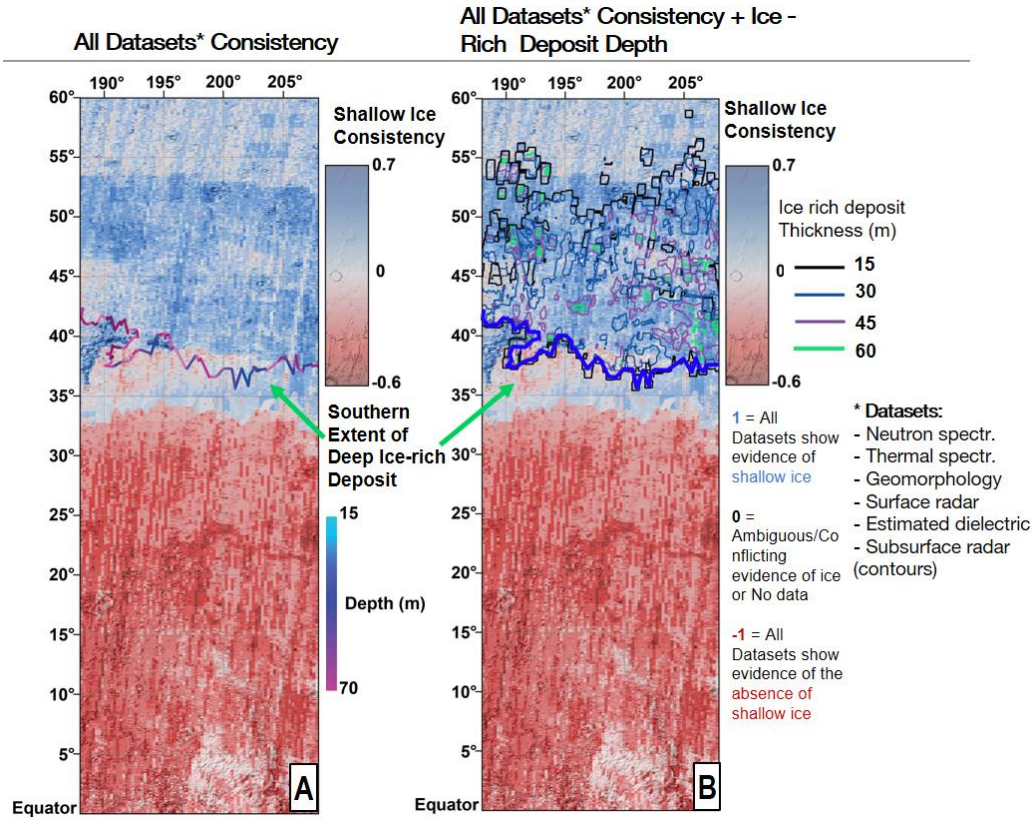
Task A – Subsurface Ice:

Two teams led by Nathaniel Putzig and Gareth Morgan of the Planetary Science Institute were contracted to pursue separate mapping efforts of subsurface ice deposits in Arcadia Planitia. After their mid-term reports showed significant synergy, the teams were combined in a joint project called: Subsurface Water Ice Mapping (SWIM), which extends the coverage of the mapping project from an experimental swath over Arcadia Planitia to low elevation regions across the entire Northern Hemisphere of Mars. The SWIM team is producing new maps of the likelihood of subsurface ice deposits over these regions by combining radar, thermal, altimetry, and image data from several Mars-orbiting spacecraft. The team is also employing newly developed techniques that include using radar returns to infer the presence of ice within the top 5 m of the crust and applying advanced radar processing to improve resolution at depth and to estimate the purity of ice in the subsurface. To integrate the different techniques, the team has developed the "SWIM Equation," which provides a measure of the consistency of all data with the presence of subsurface ice. Delivery of this first integrated "ice consistency" map is slated for the end of April 2019. If successful, these mapping techniques may be further developed and expanded to all areas of interest for human landing sites in both hemispheres of Mars.

Preliminary results of the combined dataset analysis over the Arcadia Planitia study area are shown in the figures on the following page.

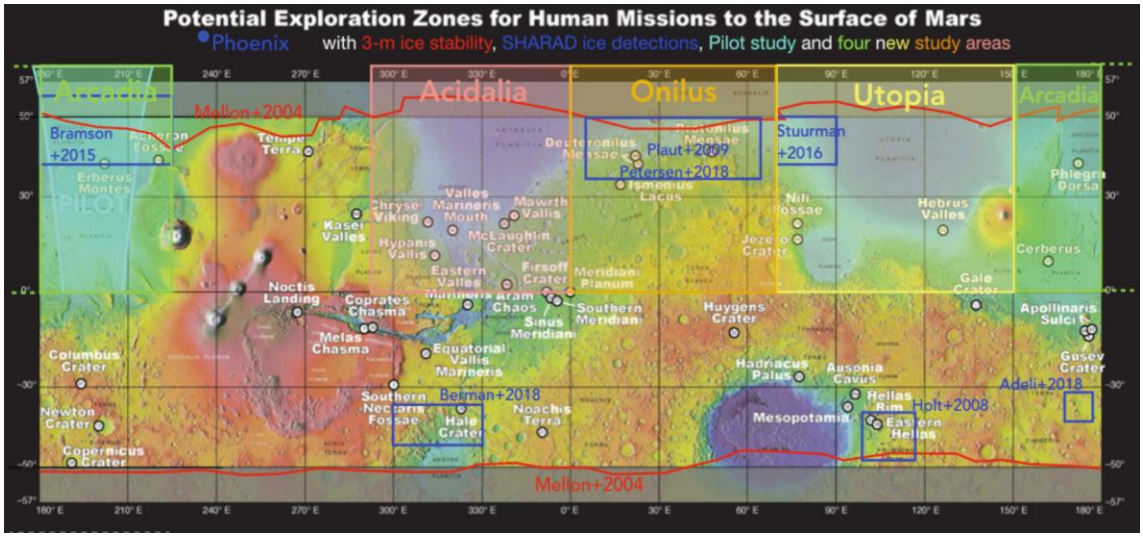


Comparison of Subsurface Water Ice Detections over the Arcadia Planitia derived from SHARAD radar profiles (Preliminary Results) ***A.*** *The best map of radar detections of the base of a suspected subsurface water ice sheet prior to this study (see: Bramson et al. 2015)* ***B.*** *An updated version of the Bramson map produced as part of the current study, indicating a potentially larger and more contiguous subsurface water ice sheet over the same region extending to more equatorial latitudes* ***C.*** *A comparison of the previous and currently derived Southern Ice Boundary Line over the Arcadia Planitia region, indicating the presence of more equatorward ice that is more favorable for future ISRU applications*



Preliminary Shallow Subsurface Ice Consistency Map over the Arcadia Planitia Region. Regions colored blue are those where multiple methods detect signs of shallow ice (within 5m of the surface). Regions colored red are those where there is high confidence that shallow ice is likely not present ***A.*** *Consistency Map with Southern Ice Boundary line colored by depth to the base of its ice layer* ***B.*** *Consistency Map with the boundaries of ice-rich deposits of various thicknesses over-plotted, indicating a subsurface ice-rich deposit of 15-60m thickness throughout the region*

In addition to the Arcadia region, the SWIM team has been contracted to map three additional study regions. These are the Acidalia, Onilus, and Utopia regions shown in the below figure.



The SWIM Project Study Regions

As mentioned earlier, results from each of these study regions are planned to be integrated into a single Northern Hemisphere ice consistency map by the end of April 2019.

Task B – Hydrated Minerals:

Two teams have been selected to complete Task B of the Mars Water Mapping Projects – the development of next-generation global maps of the areal extent of hydrated minerals with the highest potential for exploitation by future human crews. Both projects will process hundreds of thousands of spectra collected by the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) and the Infrared Mineralogical Mapping Spectrometer (OMEGA) instruments. Once complete, the two maps will be compared to build confidence in the presence and extent of attractive hydrated mineral deposits that may guide human landing site selection.

Frank Seelos's team at the Johns Hopkins University Applied Physics Laboratory is developing semi-automated algorithms to process multispectral and hyperspectral data collected by the CRISM instrument to identify and map all exposures of six of the most promising classes of hydrated minerals. In parallel, the team of John Carter and Francois Poulet at Universite Paris-Sud will build upon their ongoing "Mars Orbital Catalog of Chemical Alteration Signatures" (MOCCAS) project to also map the major classes of Martian hydrated minerals, focusing mainly on OMEGA data from Mars Express. For each deposit, the Carter and Poulet team will derive its composition using spectral mixture models updated with new laboratory data on the optical properties of relevant minerals. This will yield a global map of estimated water content within detected hydrated mineral deposits. Maps from both teams are expected by the end of March 2019.

Announcement of Google Hangouts

We will be continuing our Google Hangouts lecture series on subjects relevant to the HLS^2 community. Below is the schedule for upcoming briefings. We will be hosting these Google Hangouts on our YouTube channel (found here):

Title	Date/Time (tentative)	Speaker(s)
Subsurface Water-Ice Mapping Project Briefing	March 6 1:00pm EST	Sydney Do, Gareth Morgan, Than Putzig
How Small Missions can enhance reconnaissance and human exploration at Mars	April 11 1:00pm EST	Mimi Aung, Jake Bleacher, Len Dudzinski, Carolyn Mercer, Chris Zacny

These interactive lectures will be livestreamed via Google Hangouts, 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.

Update on HLS^2 Imaging Requests

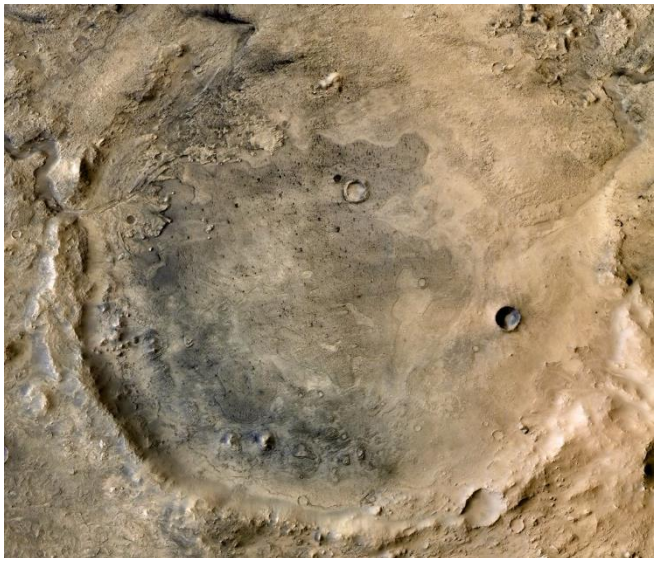
Due to the global dust storm, opportunities to complete HiRISE and CRISM imaging requests were extremely limited. We will provide an update on the status of the existing HLS^2 image requests as soon as we know more. We are still looking to host Google Hangouts with exploration zone proposers whose image requests have been completed.

Please let us know via email (NASA-Mars-Exploration-Zones@mail.nasa.gov) if you're interested.

Mars 2020 Landing Site Selection

On November 19, 2018 NASA announced that the Mars 2020 rover will land at Jezero Crater after in launches in July 2020. Jezero crater is suspected to contain an ancient river delta that will hopefully provide insight into the wetter periods of Martian history. If all goes well the site will help meet both scientific objectives as well as reconnaissance into hydrated mineral deposits.

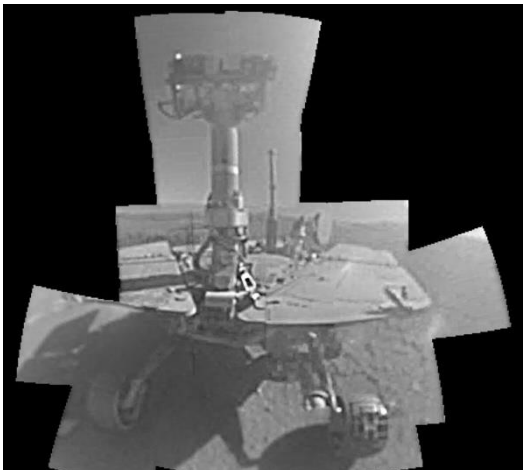
Learn more about the site:
https://www.nasa.gov/press-release/nasa-announces-landing-site-for-mars-2020-rover



A mosaic of Jezero Crater assembled using data from HiRISE

Opportunity Rover End of Mission:

As of February 13, 2019, after 15 years and 28 miles the Opportunity rover's mission has come to an end. The announcement came after 8 months of trying to contact the rover after a dust storm impeded Opportunity's ability to recharge its batteries. The Mars Reconnaissance Orbiter detected the first signs of a dust storm brewing near Perseverance Valley near the rover on June 1st of 2018. The dust storm grew to encompass the planet over just a few days. The storm dimmed Martian skies for 3 months before subsiding. Although the Curiosity rover faired just fine, thanks to its nuclear power source, Opportunity lost power and was forced into sleep mode as the available sunlight dropped. Last contact was on June 10th 2018. These global dust storms usually occur every 5-10 years with the last one observed in 2007. While these storms provide our orbital assets ample opportunity to study Martian weather and climate, they do pose a risk to ground assets – especially those relying on solar power. A human mission to Mars will likely rely in part on solar powered instruments, so understanding the mechanisms of dust storm formation and expansion, as well as determining areas of the surface that are most prone to dust activity, are vital for successful human exploration of Mars. They also highlight the importance of a diverse power system, consisting of solar and nuclear power, for crewed missions.

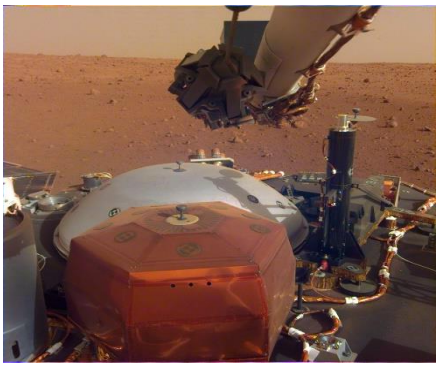


1A composite selfie of the Opportunity rover taken on its 5000th sol of operation

Learn more about Opportunity: https://mars.nasa.gov/mer/

Learn more about the dust storm: https://mars.nasa.gov/weather/storm-watch-2018/

InSight Landing



InSight photographs its science instruments from its new home in Elysium Planitia

On November 26, 2018 NASA successfully landed the Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight) lander at Elysium Planitia. The lander will investigate the Martian interior's temperature and seismic activity. As part of this, the lander will drill up to 5 meters (16 feet) below the Martian surface – the deepest ever drilled on Mars. InSight will not only improve our understanding of the Martian interior, it will also demonstrate drilling technologies that may be critical for accessing subsurface ice for ISRU purposes.

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

Rodwell Drill Modelling

Researchers at the Johnson Space Center have begun small scale testing of key performance parameters of a Rodriquez Well, colloquially known as a Rodwell, under Martian atmospheric conditions to examine its potential as a tool for in-situ resource utilization for human missions to Mars. Rodwells, which are in regular use in Antarctic expeditions, operate by drilling into solid ice, melting a reservoir below a solid overburden, and pumping the meltwater out. On Mars, this approach will require drilling through the insulating overburden layer and far enough into the ice layer so that the resulting cavity will not collapse due to the weight of the overburden. It will also require a cased hole through at least the overburden and possibly the upper ice layer so that the cavity can be sealed and pressurized to some TBD level to minimize water sublimation. If the initial tests scheduled for early this year prove successful, the team at JSC will move on to Phase 2. Phase 2 will introduce impurities into the ice to see how it affects Rodwell operations followed by a proof-of-concept test in a vacuum chamber simulating Martian environmental conditions for Phase 3.

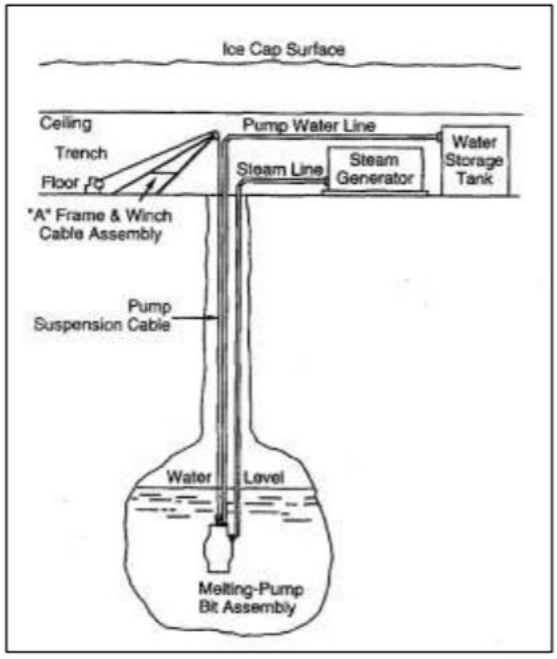
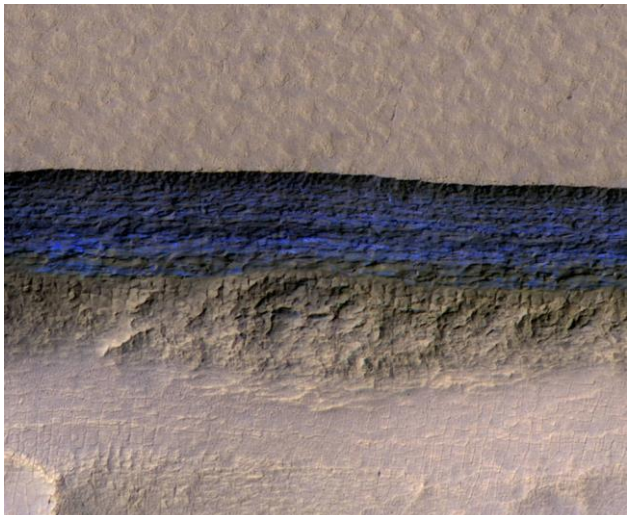


Diagram of a Rodwell

Additional evidence of water ice near the Martian surface:

A recent study used the High Resolution Imaging Science Experiment (HiRISE) instrument onboard NASA's Mars Reconnaissance Orbiter (MRO) to identify eight locations on Mars where steep geologic scarps reveal extensive underlying water ice. These water ice deposits can be over 100 meters thick and can potentially serve as important resources for future human explorers on the surface. Ice drilling capabilities are currently being developed that could probe these subsurface ice deposits for use in situ resource utilization (ISRU) processes.

Story Link:
(http://science.sciencemag.org/content/359/6372/199)



An exposed subsurface ice deposit at 56° south imaged by HiRISE.

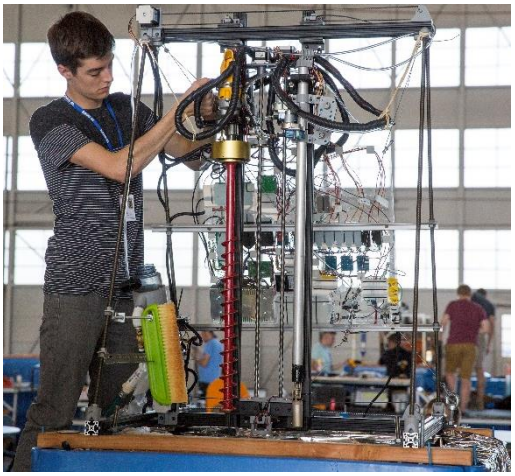
2nd International Mars Sample Return Conference

In late April of 2018 the International Mars Exploration Working Group (IMEWG) and international Mars sample return communities met in Berlin Germany to discuss coordination and ideas for future Mars Sample Return activities. The conference presentations, posters, and webcast can be found at the below link.

Conference Proceedings Link: https://atpi.eventsair.com/QuickEventWebsitePortal/2nd-international-conference-on-mars-sample-return/home/ExtraContent/ContentPage?page=8

Mars Ice Challenge

For the second year, Langley Research Center hosted the Revolutionary Aerospace Systems Concepts Academic Linkage (RASC-AL) Special Edition: Mars Ice Challenge in June. Ten teams were asked to build and test prototype rigs to compete to see who could retrieve the most water from a subsurface ice deposit locked beneath Martian regolith simulant. Teams also submitted a technical paper with the "path-to-flight" trade modifications needed to operate their systems on Mars. From 2017 to 2018, the competition saw nearly 1000% increase in the total amount of water extracted. These teams are helping pave the way forward for subsurface ice drill designs and water extraction technologies that may someday inform NASA's own designs.



The Winning Drill Rig from Northeastern University at the 2018 Mars Ice Challenge

The competition will be held once again in 2019 as the "Moon to Mars Ice and Prospecting Challenge," in which teams will be asked to not only retrieve subsurface ice, but also use system telemetry to distinguish between overburden layers and create a digital core of the various layers. A unique hallmark of this challenge is the synergy created through the government/academia/non-profit/industry collaboration and knowledge capture that continuously builds on the collective knowledge of extraterrestrial ISRU for water extraction. The challenge is funded by multiple NASA mission directorates, and also receives industry sponsorships from partners such as Honeybee Robotics, Beuchel Stone, Aercon, and SpaceX.

Learn more about the challenge: http://specialedition.rascal.nianet.org/

Opportunity for Internship at NASA HQ

The Mars Exploration Program office of the Science Mission Directorate at NASA Headquarters in Washington, DC is looking for both paid and unpaid interns for the summer and/or fall with a strong interest in the robotic/human exploration of Mars. We are looking for driven team players with strong writing and organizational skills to help with our ongoing integration efforts. Candidates will have the

opportunity to learn about the strategy and next steps in NASA's journey to Mars. Additionally, the position can be molded to offer a research component for academic credit.
Interested applicants should reach out to: robert.b.collom@nasa.gov for more information.

Upcoming Meetings/Conferences of Potential Interest to the HLS² Community:

1. *IEEE Aerospace 2019* (March 2-9, 2019)
   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/

2. *50th Lunar and Planetary Science Conference* (March 18-22, 2019)
   The LPSC brings together international specialists from around the world to present the latest results of research in planetary science. A special session showcasing new results concerning Insight on Mars, will take place.
   Link: https://www.hou.usra.edu/meetings/lpsc2019/program/

3. *Humans to Mars Summit* (May 14-16, 2019)
   The 2019 Summit will feature a diverse lineup of topics, technologies, breakout sessions, and audience participation that will address the future challenges and progress of human exploration of Mars.
   Link: https://h2m.exploremars.org/

4. *International Space Development Conference 2019* (June 6-9, 2019)
   The International Space Development Conference brings together leaders from all sectors to work toward a common goal of developing a space-faring civilization. Breakout sessions on Mars, Space Solar Power, and Space Settlement will be spread throughout the program.
   Link: https://isdc2019.nss.org/

5. *9th International Conference on Mars* (July 22-26, 2019)
   In addition to discussing science results from past and active robotic missions, telescopic studies, laboratory analyses of SNC meteorites, terrestrial analog studies, and numerical models, we anticipate new geophysical understanding gained from the InSight mission, as well as a review of objectives for several spacecraft scheduled for launch in 2020 from public, private, and international institutions.
   Link: https://www.hou.usra.edu/meetings/ninthmars2019/#nav

6. *70th International Astronautical Congress* (October 21-25,2019)
   The 70th IAC, will host the global space community in Washington, D.C. Some of the technical sessions featured will include Human Exploration of Mars, Deep Space Transport, Current and Future Mission Overview, and more.
   Abstract Submission Due Date: February 28, 2019
   Link: https://www.iac2019.org/registration2019

Other News of Interest:

2018 Humans to Mars Report

Explore Mars released the annual Humans to Mars Report during the Humans to Mars Summit held in Washington DC from May 8-10, 2018. The report provides a summary of the current state of Mars exploration, highlighting key advances that have been made and challenges that still exist in trying to send humans to Mars.

Report link: (https://www.exploremars.org/wp-content/uploads/2016/12/H2MR_18_Web.pdf)
The livestream from the summit can be found at: https://livestream.com/viewnow/HumanstoMars2018

We want to hear from you:

Please send any feedback, questions, or comments to this email. And, 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