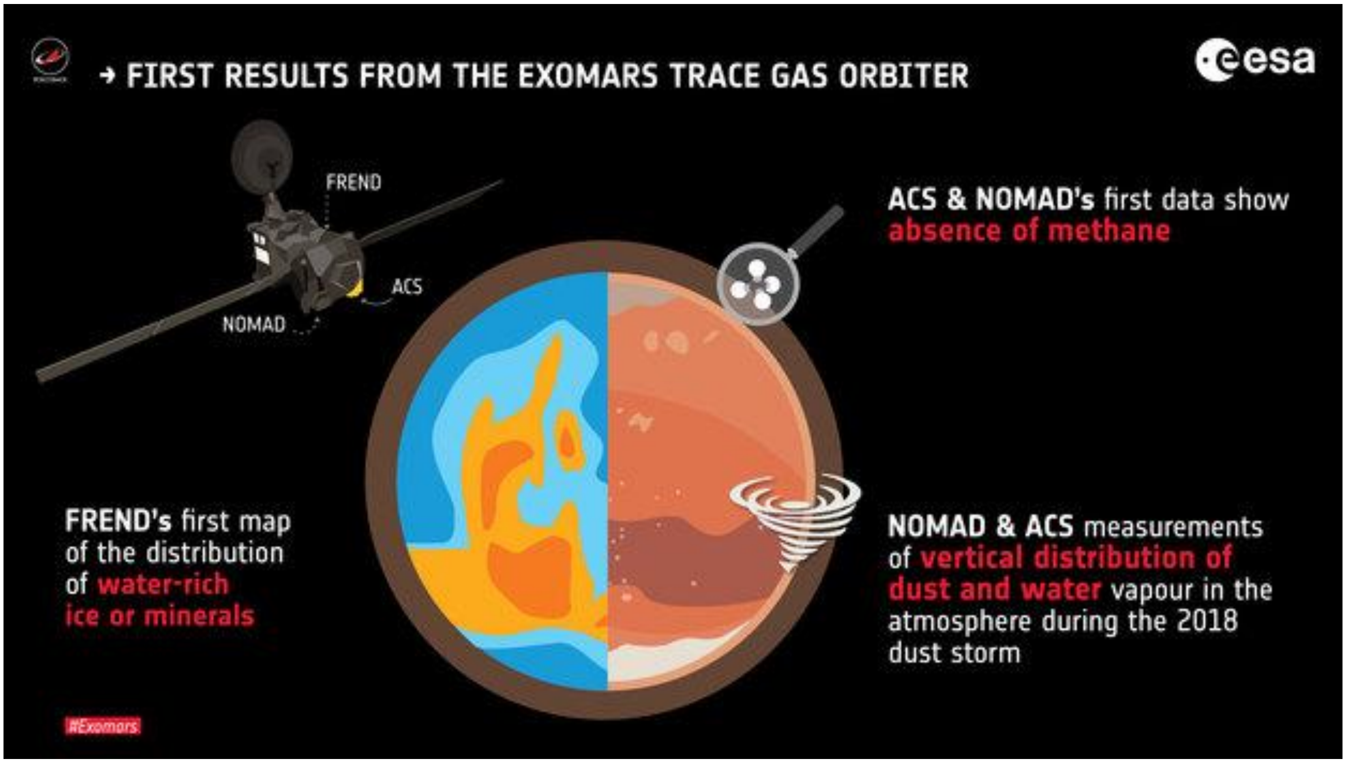
Space News Update

— April 16, 2019 —

Contents

1. First Results from ESA's ExoMars Trace Gas Orbiter



New evidence of the impact of the recent planet-encompassing dust storm on water in the atmosphere, and a surprising lack of methane, are among the scientific highlights of the ExoMars Trace Gas Orbiter's first year in orbit.

Two papers are published in the journal *Nature* today describing the new results, and reported in a dedicated press briefing at the *European Geosciences Union* in Vienna.

A third paper, submitted to the *Proceedings of the Russian Academy of Science,* presents the most detailed map ever produced of water-ice or hydrated minerals in the shallow subsurface of Mars.

The joint ESA-Roscosmos ExoMars Trace Gas Orbiter, or TGO, arrived at the Red Planet in October 2016, and spent more than one year using the aerobraking technique needed to reach its two-hour science orbit, 400 km above the surface of Mars.

"We are delighted with the first results from the Trace Gas Orbiter," says Håkan Svedhem, ESA's TGO project scientist.

"Our instruments are performing extremely well and even within the first few months of observation were already providing exquisite data to a much higher level than previously achieved."

TGO's main science mission began at the end of April 2018, just a couple of months before the start of the global dust storm that would eventually lead to the demise of NASA's Opportunity rover after 15 years roving the Martian surface.

Spacecraft in orbit, however, were able to make unique observations, with TGO following the onset and development of the storm and monitoring how the increase in dust affected the water vapour in the atmosphere – important for understanding the history of water at Mars over time.

Exploiting the dust storm

Two spectrometers onboard – NOMAD and ACS – made the first high-resolution solar occultation measurements of the atmosphere, looking at the way sunlight is absorbed in the atmosphere to reveal the chemical fingerprints of its ingredients.

This enabled the vertical distribution of water vapour and 'semi-heavy' water – with one hydrogen atom replaced by a deuterium atom, a form of hydrogen with an additional neutron – to be plotted from close to the Martian surface to above 80 km altitude. The new results track the influence of dust in the atmosphere on water, along with the escape of hydrogen atoms into space.

"In the northern latitudes we saw features such as dust clouds at altitudes of around 25–40 km that were not there before, and in southern latitudes we saw dust layers moving to higher altitudes," says Ann Carine Vandaele, principal investigator of the NOMAD instrument at the Royal Belgian Institute for Space Aeronomy.

"The enhancement of water vapour in the atmosphere happened remarkably quickly, over just a few days during the onset of the storm, indicating a swift reaction of the atmosphere to the dust storm."

The observations are consistent with global circulation models. Dust absorbs the Sun's radiation, heating the surrounding gas and causing it to expand, in turn redistributing other ingredients – like water – over a wider vertical range. A higher temperature contrast between equatorial and polar regions is also set up, strengthening atmospheric circulation. At the same time, thanks to the higher temperatures, fewer water-ice clouds form – normally they would confine water vapour to lower altitudes.

The teams also made the first observation of semi-heavy water simultaneously with water vapour, providing key information on the processes that control the amount of hydrogen and deuterium atoms escaping to space. It also means the deuterium-to-hydrogen (D/H) ratio can be derived, which is an important marker for the evolution of the water inventory on Mars.

"We see that water, deuterated or not, is very sensitive to the presence of ice clouds, preventing it from reaching atmospheric layers higher up. During the storm, water reached much higher altitudes," says Ann Carine. "This was theoretically predicted by models for a long time but this is the first time we have been able to observe it."

Since the D/H ratio is predicted to change with the season and with latitude, TGO's continued regional and seasonal measurements are expected to provide further evidence of the processes at play.

Methane mystery plot thickens

The two complementary instruments also started their measurements of trace gases in the Martian atmosphere. Trace gases occupy less than one percent of the atmosphere by volume, and require highly precise measurement techniques to determine their exact chemical fingerprints in the composition. The presence of trace gases is typically measured in 'parts per billion by volume' (ppbv), so for the example for Earth's methane inventory measuring 1800 ppbv, for every billion molecules, 1800 are methane.

Methane is of particular interest for Mars scientists, because it can be a signature of life, as well as geological processes – on Earth, for example, 95% of methane in the atmosphere comes from biological processes. Because it can be destroyed by solar radiation on timescales of several hundred years, any detection of the molecule in present times implies it must have been released relatively recently – even if the methane itself was produced millions or billions of years ago and remained trapped in underground reservoirs until now. In addition, trace gases are mixed efficiently on a daily basis close to the planet's surface, with global wind circulation models dictating that methane would be mixed evenly around the planet within a few months.

Reports of methane in the Martian atmosphere have been intensely debated because detections have been very sporadic in time and location, and often fell at the limit of the instruments' detection limits. ESA's Mars Express contributed one of the first measurements from orbit in 2004, at that time indicating the presence of methane amounting to 10 ppbv.

Earth-based telescopes have also reported both non-detections and transient measurements up to about 45 ppbv, while NASA's Curiosity rover, exploring Gale Crater since 2012, has suggested a background level of methane that varies with the seasons between about 0.2 and 0.7 ppbv – with some higher level spikes. More recently, Mars Express observed a methane spike one day after one of Curiosity's highest-level readings.

The new results from TGO provide the most detailed global analysis yet, finding an upper limit of 0.05 ppbv, that is, 10–100 times less methane than all previous reported detections. The most precise detection limit of 0.012 ppbv was achieved at 3 km altitude.

As an upper limit, 0.05 ppbv still corresponds to up to 500 tons of methane emitted over a 300 year predicted lifetime of the molecule when considering atmospheric destruction processes alone, but dispersed over the entire atmosphere, this is extremely low.

"We have beautiful, high-accuracy data tracing signals of water within the range of where we would expect to see methane, but yet we can only report a modest upper limit that suggests a global absence of methane," says ACS principal investigator Oleg Korablev from the Space Research Institute, Russian Academy of Sciences, Moscow.

"The TGO's high-precision measurements seem to be at odds with previous detections; to reconcile the various datasets and match the fast transition from previously reported plumes to the apparently very low background levels, we need to find a method that efficiently destroys methane close to the surface of the planet."

"Just as the question of the presence of methane and where it might be coming from has caused so much debate, so the issue of where it is going, and how quickly it can disappear, is equally interesting," says Håkan.

"We don't have all the pieces of the puzzle or see the full picture yet, but that is why we are there with TGO, making a detailed analysis of the atmosphere with the best instruments we have, to better understand how active this planet is – whether geologically or biologically."

Best map of shallow subsurface water

While the lively debate on the nature and presence of methane continues, one sure thing is that water once existed on Mars – and still does in the form of water-ice, or as water-hydrated minerals. And where there was water, there might have been life.

To help understand the location and history of water on Mars, TGO's neutron detector FREND is mapping the distribution of hydrogen in the uppermost metre of the planet's surface. Hydrogen indicates the presence of water, being one of the constituents of the water molecule; it can also indicate water absorbed into the surface, or minerals that were formed in the presence of water.

The instrument's mapping task will take about one Mars year – almost two Earth years – to produce the best statistics to generate the highest quality map. But the first maps presented based on just a few month's data already exceed the resolution of previous measurements.

"In just 131 days the instrument had already produced a map that has a higher resolution than that of the 16 years data from its predecessor onboard NASA's Mars Odyssey – and it is set to continue getting better," says Igor Mitrofanov, principal investigator of the FREND instrument at the Space Research Institute, Russian Academy of Sciences, Moscow.

Aside from the obviously water-rich permafrost of the polar regions, the new map provides more refined details of localised 'wet' and 'dry' regions. It also highlights water-rich materials in equatorial regions that may signify the presence of water-rich permafrost in present times, or the former locations of the planet's poles in the past.

"The data is continually improving and we will eventually have what will become the reference data for mapping shallow subsurface water-rich materials on Mars, crucial for understanding the overall evolution of Mars and where all the present water is now," adds Igor. "It is important for the science on Mars, and it is also valuable for future Mars exploration."

Source: European Space Agency

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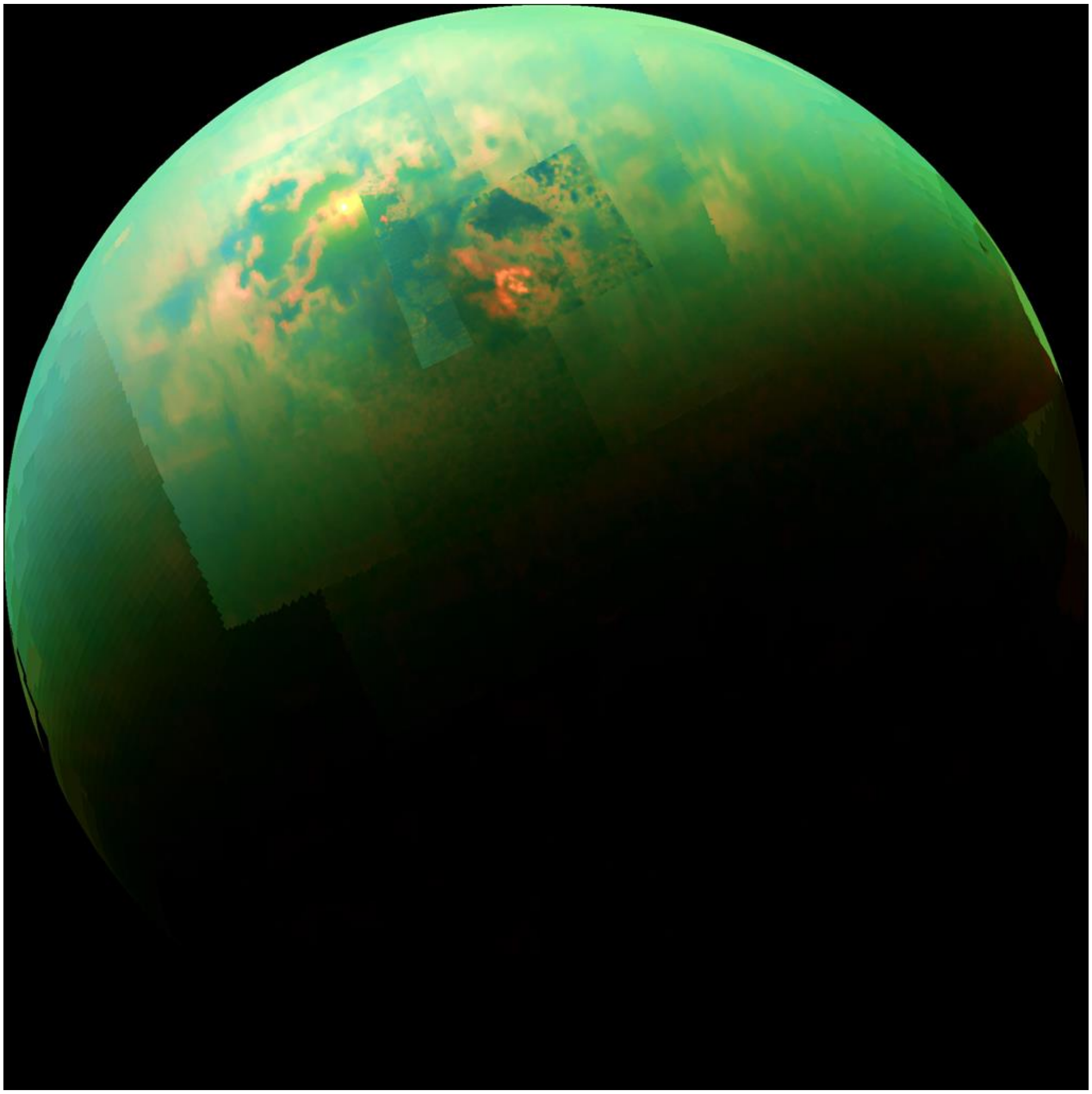
2. NASA's Cassini Reveals Surprises with Titan's Lakes



This near-infrared, color view from Cassini shows the sun glinting off of Titan's north polar seas. Credits: NASA/JPL-Caltech/Univ. Arizona/Univ. Idaho

On its final flyby of Saturn's largest moon in 2017, NASA's Cassini spacecraft gathered radar data revealing that the small liquid lakes in Titan's northern hemisphere are surprisingly deep, perched atop hills and filled with methane.

The new findings, published April 15 in Nature Astronomy, are the first confirmation of just how deep some of Titan's lakes are (more than 300 feet, or 100 meters) and of their composition. They provide new information about the way liquid methane rains on, evaporates from and seeps into Titan — the only planetary body in our solar system other than Earth known to have stable liquid on its surface.

Scientists have known that Titan's hydrologic cycle works similarly to Earth's — with one major difference. Instead of water evaporating from seas, forming clouds and rain, Titan does it all with methane and ethane. We tend to think of these hydrocarbons as a gas on Earth, unless they're pressurized in a tank. But Titan is so cold that they behave as liquids, like gasoline at room temperature on our planet.

Scientists have known that the much larger northern seas are filled with methane, but finding the smaller northern lakes filled mostly with methane was a surprise. Previously, Cassini data measured Ontario Lacus, the only major lake in Titan's southern hemisphere. There they found a roughly equal mix of methane and ethane. Ethane is slightly heavier than methane, with more carbon and hydrogen atoms in its makeup.

"Every time we make discoveries on Titan, Titan becomes more and more mysterious," said lead author Marco Mastrogiuseppe, Cassini radar scientist at Caltech in Pasadena, California. "But these new measurements help give an answer to a few key questions. We can actually now better understand the hydrology of Titan."

Adding to the oddities of Titan, with its Earth-like features carved by exotic materials, is the fact that the hydrology on one side of the northern hemisphere is completely different than the that of other side, said Cassini scientist and co-author Jonathan Lunine of Cornell University in Ithaca, New York.

"It is as if you looked down on the Earth's North Pole and could see that North America had completely different geologic setting for bodies of liquid than Asia does," Lunine said.

On the eastern side of Titan, there are big seas with low elevation, canyons and islands. On the western side: small lakes. And the new measurements show the lakes perched atop big hills and plateaus. The new radar measurements confirm earlier findings that the lakes are far above sea level, but they conjure a new image of landforms — like mesas or buttes — sticking hundreds of feet above the surrounding landscape, with deep liquid lakes on top.

The fact that these western lakes are small — just tens of miles across — but very deep also tells scientists something new about their geology: It's the best evidence yet that they likely formed when the surrounding bedrock of ice and solid organics chemically dissolved and collapsed. On Earth, similar water lakes are known as karstic lakes. Occurring in in areas like Germany, Croatia and the United States, they form when water dissolves limestone bedrock.

Alongside the investigation of deep lakes, a second paper in Nature Astronomy helps unravel more of the mystery of Titan's hydrologic cycle. Researchers used Cassini data to reveal what they call transient lakes. Different sets of observations — from radar and infrared data — seem to show liquid levels significantly changed.

The best explanation is that there was some seasonally driven change in the surface liquids, said lead author Shannon MacKenzie, planetary scientist at the Johns Hopkins Applied Physics Laboratory in Laurel, Maryland. "One possibility is that these transient features could have been shallower bodies of liquid that over the course of the season evaporated and infiltrated into the subsurface," she said.

These results and the findings from the Nature Astronomy paper on Titan's deep lakes support the idea that hydrocarbon rain feeds the lakes, which then can evaporate back into the atmosphere or drain into the subsurface, leaving reservoirs of liquid stored below.

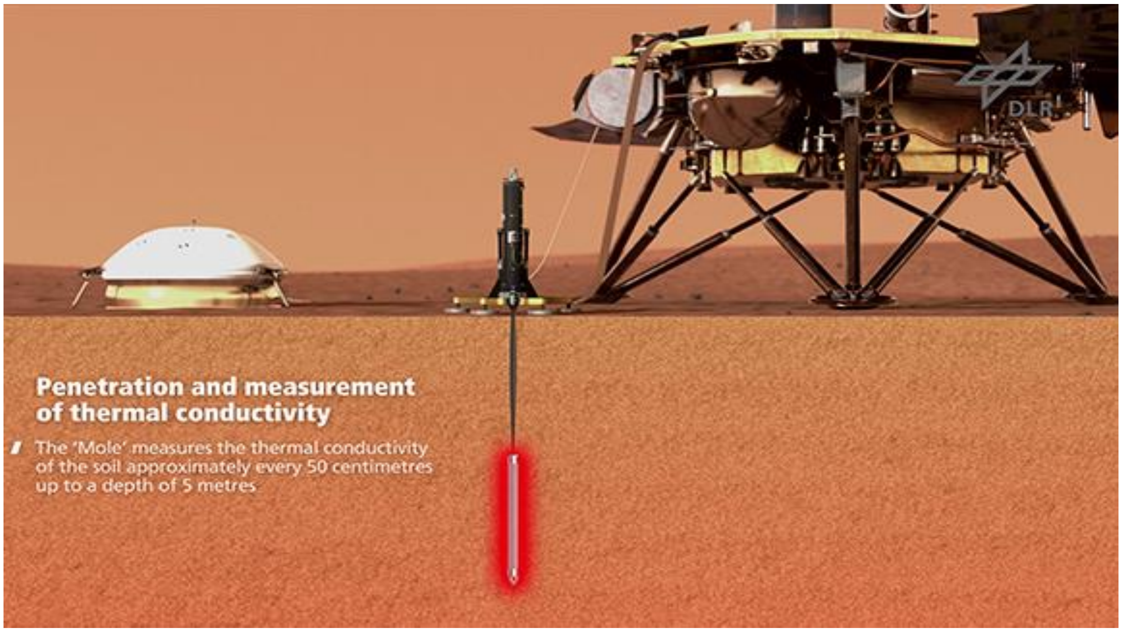
Cassini, which arrived in the Saturn system in 2004 and ended its mission in 2017 by deliberately plunging into Saturn's atmosphere, mapped more than 620,000 square miles (1.6 million square kilometers) of liquid lakes and seas on Titan's surface. It did the work with the radar instrument, which sent out radio waves and collected a return signal (or echo) that provided information about the terrain and the liquid bodies' depth and composition, along with two imaging systems that could penetrate the moon's thick atmospheric haze.

The crucial data for the new research were gathered on Cassini's final close flyby of Titan, on April 22, 2017. It was the mission's last look at the moon's smaller lakes, and the team made the most of it. Collecting echoes from the surfaces of small lakes while Cassini zipped by Titan was a unique challenge.

"This was Cassini's last hurrah at Titan, and it really was a feat," Lunine said

Source: NASA Return to Contents

3. More Testing for Mars InSight's 'Mole'



Credit: DLR (CC-BY 3.0)

Updated at 5 p.m. PDT (8 p.m. EDT) on April 11: InSight's Heat and Physical Properties Package (HP^3) instrument completed a new round of diagnostic hammering into the Martian surface on March 26, 2019, while the spacecraft's seismometer listened in. The team working with the heat probe is continuing to analyze seismic data from this test. Based on the time between hammer strikes, scientists may be able to learn something new about what's obstructing the probe from digging farther underground.

This week, the German Aerospace Center (DLR) is busy wrapping up tests at a facility in Bremen, Germany, to better understand the properties of Martian soil. There are many questions about how the soil around InSight compacts or shifts during hammering. In addition to investigating whether the probe has struck a rock or a layer of gravel, scientists are exploring whether this sand isn't providing enough friction for the probe, also known as "the mole," to dig down.

Even more testing is due to happen on Earth in coming weeks, after a replica of the HP^3 instrument, which has been shipped to NASA's Jet Propulsion Laboratory in Pasadena, California, arrives and is set up. Engineers will use it to further analyze how InSight's robotic arm might be used to lift or move the mole's support structure as it digs.

German Aerospace Center (DLR) Logbook entry: 11 April 2019

In his logbook, Instrument Lead Tilman Spohn who is at NASA in Pasadena, USA, gives us the latest updates regarding the InSight mission and our HP^3 instrument - the 'Mole' - which will hammer into the Martian surface:

"It is about time to report on the progress that has been made since the last entry on March 22. After the diagnostic hammering was approved, it was actually commanded on the 25th, executed on Mars on the 26th and the first results were down on the 27th of March. However, the seismic data came only down by the end of that week and we had the first meeting to learn about the results on April 1st. Operations in Space take their time! As I have already described in earlier mails, the progress depends on commanding opportunities on Earth (3 per week), flybys of communication orbiters on Mars, and data downlink pipelines. Our discussions – now that the European teams are all back in home - use web communication interfaces and occur several times per week - early in the day in California, late in the afternoon in central Europe.

"The diagnostic hammering was successful. The movie showed the Support Structure pitching forward as the mole hammered. The forward pitching could have been the result of the mole somehow pulling at the

support structure or the shaking of the latter by the mole allowed it to "fall down" by about half or so of a centimeter. The seismic data are still under evaluation but if you recall that we were wondering whether the time difference between the two major hammer strokes was 50 or 100 msec, the results indicate that the measured value is somewhere in-between the two. No final value yet, but we may end up somewhere around 70-80 msec. What that means in terms of the mole movement must be assessed by the mole engineers!

"The discussion about the reasons of the mole not penetrating further have settled to three hypotheses of similar credibility but differing likelihood of occurring:

1. The mole or the tether that it is trailing behind may be snagged in the Support Structure. While this hypothesis is credible it so far lacks a clear mechanism of how this may have happened. Tests at the DLR Institute of Space Systems have shown, that the tether may get snagged but only in very special circumstances. Still, a functioning model of the hardware has been shipped to JPL this weekend for engineers there to also check this possibility (BTW: It takes 2 entire weeks to clear customs over here for such a shipment. Add to that some time for customs clearing in the US)

2. The mole may have encountered a sufficiently large rock or stone at 30cm depth. The size of the rock would have to be 10cm or larger for the mole not being likely to push it aside or to go around it. This explanation is so simple that everybody would be ready to believe it. But, the likelihood of such a stone blocking the moles' way is only a few percent judging from the well-established (surface) rock-size-frequency distribution for the landing site.

3. The mole may not have enough friction on the hull to balance the recoil (as explained in part in my earlier posts (e.g., the one of March 21st)). Consider hammering a nail into a wall. You need the wall to provide enough friction to the nail so that it will move forward and not simply rebound as you hit it with the hammer. In a similar way this is true for the mole. Although its internal masses and springs are dimensioned such that most of the energy is directed forward, there is a resulting force of about 7N that still needs to be balanced by hull friction from the sand around it. This would not be a severe problem if the sand were like quartz sand, for example, having no or little cohesion. What is a daily life analog? Well, consider sugar vs. flour. If you stick a finger in sugar and pull it back, the hole will disappear as the sugar will flow back into the hole you made. Try the same with flour! In this case, the hole will stay open. Sugar is cohesionless, while flour has cohesion. Geologists have seen in other missions on Mars that the Mars sand is cohesionless and therefore a borehole should collapse and provide pressure and friction to the mole hull. But geologists have also seen that the topmost centimeters on Mars is formed by what is called a "duricrust". Here, chemical reactions between grains of sand have made them stick together, providing cohesion in that layer. The duricrust is usually thin and not a problem. But at the InSight landing site, it seems to be 20 or so centimeters thick! If the mole is sitting in the duricrust, its hull may very well have lost friction and upon time, the mole may have widened the hole in the duricust as is suggested by the data from our accelerometer and by our thermal data. One may argue that the duricrust would likely collapse as the mole hammers through. Yes, but a hole a few times the moles diameter filled with collapsed duricrust is still likely to not provide enough pressure and thus friction to the hull. It should be said here that the Martian environment adds to the problem. Because the gravity is only about a third of the Earth's the moles weight is of less help then it is on Earth. And the low atmosphere pressure of only 0.6% of the Earth's amplifies the problem.

"At the moment it seems that the discussion is leaning towards hypothesis #3, not the least as we have seen such a behavior in tests on Earth in cohesive sand and low atmosphere pressure. But we have not settled yet on this explanation. In any case, if hypothesis #3 were found to be the best explanation, it may also offer the simplest remedy. All we would need to do is help the mole to balance the recoil. The arm may be of help here but that needs to be assessed further by our engineers."

Sources: NASA and DLR Return to Contents

The Night Sky

Tuesday, April 16

• As Arcturus climbs the eastern sky these evenings, equally bright Capella is descending high in the northwest. They stand at exactly the same height above your horizon at some moment between about 9 and 10 p.m. daylight-saving time, depending mostly on how far east or west you live in your time zone.

How accurately can you time this event for your location? Like everything constellation-related, it happens 4 minutes earlier each night.

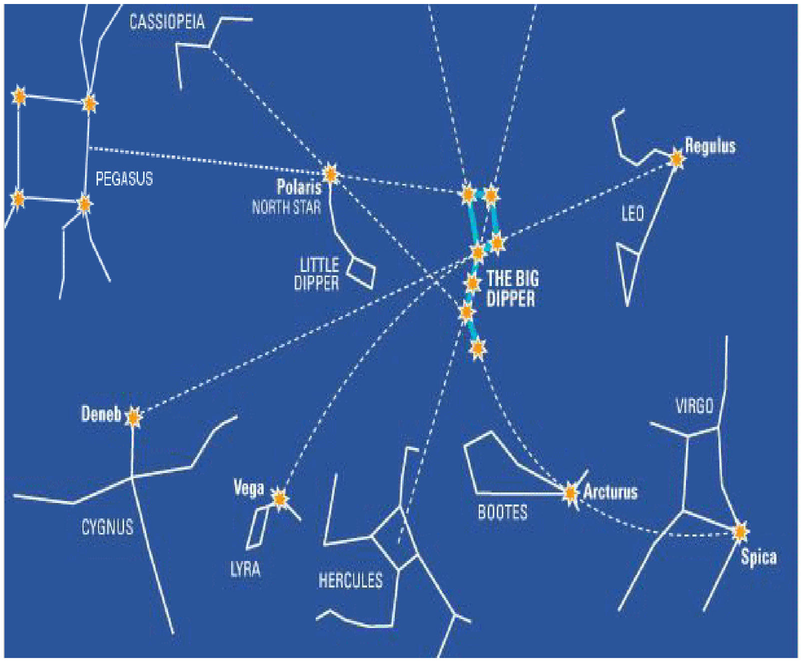
Wednesday, April 17

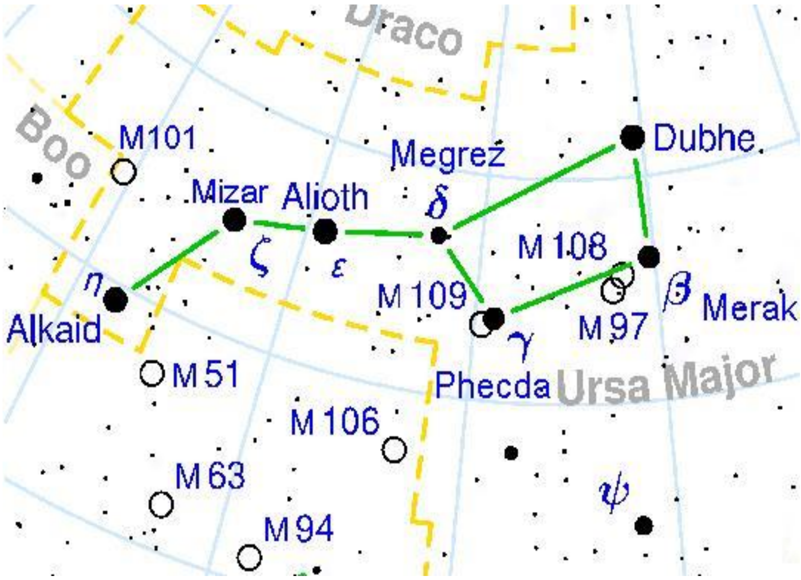
• Vega, the bright "Summer Star," rises in the northeast right around the end of twilight depending on your latitude.

Exactly where should you watch for it to come up? Spot the Big Dipper almost overhead in the northeast. Look at Mizar at the bend of its handle. If you can see Mizar's tiny, close companion Alcor (binoculars make it easy), follow a line from Mizar through Alcor all the way down to the horizon. That's where Vega makes its appearance.

Thursday, April 18

• The Moon this evening, nearly full, shines between Spica to its lower right and brighter Arcturus about four times farther to the Moon's upper left (for North America).





Credits: Top, Fort Worth Astronomical Society
Bottom, Wikipedia

Friday, April 19

• Full Moon (exact at 7:12 a.m. Eastern Daylight Time). This evening look for Spica about a fist and a half to the Moon's upper right, and brighter Arcturus about twice as far to the Moon's upper left.

Saturday, April 20

• About an hour after dark now, the Pointer stars forming the end of the Big Dipper's bowl point straight down toward Polaris, three fists at arm's length below them. Face north and look *way* up.

Source: Sky and Telescope Return to Contents

ISS Sighting Opportunities (from Denver)

No Sightings in Denver through Friday Apr 26th

Sighting information for other cities can be found at NASA's Satellite Sighting Information

NASA-TV Highlights (all times Eastern Time Zone)

April 16, Tuesday

- 2 p.m. – Northrop Grumman Cygnus CRS-11 What's on Board Science Briefing (All Channels)
- 4 p.m. – Northrop Grumman Cygnus CRS-11 Pre-Launch News Conference (All Channels)
- 8 p.m. - The Kalb Report – A Conversation with Astronaut Michael Collins on the 50th Anniversary of the Apollo 11 Moon Landing at the National Press Club (All Channels)

April 17, Wednesday

- 11:55 a.m. - International Space Station In-Flight Event for the Canadian Space Agency with the "Let's Talk Science" Event at the Ecole Champs Vallee School in Beaumont, Alberta and astronaut David Saint-Jacques of CSA – (Public Channel with interpretation; Media Channel in native language)
- 4:15 p.m. - Coverage of the launch of the Northrop Grumman Cygnus Cargo Craft on the CRS-11 Mission to the Space Station; launch scheduled at 4:46 p.m. ET (All Channels)
- 7 p.m. – Coverage of the solar array deployment on the Northrop Grumman CRS-11 Cygnus Cargo Craft (time subject to change) (All Channels)
- 8:15 p.m. – Northrop Grumman Cygnus CRS-11 Post-Launch News Conference (time subject to change) (All Channels)

April 19, Friday

- 4 a.m. - Coverage of the rendezvous and capture of the Northrop Grumman Cygnus CRS-11 cargo craft at the Space Station; capture scheduled at approximately 5:30 a.m. EDT (All Channels)
- 7 a.m. - Coverage of the Installation of the Northrop Grumman Cygnus CRS-11 cargo craft to the Unity Module of the Space Station (All Channels)
- 10 a.m. – SpaceCast Weekly (All Channels)
- 11:10 a.m. – International Space Station In-Flight Event with Military Officers Magazine with NASA astronaut Nick Hague (All Channels)
  (SpaceCast Weekly will be pre-empted on Friday, April 19 by other programming)
- 2 p.m. – International Space Station Expedition 60-61 Crew News Conference (Skvortsov, Morgan, Parmitano) (All Channels)
- TBD – International Space Station Expedition 59 In-Flight Event with Military Officers Magazine with NASA astronauts Anne McClain and Nick Hague (All Channels)

Watch NASA TV online by going to the NASA website.

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Space Calendar

- Apr 16 - Apollo Asteroid 2019 GW20 Near-Earth Flyby (0.009 AU)
- Apr 16 - Apollo Asteroid 2019 GR20 Near-Earth Flyby (0.028 AU)
- Apr 16 - Asteroid 1584 Fuji Closest Approach To Earth (1.390 AU)
- Apr 16 - Asteroid 129564 Christy Closest Approach To Earth (1.553 AU)
- Apr 16 - Virtual Seminar: Scientific Analogs and the Development of Human and Robotic Mission Architectures for Solar System Exploration
- Apr 16 - Webinar: Understanding Past and Future Extreme Events and Their Causes
- Apr 16 - Colloquium: Redox in Impact Melt Bodies from Fe-XANES and Implications for Outgassing, Tucson, Arizona
- Apr 16-17 - 9th International Workshop on Occultation and Eclipse (IWOE9), Dubai, United Arab Emirates
- Apr 16-18 - 36th National Radio Science Conference (NRSC2019), Port Said, Egypt
- Apr 16-19 - Workshop: Precision Era in High Energy Physics (Portoroz 2019), Portoroz, Slovenia
- **Apr 17 -Cygnus CRS-11 (NG-11)/ CAPSat/ HARP/ OPAL/ TJREVERB/ VCC A (Aeternitas)/VCC B (Libertas)/VCC C (Ceres)/ Swiatowid/ KrakSat/ AeroCube 10A & 10B/ SASSI2/ NSLSat 1/ ThinSat 1A-1L Antares 230 Launch (International Space Station)**
- Apr 17 - Asteroid 2579 Spartacus Closest Approach To Earth (1.107 AU)
- Apr 17 - Colloquium: How Long Does Anthropogenic CO2 Stay in the Atmosphere?, Greenbelt, Maryland
- Apr 17 - Lecture: Where is the Origin of Life on Earth, Menlo Park, California
- Apr 17 - Colloquium: Star Formation, Turbulence, Transport, and Feedback - Unified Model for the Dynamical State of Galactic Discs, Sydney, Australia
- Apr 17 - Lecture: Stimulating a Culture of Innovation at The Aerospace Corporation, Pasadena, California
- Apr 17-18 - Meeting: Near Earth Object Observations in the Infrared and Visible Wavelengths, Washington DC
- **Apr 18 - Apollo Asteroid 2019 GC6 Near-Earth Flyby (0.001 AU)**
- Apr 18 - Aten Asteroid 2019 FN2 Near-Earth Flyby (0.010 AU)
- Apr 18 - Aten Asteroid 2012 XO134 Near-Earth Flyby (0.038 AU)
- Apr 18 - Asteroid 14764 Kilauea Closest Approach To Earth (0.907 AU)
- Apr 18 - Asteroid 2999 Dante Closest Approach To Earth (1.274 AU)
- Apr 18 - Lecture: The Future is Cloudy - NASA's Look at Clouds and Climate, Pasadena, California
- Apr 18 - Lecture: A Good Hard Look at Cosmic Supermassive Black Hole Growth, Ithaca, New York
- Apr 18 - Seminar: Refractory Ca-Al-Rich Inclusions in Carbonaceous Chondrites – A Record of High-Temperature Events in the Early Solar Nebula, Houston, Texas
- Apr 18-21 - Space Access 2019 Conference, Silicon Valley, California
- Apr 19 - Aten Asteroid 522684 (2016 JP) Near-Earth Flyby (0.049 AU)
- Apr 19 - Asteroid 2409 Chapman Closest Approach To Earth (1.588 AU)
- Apr 19 - Asteroid 1489 Attila Closest Approach To Earth (1.776 AU)
- Apr 19 - Lecture: The Future is Cloudy - NASA's Look at Clouds and Climate, Pasadena, California

Source: JPL Space Calendar Return to Contents

Food for Thought

Iron Volcanoes May Have Erupted on Metal Asteroids

As a metallic asteroid such as Psyche cooled and solidified, iron volcanoes may have erupted onto its surface. (Illustration by Elena Hartley)

Metallic asteroids are thought to have started out as blobs of molten iron floating in space. As if that's not strange enough, scientists now think that as the metal cooled and solidified, volcanoes spewing liquid iron could have erupted through a solid iron crust onto the surface of the asteroid.

This scenario emerged from an analysis by planetary scientists at UC Santa Cruz whose investigation was prompted in part by NASA's plans to launch a probe to Psyche, the largest metallic asteroid in the solar system. Francis Nimmo, professor of Earth and planetary sciences, said he was interested in the composition of metallic asteroids indicated by analyses of iron meteorites, so he had graduate student Jacob Abrahams work on some simple models of how the asteroids cooled and solidified.

"One day he turned to me and said, 'I think these things are going to erupt,'" Nimmo said. "I'd never thought about it before, but it makes sense because you have a buoyant liquid beneath a dense crust, so the liquid wants to come up to the top."

The researchers described their findings in a paper that has been accepted for publication in *Geophysical Research Letters* and is available online.

Metallic asteroids originated early in the history of the solar system when planets were beginning to form. A protoplanet or "planetesimal" involved in a catastrophic collision could be stripped of its rocky outer layers, exposing a molten, iron-rich core. In the cold of space, this blob of liquid metal would quickly begin to cool and solidify.

"In some cases it would crystallize from the center out and wouldn't have volcanism, but some would crystallize from the top down, so you'd get a solid sheet of metal on the surface with liquid metal underneath," Nimmo said.

As for what the iron volcanoes would look like, Abrahams said it depends on the composition of the melt. "If it's mostly pure iron, then you would have eruptions of low-viscosity surface flows spreading out in thin sheets, so nothing like the thick, viscous lava flows you see on Hawaii," he said. "At the other extreme, if there are light elements mixed in and gases that expand rapidly, you could have explosive volcanism that might leave pits in the surface."

NASA's Psyche mission is scheduled to launch in 2022 and reach the asteroid in 2026. Signs of past volcanism that researchers could look for include variations in the color or composition of material on the surface, and possibly features that look like volcanic vents. Large volcanic cones are probably unlikely, Abrahams said.

Unfortunately, because metallic asteroids would have solidified fairly quickly after their formation, there has been plenty of time (billions of years) for any surface features of volcanism to be degraded. "It's not clear what they might look like now," Abrahams said.

The best opportunity to find evidence of ferrovolcanism on metallic asteroids might actually come from studying iron meteorites already in collections on Earth, the researchers said.

"There are lots of these metallic meteorites, and now that we know what we're looking for, we might find evidence of volcanism in them," Nimmo said. "If material got erupted onto the surface, it would cool very fast, which would be reflected in the composition of the meteorite. And it might have holes in it left by escaping gas."

When they presented their findings at a recent Lunar and Planetary Science Conference, Abrahams and Nimmo discovered that another research team had independently arrived at similar conclusions about the possibility of ferrovolcanism.

"It's not a shocking idea, but we'd just never thought about iron volcanism before, so it's something new and interesting to investigate," Abrahams said.

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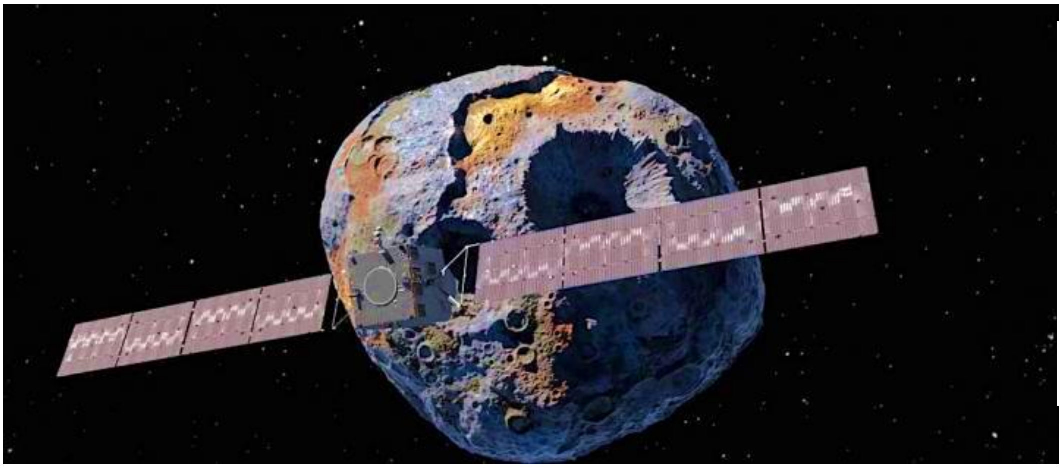

The Psyche mission spacecraft, led by Arizona State University, meets its target asteroid, 16 Psyche. The asteroid is believed to be the metallic core of a protoplanet. Such an object has never before been visited by a space mission. Credit: Peter Rubin/ASU/SSL

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Space Image of the Week

A Cosmic Rose: The Rosette Nebula in Monoceros

Image Credit & Copyright: Jean Dean

Explanation: The Rosette Nebula, NGC 2237, is not the only cosmic cloud of gas and dust to evoke the imagery of flowers, but it is the most famous. At the edge of a large molecular cloud in Monoceros some 5,000 light years away, the petals of this cosmic rose are actually a stellar nursery. The lovely, symmetric shape is sculpted by the winds and radiation from its central cluster of hot young, O-type stars.

Stars in the energetic cluster, cataloged as NGC 2244, are only a few million years young, while the central cavity in the Rosette Nebula, is about 50 light-years in diameter. The nebula can be seen with a small telescope toward the constellation of Monoceros, the Unicorn. This natural appearing telescopic portrait of the Rosette Nebula was made using broadband and narrowband filters, because sometimes roses aren't red.

Source: NASA APOD Return to Contents