IN THE STARS: NEIGHBORING LIFE IS LOOMING
By Phil Berardelli
From United Press International and SpaceDaily
20 January 2005

For the past four decades, spacecraft from Earth have been probing the other worlds of the solar system. During that time, these robotic machines, displaying a continually improving technological prowess, have collected a massive amount of data about the composition and dynamics of our neighboring worlds. Along with much information about the differences and distinctions of these various destinations, the spacecraft also have found something remarkably consistent: the basic elements of life are plentiful and common, at least in this galactic neck of the woods.

The molecules that comprise all known living things require the same four elements: hydrogen, nitrogen, carbon and oxygen. Together, these substances, along with smidgens and smatterings of a dozen or so other constituents, such as potassium, calcium, iron and magnesium, will produce life—if given the right conditions and enough time. Given the latest contributions to the extraterrestrial compendium, there is little doubt the ingredients are there.

NEW EVIDENCE INDICATES BIGGEST EXTINCTION WASN'T CAUSED BY ASTEROID OR COMET
University of Washington release
20 January 2005

For the last three years evidence has been building that the impact of a comet or asteroid triggered the biggest mass extinction in Earth history, but new research from a team headed by a University of Washington scientist disputes that notion. In a paper published January 20 by Science Express, the online version of the journal Science, the researchers say they have found no evidence for an impact at the time of "the Great Dying" 250 million years ago. Instead, their research indicates the culprit might have been atmospheric warming because of greenhouse gases triggered by erupting volcanoes.

Mount Saint Helens, Washington State. Greenhouse gases from erupting volcanoes may have caused the "Great Dying" of 250 million years ago. Image credit: Ken McGee, USGS.

The extinction occurred at the boundary between the Permian and Triassic periods at a time when all land was concentrated in a supercontinent called Pangea. The Great Dying is considered the biggest catastrophe in the history of life on Earth, with 90 percent of all marine life and nearly three-quarters of land-based plant and animal life going extinct.

"The marine extinction and the land extinction appear to be simultaneous, based on the geochemical evidence we found," said UW paleontologist Peter Ward, lead author of the paper. "Animals and plants both on land and in the sea were dying at the same time, and apparently from the same causes—too much heat and too little oxygen."

The paper is to be published in the print edition of Science in a few weeks. Co-authors are Roger Buick and Geoffrey Garrison of the UW; Jennifer Botha and Roger Smith of the South African Museum; Joseph Kirschvink of the California Institute of Technology; Michael De Kock of Rand Afrikaans University in South Africa; and Douglas Erwin of the Smithsonian Institution.

The Karoo Basin of South Africa has provided the most intensively studied record of Permian-Triassic vertebrate fossils. In their work, the researchers were able to use chemical, biological and magnetic evidence to correlate sedimentary layers in the Karoo to similar layers in China that previous research has tied to the marine extinction at the end of the Permian period. Evidence from the marine extinction is "eerily similar" to what the researchers found in the Karoo Basin, Ward said. Over seven years, they collected 126 reptile or amphibian skulls from a nearly 1,000-foot thick section of exposed Karoo sediment deposits from the time of the extinction. They found two patterns, one showing gradual extinction over about 10 million years leading up to the boundary between the Permian and Triassic periods, and the other for a sharp increase in extinction rate at the boundary that then lasted another 5 million years.

The scientists said they found nothing in the Karoo that would indicate a body such as an asteroid hit around the time of the extinction, though they looked specifically for impact clays or material ejected from a crater left by such an impact. They contend that if there was a comet or asteroid impact, it was a minor element of the Permian extinction. Evidence from the Karoo, they said, is consistent with a mass extinction resulting from catastrophic ecosystem changes over a long time scale, not sudden changes associated with an impact.

The work, funded by the National Aeronautics and Space Administration's Astrobiology Institute, the National Science Foundation and the National Research Foundation of South Africa, provides a glimpse of what can happen with long-term climate warming, Ward said. In this case, there is ample evidence that the world got much warmer over a long period because of continuous volcanic eruptions in an area known as the Siberian Traps. As volcanism warmed the planet, large stores of methane gas frozen on the ocean floor might have been released to trigger runaway greenhouse warming, Ward said. But evidence suggests that species began dying out gradually as the planet warmed until conditions reached a critical threshold beyond which most species could not survive.

"It appears that atmospheric oxygen levels were dropping at this point also," he said. "If that's true, then high and intermediate elevations would have become uninhabitable. More than half the world would have been unlivable, life could only exist at the lowest elevations."

He noted that the normal atmospheric oxygen level is around 21 percent, but evidence indicates that at the time of the Great Dying it dropped to about 16 percent—the equivalent of trying to breathe at the top of a 14,000-foot mountain.

"I think temperatures rose to a critical point. It got hotter and hotter until it reached a critical point and everything died," Ward said. "It was a double-whammy of warmer temperatures and low oxygen, and most life couldn't deal with it."

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The theory that impact with an asteroid or comet caused the Permian mass extinction was first published three years ago. A news release on that subject can be found at http://www.wwnews.org/article.asp?articleID=3131. Luann Becker is now at the University of California, Santa Barbara.

Read the original news release at http://www.wwnews.org/article.asp?articleID=7601.

Additional articles on this subject are available at:
http://www.astrobio.net/news/article1405.html
http://www.universetoday.com/am/publish/dispute_great_dying.html

TITAN: STRANGER TO THE FAMILIAR
By David Noever
From Astrobiology Magazine
21 January 2005

Interpreting aerial photographs is a matter of training and a good sense of scale. Images that look similar may mask the underlying landscape if the scales are different. The images returned from Titan two billion miles away can look like the familiar aerial picture of a terrestrial shoreline, depending on the local weather, scale of measurement and even the eye of the beholder.

A comparison of Lake Superior's shoreline with a possible dry shoreline on Titan.

What the Huygens probe discovered however had nothing to do with lakes of liquid water, since any surface pools would freeze solid instantly. Instead of a base chemistry defined by hydrogen and oxygen like Earth's, Titan offers a
eroded landscape shaped by the chemistry of hydrogen and carbon. This new hydrocarbon world is frozen, choking and wind-blown.

After a 4 billion kilometer (2.4 billion mile) journey through the Solar System that lasted almost seven years, the tiny Huygens probe plunged into the hazy atmosphere of Titan in the early morning hours on January 14th and landed safely on its frozen ground at 7:45 EST. The probe continued transmitting from the surface for several hours, even after the Cassini orbiter dropped below the horizon and stopped recording the data to relay them towards Earth. The mothership circling overhead served as the communications relay for the probe far below the clouds. Cassini received excellent data from the surface of Titan for 1 hour and 12 minutes.

More than 474 megabits of data (approximately 60 megabytes) were received in 3 hours 44 minutes from Huygens, including some 350 pictures collected during the descent and on the ground. Once communications reached Earth, the data could be written to a single compact disk for transfer among scientists stationed around the world. Among the surprises from those early pictures, the Titan lander revealed a landscape apparently modeled by erosion. Titan had an intricate maze of drainage channels, shoreline-like features and even pebble-shaped objects on the surface.

The temperature measured at ground level was indeed supercold, about minus 180 degrees Celsius (or minus 292 Fahrenheit). There is no place on Earth even remotely like Titan's winter. The lowest temperature ever recorded on Earth (-129°F, -90°C) was at Vostok, Antarctica on July 21, 1983.

Titan's atmosphere was probed and sampled for analysis at altitudes from 160 km (96 miles) to the ground, revealing a uniform mix of methane with nitrogen in the stratosphere. Methane concentration increased steadily in the troposphere down to the surface. Clouds of methane at about 20 km (12 miles) altitude and methane or ethane fog near the surface were detected. The probe's signal, monitored by a global network of radio telescopes on Earth, will help reconstruct its actual trajectory with an accuracy of 1 km (0.6 miles) and will provide data on Titan's winds.

Early analysis of the received signal indicates that Huygens was still transmitting after three hours on the surface. Later recordings are being analyzed to see how long Huygens kept transmitting from the surface. The initial signal sent to terrestrial radio telescopes from Titan had little more strength than the power of an average cell phone.

Samples of aerosols were also collected at altitudes between 125 and 20 km (12-100 miles) and analyzed on board. During the descent, sounds were recorded in order to detect possible distant thunder from lightning, providing an exciting acoustic backdrop to Huygens' descent. As the probe touched down at about 4.5 meters per second (10 miles per hour), a whole series of instruments provided a large amount of data on the texture of the surface. At ground level, Titan resembles wet sand or clay with a thin solid crust, and its composition as mainly a mix of dirty water ice and hydrocarbon ice, resulting in a darker soil than expected. Scientist will continue to test the image and chemical data for clues to whether Titan's surprising landscape might ever have been wet or warm enough for more interesting biochemistry to arise.

Read the original article at http://www.astrobio.net/news/article1406.html.

**LIGHTING UP THE FLAMMABLE MOON—TITAN'S GOLDEN GOO**
By Leslie Mullen
From *Astrobiology Magazine*
21 January 2005

The region where the Huygens probe landed looks oddly familiar. The same processes of precipitation, erosion, and abrasion that shape the Earth are also occurring on Titan, although the ingredients are very different. While the rocks of Earth—from the sandy beaches to tallest mountains—are mostly made of silicates, on Titan the rocks are made of water ice. While the Earth's rain showers, mountain springs, and rivers are composed of liquid water, on Titan they're all liquid methane.

![Nitrogen Isotope Ratio](https://example.com/nitrogen_isotope.png)


"We had great difficulty obtaining these pictures. We had only one percent of the illumination from the sun, we're going into a very thick atmosphere with lots of haze that blocks light from penetrating to low levels, and we're taking pictures of an asphalt parking lot in dusk situations, and trying to stretch the contrast. So to a human eye, those dark regions would be very black. But there are bright regions as well, the hills, for example—those are significantly brighter. I think that's because the dark material has washed off the top of those hills, and has now been concentrated into the river channels and into the low lying regions where the liquid finally dries out and leaves the dark organic material concentrated." —Martin Tomasko. Image credit: ESA.

Titan is a world where bits of muck continually fall out of the smoggy sky, blanketing the frozen surface like dark gooeey snow. Squalls of methane rain periodically wash the surface clean, sweeping the organic gunk into rivers. The methane rivers ferry the gunk down through hills of rock-hard ice, and empty into the valley below. But the river delta photographed by Huygens does not lead to an open sea.

"The region we landed in is more typical of arid regions on the Earth," says Martin Tomasco, Principal Investigator for the Descent Imager and Spectral Radiometer, from the University of Arizona in Tucson. "It's like Arizona, where the riverbeds are dry most of the time. Right after a rain you might have open flowing liquids, but then there are pools that gradually dry out, or liquid sinks down into the surface."

Both Titan and the Earth have an atmosphere mainly composed of nitrogen. But the secondary gas on Earth is oxygen, while on Titan it is methane.

"Whenever you see a planet with a dominant nitrogen atmosphere, you have to ask yourself, 'Where is the carbon?' because carbon is more abundant than nitrogen," says Toby Owen, Cassini Interdisciplinary Scientist for the...
atmospheres of Titan and Saturn, from the Institute for Astronomy in Honolulu, Hawaii.

Owen says that on Earth, the carbon became carbon dioxide (CO₂), which then became carbonate rocks. If the CO₂ from carbonate rocks were put back into the atmosphere, the Earth's surface pressure would increase 70 times its present level, making our planet more like Venus.

"Venus and Mars, which have predominately CO₂ atmospheres, represent normal conditions," says Owen. "Earth is kind of odd, because the CO₂ is not there."

Titan is odd, too, because its methane has not turned into CO₂ over time. The reason for that, says Owen, is because there is no oxygen on Titan to facilitate the transition.

"Water, which is the dominant oxygen reservoir on these planets, is frozen out on the surface," says Owen. "There's no source of free oxygen available, which is a good thing, or Titan would have exploded a long time ago."

The vast amount of methane on Titan makes the whole moon flammable. But where is all the methane coming from? If methane has been producing the moon's signature photochemical smog for millions or even billions of years, why hasn't it been used up by now? Scientists suspect there are reservoirs of methane just beneath the thin surface crust. When the Huygens probe landed on Titan's surface, it broke through this crust and settled a few centimeters deep into the icy sand-like surface. Heat from the probe's instruments thawed the icy ground and produced a burst of methane gas.

Another puzzle about Titan's atmosphere involves the lack of noble gases like krypton and xenon.

"We find these gases in our atmosphere, we're all breathing them right now," says Owen. "We find them on Venus, on Mars, on Jupiter, but they're not present on Titan at limits that we can detect with our sensitivity - which is equal to one thousand times less than what we see on the Earth. Surely there's an interesting clue there as to how Titan formed, which we're going to be working on over the next few months."

Jean Pierre Lebreton, ESA's Huygens Project Scientist and Mission Manager, says the next mission to Titan will probably involve some sort of machine that would fly all around the moon to sample the atmosphere, and then land and sample the surface.

"But I just got a message from the Mars rover team," says Lebreton. "I don't know if Mars is now becoming boring, but they are now dreaming of sending their rovers to the surface of Titan. I think from what we have seen, this is possible."

Read the original article at http://www.astrobio.net/news/article1408.html.

MOONLANDER: LET IT RAIN (INTERVIEW WITH ANTHONY DEL GENIO)
From Astrobiology Magazine
22 January 2005

Since the remarkable landing of the Huygens probe on the surface of Saturn's largest moon, Titan, the community of planetary scientists has wondered anew about the discovery prospects in our own solar system. As part of the Cassini Imaging team studying the atmosphere on Saturn, Anthony Del Genio explained to Astrobiology Magazine his interests in the giant ringed world and its strange moons. Del Genio is a research scientist at NASA Goddard Institute for Space Studies, GISS) New York, and an Adjunct Professor in the Columbia University Department of Earth and Environmental Science. His interests in the terrestrial atmosphere have led him to study storms on other planets such as Jupiter, Saturn and Titan, fundamentally to gain greater understanding of how their meteorology differs from that of Earth. Del Genio contributed his thoughts to Astrobiology Magazine as he explained in this part of the interview what role liquid methane might be playing on Titan.

Anthony del Genio against a backdrop of Titan's surface. Image credit: ESA.

Astrobiology Magazine (AM): What are your initial reflections post-landing, only one week after Huygens reached the surface on Titan?

Anthony Del Genio (ADG): The first thing to say is that last Friday [January 14] was arguably the most exciting day in the history of planetary exploration. One could make the case for the first ever planetary flyby, Mariner 2 Venus, in the 1960s, or the Viking landings on Mars and the Voyager Jupiter flybys in the 1970s.

But successfully landing on a moon so far away, and one that seems more Earth-like and currently active than any other place in the solar system, with all that implies about what we might learn about Earth's own early history and the odds of life elsewhere in the universe—well, it's hard to describe how exciting that is. If NASA is going to go in a new exploration direction in the coming years, how can Titan not be our number one long-term priority?

AM: Not to put too fine of a point on it, were you surprised by the first sights of "alien mud"?

ADG: My thinking about Titan has been going up and down like a yo-yo in the past year. Before we got there, we knew about the dark and bright regions, the apparent need to have a surface source of methane to explain its continued presence in the atmosphere, and the ground-based radar detection of specular reflection (the equivalent of sunglint, but for radar waves), all pointing to at least a partially wet surface.

Then after a few Cassini Orbiter flybys seeing few clouds outside the polar region and no sunglint at near-infrared wavelengths, I began thinking that the atmosphere and surface are drier than I had imagined, and that maybe the methane is locked up underground and only gets out occasionally.

But now Huygens has apparently seen evidence of a methane reservoir just beneath the surface. It's still not clear to me whether it's really like mud, i.e., whether you've got solid water ice/organic particles suspended in a methane liquid or not. And of course we don't know if the landing site is typical of other places on Titan.

But the Huygens data make it pretty likely that it's rained sometime or other on that part of the moon, whether just yesterday, in which case it may really be mud, or 7 years ago when Titan was at its autumnal equinox and methane storms would have been more prevalent at the landing site, as is the case in Earth's tropics.

AM: The atmospheric composition seems dominated by nitrogen and methane. Does this chemical composition have implications for modelling global circulation, temperature profiles, etc.?
ADG: Yes, it has implications for both of those things, especially the methane. The nitrogen was inferred from Voyager data and from our knowledge of the solar abundance of nitrogen and associated expectations of what a cold planet's atmosphere should mostly be made of. We haven't heard yet from the Huygens people what the actual abundance of methane in the troposphere is, and what the relative humidity of methane is.

From a purely observational standpoint, knowing the vertical profile of methane abundance will help the [Cassini] Orbiter scientists in several ways. First, when we look at near-infrared images taken at wavelengths where methane absorbs sunlight weakly, it will help us figure out how high the cloud tops are. Second, Cassini will be indirectly measuring the temperature structure of Titan's atmosphere at many latitudes by observing how light is affected as it passes tangentially through the atmosphere. Knowing how much methane there is allows that [profile] to be converted into temperature information more accurately.

AM: What if it really does rain on Titan?

ADG: For modeling, we've been speculating for a long time about whether models of Titan need to include the methane equivalent of a "hydrologic" cycle. Now it's pretty clear that we do.

Once we know exactly how much methane there is, and have a better idea of what the surface is really like, we'll have to include the possibility of rainmaking clouds and an interactive surface in our models, one that gets wet when it rains, lets methane infiltrate into the "soil" (or whatever one wants to call the stuff that Huygens landed on) and then evaporates at a rate that depends on how often the methane gets exposed to the atmosphere, how turbulent the air is near the ground, what its relative humidity is, etc.

Then we can ask the question of whether without these processes, Titan's atmospheric circulation would be very different or not. Rain, evaporation, etc. could just be a by-product of the atmospheric circulation, as it is for example on Earth when a weak low pressure system makes rain in New York in December. Or it could be that the circulation itself is modified in an important way by methane rain, as is the case for example in the tropics on Earth where Amazon and Indonesian thunderstorms control what the large-scale circulation patterns look like.

AM: Is there a sense of surprise about what you have seen so far from the surface pictures particularly?

ADG: Ecstasy is more like it. I think we had all been hoping that there would be liquid methane on the surface, that we'd see evidence of a hydrologic cycle, and that there would be some hint of what differentiates the dark and bright areas we can see from space.

There had been suggestions from ground-based data that water ice was exposed on the surface, and that this was a likely candidate for the bright areas. Then the early Cassini results made me, at least, start to wonder about what we'd really get—we saw hints of all these things from the morphology of the surface features and the presence of clouds, but some confusing things as well.

We were really fortunate in that Huygens landed right smack in a region where there is a dark-bright boundary in the Cassini images. That gives us the variety of surface types in the same scene that allows the viewer some perspective about what we're looking at.

AM: So to paraphrase, on the wish-list for Titan there would be listed the three items: liquid methane on the surface, rainmaking and whether the dark-light boundary were really surface features?

ADG: As for the things I'd been hoping for, it looks we got two out of three at least, and maybe all three. We're already pretty sure that at least in this part of the moon the bright stuff is ice bedrock and at a somewhat higher elevation. And we're pretty sure that the dark stuff is lower and is the place where stuff collects after flowing down the drainage channels. And the channels themselves, at least some of them, say that it rains there. The jury's still out on whether there's currently liquid on the surface, or whether it's mostly organic residue from previous flow events. But the story in these images says that if surface liquid is not present there and then, then somewhere, sometime on Titan.

AM: Just from what we know about Saturn's distance from the Sun, can one give a relative or approximate sense of the illumination (solar power) beyond the two-billion-mile marker, relative to the earth's 93 million miles?

ADG: If's pretty dark there. The illumination by the Sun scales as the inverse square of distance. Titan is almost 10 times farther from the Sun than Earth is, so the sunlight it receives is about 1 divided by 10 squared times, or about 1 percent, what the Earth receives. And that's at the top of the atmosphere.

Much of the incoming sunlight is reflected back into space by the hydrocarbon haze that covers Titan, so only a fraction of that 1% actually reaches the surface. The Huygens DISR instrument will eventually tell us exactly how much. But Marty Tomasko, the DISR PI, described imaging the dark areas on Titan's surface as being something like taking a picture of a blacktop driveway at dusk.

AM: Others have mentioned that Huygens had a fairly bumpy ride through the atmosphere (20 degree or more tilt windward) but landed softer than predicted (although still a 15-G collision or so). Can you suggest anything about the relation, if any, between high winds and what the Cassini Imaging team's models might try to pinpoint for superrotation or global circulation?

ADG: Just speculating, Huygens might have encountered some "clear air turbulence" as we get sometimes on plane rides here on Earth. Turbulence like that often results from what we call gravity waves, waves that oscillate in the air as the buoyancy of up-down moving air fluctuates, analogous to the ripples that form when you throw a rock onto a pond.

When gravity waves propagate upward, the decreasing density of the air with height makes the amplitudes of the waves larger, i.e., for the same kinetic energy of the wave motion the air motion is stronger where the air is thinner. It's like the effect of cracking a whip—you move the thick end of the whip a little, and you get a large movement at the thin end. So high up the winds associated with these waves can get strong enough that sometimes they induce turbulence.

Now where the superrotation may come into the picture is that as the superrotation gets stronger with height, the wavelengths of any gravity waves may get smaller, i.e., the wave crests and troughs may get closer together. We think we may see that in some of our Cassini images. And the closer they get, the more likely that they become turbulent.

AM: Some have suggested that volcanicism of some kind may be shaping Titan's surface. Any of this fit into a planetary model of its history with a hot core for Titan?

ADG: There's been speculation about the possibility of "cryovolcanism" on Titan, in other words, volcanic emissions of ice and gases rather than lava. And the images we've gotten to date suggest the possibility of cracks, striations on the surface that might indicate tectonic activity on Titan. And that in turn would suggest an active interior.

Now we hear from Huygens data that argon-40, which results from the decay of potassium in the interior, is present in the atmosphere, and that, along with some apparent ice extrusions seen in the Huygens images, seems to be pointing the geologists toward cryovolcanism.
Microbes living in the brilliantly colored hot springs of Yellowstone National Park use primarily hydrogen for fuel, a discovery University of Colorado at Boulder researchers say bodes well for life in extreme environments on other planets and could add to understanding of bacteria inside the human body. A team of CU-Boulder biologists led by Professor Norman Pace, one of the world's leading experts on molecular evolution and microbiology, published their report "Hydrogen and bioenergetics in the Yellowstone geothermal system" this week in the online edition of the Proceedings of the National Academy of Sciences. The team's findings, based on several years of research at the park, refute the popular idea that sulfur is the main source of energy for tiny organisms living in thermal features.

"It was a surprise to find hydrogen was the main energy source for microbes in the hot springs," Pace said. "This project is also interesting in the context of microbiology because it's one of the few times we've been able to study microbes to get information on an entire ecosystem. That's never before been possible."

The study was specifically designed to determine the main source of metabolic energy that drives microbial communities in park features with temperatures above 158 degrees Fahrenheit. Photosynthesis is not known to occur above that temperature. A combination of three different clues led researchers to conclude that hydrogen was the main source of energy. Genetic analysis of the varieties of microbes living in the hot springs communities revealed that they all prefer hydrogen as an energy source. They also observed ubiquitous H₂ in all the hot springs at concentrations sufficient for microbial bioenergetics. Thermodynamic models based on field data confirmed that hydrogen metabolism was the most likely fuel source in these environments.

"This work presents some interesting associated questions," said John Spear, lead author of the report. "Hydrogen is the most abundant element in the universe. If there is life elsewhere, it could be that hydrogen is its fuel," Spear said. "We've seen evidence of water on Mars, and we know that on Earth, hydrogen can be produced biogenetically by photosynthesis and fermentation or non-biogenetically by water reacting with iron-bearing rock. It's possible that non-biogenic processes produce hydrogen on Mars and that some microbial life form could be using that," he said.

There are many examples of bacteria living in extreme environments—including the human body—using hydrogen as fuel, according to Spear. "Recent studies have shown that Helicobacter pylori bacteria, which cause ulcers, live on hydrogen inside the stomach," said Spear. "Salmonella metabolizes hydrogen in the gut. It makes me wonder how many different kinds of microbes out there are metabolizing hydrogen in extreme environments."

Instead of relying on traditional techniques of microbiology that utilize cultures grown in the lab, the CU-Boulder team used methodology developed by Pace to genetically analyze the composition of the microbial community as it appeared in the field. "We didn't look at what grows in a culture dish, we looked at the RNA of samples directly from the field," Spear said.

"We've never before known what microbes were living in Yellowstone hot springs, and now we do," Pace said.

A novel suite of instruments was used to gather data, some of which had never before been collected. "No one had measured the concentration of hydrogen in the hot springs before because the technology didn't exist until about seven years ago. Now we can detect very low-level concentrations of hydrogen in water," Spear explained.

"We found lots of hydrogen in the hot springs—an endless supply for bacteria," he said. Measurements of the amount of H₂ in water were recorded in Yellowstone hot springs, streams and geothermal vents in different parts of the park and during different seasons. All of the environments had concentrations appropriate for energy metabolism.

The team used computer-generated thermodynamic models to find out if hydrogen was indeed the principle source of energy. "You can smell sulfide in the air at Yellowstone, and the accepted idea was that sulfur was the energy source for life in the hot springs," Spear said. Not so, according to the team's computer models built on field measurements of hydrogen, sulfide, dissolved oxygen concentration and other factors.

Spear said it was difficult to explore a microbial ecosystem. "We have a hard enough time explaining what's going on in a forest, for example, with all the interlacing systems. We can't even see a microbial system."
Sample extraction was a dangerous and delicate operation. In order to accurately analyze a hot spring's entire microbial community, Spear needed to collect only about as much material as a pencil eraser. Sediment samples were scooped into special sample vials and immediately frozen in liquid nitrogen canisters to preserve the microbial community.

In springs where there was no sediment, Spear collected samples of planktonic organisms by hanging a glass slide in the water and allowing the microbes to accumulate. "Bacteria are just like us. They like to be together, they like to be attached to a surface and they like to have their food—dissolved hydrogen, in this case—brought to them."

Spear explained that the hot springs' colors are the result of interactions between minerals and the microbes living in the pools. Hotter water usually shows colors from minerals, and cooler water plays host to photosynthetic pigments.

"Based on what I've seen in this analysis, I think hydrogen probably drives a lot of life in a lot of environments," Spear said. "It's part speculation, but given the number and kinds of bacteria that are metabolizing hydrogen, it's probably a very old form of metabolism. That's important because it tells us about the history of life on Earth. And if it works this way on Earth, it's likely to happen elsewhere. When you look up at the stars, there is a lot of hydrogen in the universe."

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An additional article on this subject is available at http://www.universetoday.com/am/publish/microbes_hydrogen_fuel.html.

CLOCKWORK ORANGE PLANET
By Leslie Mullen  
From Astrobiology Magazine  
24 January 2005

This month marks the one-year anniversary for both the Spirit and Opportunity Mars rovers. Spirit landed on Mars on January 3, 2004, and Opportunity arrived 3 weeks later, on January 24. Since the rovers were designed to last for just three months, they have far exceeded the expectations of even the most optimistic mission planners. So far, Spirit has driven over 4 kilometers. Opportunity has driven half that distance, partly because it landed right in a crater on arrival, stunning scientists with their first view of martian bedrock layering.

Spirit is currently exploring the Columbia Hills within the Gusev Crater, and recently found a new type of rock. Named "Wishstone," the rock is composed of grains of various sizes, and is thought to be the result of a volcanic explosion or impact event. For reasons the scientists do not yet understand, the rock is much richer in phosphorus than any other rocks seen so far on Mars.

"One possibility is that the explosive event—the igneous rock itself—was rich in phosphorus to start with," says Steve Squyres, principal investigator for the rover science payloads. "The other possibility is it's a phosphate that was deposited with water."

Water-deposited phosphorus would suggest a different type of water chemistry than what occurred just 500 meters away, where the rocks are rich in chlorine, sulfur, and bromine. Scientists expect that Spirit will be investigating more such rocks as it climbs Husband Hill, heading for the summit.

Meanwhile, Opportunity spent some time sniffing around its discarded heat shield. This shield protected the rover during its descent through the martian atmosphere, and then detached before the rover's airbags inflated. When the heat shield hit the ground, it split in two and turned inside out. By looking at the heat shield with a microscopic imager, engineers hope to determine how deeply the atmospheric friction charred the shield's protective layers.

Opportunity found "blueberry-like" concretions scattered across the Meridiani plains. Image credit: NASA/JPL.

Spirit explored Gusev crater's geochemistry. Image credit: NASA/JPL.

"For the scientists, this has been really fun, because we get to sit back and let all the engineers do all the really hard thinking," says Squyres. "We just take pictures to make the engineers happy."

Opportunity also spotted a pitted meteorite the size of a basketball near the heat shield. While most meteorites on Earth are rocky, the meteorite on Mars is metal-rich, composed of mostly iron and nickel.

"We've seen lots of cobbles out on the plains, and this raises the possibility that some of them may in fact be meteorites," says Squyres. "We may be investigating some of those in coming weeks."
Opportunity's future plans also include a drive south toward a region called the "etched terrain." Small craters dot the landscape along the way, and the rover will move from crater to crater, eventually reaching an unusual circular feature called "Vostok."

Firouz Naderi, manager of the Mars Exploration program at the Jet Propulsion Laboratory, says that more Mars discoveries are on the way.

"The opportunity to go to Mars comes around like clockwork, every 26 months," says Naderi. "So at any given time, we have some assets on or above Mars, some that are fixing to go, some on the drawing board, and some that are still being cooked up as a concept in the minds of some pretty smart people."

"All of the (missions) are aimed at answering two fundamental questions," Naderi adds. "One is, was the environment on Mars ever right for the emergence of life? And second, if so, did life in fact emerge?"

Naderi says the current strategy for answering these questions is to have orbiters above Mars, looking for places that may have once had liquid water. The rovers are then sent in for a closer look. For instance, the Mars Global Surveyor detected hematite, a mineral that often forms in the presence of water. So the MER rovers were sent to places where hematite was plentiful and where landing wouldn't be too difficult.

Mars Odyssey recently detected water ice near the surface in the high latitudes, and in 2007 the Phoenix Mars Lander will investigate those regions. This August, the Mars Reconnaissance Orbiter will be launched. What it discovers will determine the fate of the Mars Science Laboratory, which is scheduled for launch in 2009. In the coming decade, scientists hope to bring a Mars sample back to Earth.

"We need to learn how to build upon these tremendous findings—these phosphanic rocks, these high sulfur rocks, these ancient habitable environments—by bringing those samples back here to Earth," says Jim Garvin, lead scientists for Mars exploration at NASA's Headquarters in Washington, DC. "Bringing (samples) back here (will) show us we can make the round trip before we send the women and men to hit the ultimate home run by being there on Mars."

Read the original article at http://www.astrobio.net/news/article1411.html.

**DOES TITAN RAIN METHANE? (INTERVIEW WITH SUSHIL ATREYA)**

*From Astrobiology Magazine*  
*25 January 2005*

Titan is unique as a moon because its atmosphere is even denser than Earth's. Since the early Voyager flybys in the 1970's, this Saturnian moon's smog has intrigued planetary scientists, particularly since Titan's hydrocarbon chemistry may share common features with our own atmosphere or neighboring Martian cases. For the first time, planetary scientists now can compare and contrast details of atmospheric chemistry with data and examples. What is the role of methane in explaining what drives geology and meteorology on this new and alien world? As a member of the Cassini-Huygens Science and Experiment Teams [GCMS AND ACP], Sushil Atreya kindly shared his initial thoughts soon after the successful landing of the Huygens probe on Saturn's largest moon, Titan. Atreya is a professor and director of the Planetary Science Laboratory in the University of Michigan College of Engineering. He is the author of several books including *Atmospheres and Ionospheres of the Outer Planets and their Satellites.*

**Astrobiology Magazine (AM):** If the half-life of Mars methane might be around 300 years, is there a different corresponding figure for Titan that might indicate how long methane survives in Titan's atmosphere?

**Sushil Atreya (SA):** First, unlike nuclear physics where half-life is used, the jargon in atmospheric applications is "lifetime", which actually is "e-folding time". The e-folding time is the time over which the concentration drops by a factor of e, roughly 3. The lifetime of methane in Titan's atmosphere is approximately ten million years, compared to 300-600 years on Mars.

**AM:** Does the higher density of Titan's atmosphere change its ultraviolet degradation substantially, relative to the martian case?

**SA:** Indeed, Titan's higher atmospheric density prevents the UV from penetrating to deep levels. As a consequence, most of the UV degradation occurs high in the atmosphere. Three factors are involved in determining the lifetime: first, the density and composition of the atmosphere, second, concentration of methane, and finally, the solar ultraviolet flux.

Because of (1) and (2), methane is destroyed not just by the UV (above 60 km) but also by oxidation (below 60 km, mostly near the surface) on Mars, whereas the principal destruction of methane on Titan is by the UV well above 500 km. Because of (3) alone the destruction rate at Titan, which is at ~10 AU from the Sun, is roughly a factor of 40 slower than at Mars, which is ~3.5 AU from the Sun. Considering the full photochemical loss and recycling mechanisms yields the ten million year lifetime for methane on Titan.

**AM:** The methane clouds are much different in frequency to, say, earth's water clouds—mainly Titan has fewer of these clouds that might be expected if the relative methane "humidity" was greater than 30%. Is there a better picture now of whether methane rain is ever a possible working hypothesis that holds up?

**SA:** The sudden change in the methane mixing ratio at 17-19 km altitude detected by the Huygens Gas Chromatograph Mass Spectrometer (GCMS) is a strong indicator of a thick cloud or haze layer of methane. The methane mixing ratio steadily rose below this altitude. Upon impact the GCMS inlet was heated, and a surge in the methane mixing ratio was recorded, indicating a reservoir of liquid methane on the surface.

The above behavior of methane, together with the images reminiscent of river channels, as well as the "wet clay" like surface concluded by the Surface Science Package, all argue for methane rain on Titan. Titan's methane cycle is somewhat like the water cycle of the earth involving evaporation (from oceans/lakes), clouds, and precipitation.

**AM:** Was there anything specific that you were looking for in pictures to help understand if the methane source might be surface volcanism or actual pooling of hydrocarbons?

**SA:** Unlike Mars, existence of methane on Titan is not surprising. But, how does the methane get replenished on Titan is the big question. For this, a source is required.

We were on the lookout for any telltale signs like fumaroles [vents], etc., but it was a long shot, and we didn't see any in the landing site. On the other hand, we did detect radiogenic argon (40Ar) with the GCMS. It arises from the decay of potassium (40K) that is in the rocks deep in the interior of Titan. This detection indicates that there must be out-gassing going on.

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On Earth, fumaroles are volcanic features that release gasses from below the surface. Could Titan have methane fumaroles? Image credit, R. L. Christiansen, USGS.
developing a scenario by integrating all available evidence from Huygens. Large scale magmatic or tectonic processes do not seem likely on Titan.

**AM:** On Mars, the methane was almost a trace gas in parts per billion, while almost half of Titan's thick atmosphere is methane. What does this tell about what makes all the methane on Titan? For example, is the UV so low there that the rate of decay is slower and thus methane accumulates in different ways in the outer solar system?

**SA:** First, a small correction—methane on Titan is roughly 3-4% by volume of the atmosphere, not 50%. But, yes, a much bigger fraction than on Mars.

The reservoir of carbon on Mars, Earth and Venus is carbon dioxide (CO₂), whereas carbon resides predominantly in methane (CH₄) in the outer solar system. This is due to the difference in the way the outer solar system bodies formed compared to the inner planets. In the hydrogen-rich environment of the outer solar system, carbon (which was originally in the form of organics or CO) is converted to CH₄.

The destruction by UV comes into play only after methane has been incorporated into the planet or satellite like Titan. The slower destruction rate destroyed. And, that's still a mystery, but Huygens data are expected to reveal the secret, in time.

Read the original article at http://www.astrobio.net/news/article1413.html.

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**THE ORIGINS UMBRELLA (INTERVIEW WITH NEIL DE GRASSE TYSON)**

**By Leslie Mullen**

**From Astrobiology Magazine**

26 January 2005

Neil de Grasse Tyson is the Director of the Hayden Planetarium at the American Museum of Natural History in New York, and also a Visiting Research Scientist at Princeton University's Department of Astrophysics. He writes a monthly column called "Universe" for Natural History magazine, and is the author of several books, including One Universe: At Home in the Cosmos and The Sky is Not the Limit: Adventures in an Urban Environment. His most recent project is the NOVA four-part series, Origins. As host of the PBS miniseries, Tyson guides viewers on a journey into the mysteries of the universe and the origin of life itself. In this interview with Astrobiology Magazine editor Leslie Mullen, Tyson describes the origin and evolution of "Origins."

**Astrobiology Magazine (AM):** Could you describe the process of how the NOVA "Origins" TV series and companion book came about?

**Neil de Grasse Tyson (NT):** If we go back to the beginning, we can trace the origin of Origins to some efforts by NASA to create a new funding umbrella that didn't have much precedent in the portfolio of NASA projects. This Origins umbrella would primarily bring together biologists and astrobiologists, but of course others would join in as time went on. Great work was already being done in cosmology, where we'd partnered up with particle physicists to understand the origin and evolution of the universe. But then it came time to understand the origins of other things, like the solar system and life, and NASA came to realize it might be uniquely positioned to make a research statement about that.

This happened in the mid-1990s. Shortly after that, Tom Levenson, a TV producer with whom I had worked before, saw this emerging science of origins take hold, yet there was not much public awareness. He decided the topic was right for a TV series, and then he and a fellow producer contacted me as someone who might host the series and act as the on-camera interpreter of all these different sciences. When he approached me in the late 1990s, I was too busy with the reconstruction of the Hayden Planetarium, the facility that is now known as the Rose Center for Earth and Space, itself containing the rebuilt Hayden Planetarium. But he was still fund-raising for the project, which in fact would take him several more years. By 2001, he finally got enough money and finally I had enough time, and so we got together. Meanwhile, over those several years, there were certain key developments in cosmology and in other branches of origin science. Those developments gave the final product a level of enrichment that it could not have had if we'd completed it in the 1990s.
The e-mails have been very positive, and there have been many flattering responses from the initial premier broadcast and continuing on, as PBS repeats the show. The response has the series generated among the general public? It meant that this effort—the work of producers, directors, writers and set designers, as well as my colleagues in astrophysics and my cross disciplinary colleagues in other fields—was all able to come together as one coherent and sensible project. Something this ambitious doesn't always come out as being greater than the sum of its parts.

AM: Do you see a difference in how the general public responds versus how other scientists have been responding to it?

NT: The science community has been very happy with the level of science communicated in the series. There's always the risk that you might dumb it down too low in an effort to reach a broad public audience. There are plenty of people out there who are intelligent and inquisitive, and even if they don't know the substance they're smart enough to pick it up on the fly. You don't want to make the mistake of talking down to them. Many of my colleagues saw the series as a valuable contribution to the field as well as to the public's curiosity, because it could ultimately translate into public support for the science.

AM: I've heard that scientists used to laugh Carl Sagan out of meetings because he was a popularizer of science. Now that attitude seems to have completely turned around 180 degrees.

NT: I've heard the same stories. But his legacy is undeniable. While his pioneering steps created some animosity within the professional community, today that same community, or at least the same astrophysicist community, has become sensitized to the value of that kind of investment of time. Not only for the future funding of the field, but for the public's appreciation of for the work we all do.

AM: Basically getting people excited about it.

NT: Yes. If you can't get someone excited about your life’s passion then you may as well go home.

Read the original article at http://www.astrobio.net/news/article1414.html.

LATEST NEWS ON NAI 2005 MEETING
NASA Astrobiology Institute release
From the NAI Newsletter
22 January 2005

The Canadian Institute for Advanced Research (CIAR) and the NASA Astrobiology Institute (NAI) will jointly provide travel stipends for graduate students to present their work at Earth System Processes 2, co-convened by the Geological Association of Canada and Geological Society of America (August 8-11, 2005, Calgary, Canada.) Interested pre-doctoral students are asked to submit their intended conference abstract and a statement (300 words) explaining the benefit of this opportunity to their research and career together with a curriculum vitae and advisor’s letter of reference. Priority will be given to students presenting research in astrobiology [view NASA’s Astrobiology Roadmap at http://astrobiology.arc.nasa.gov/roadmap] or in areas of relevance to CIAR’s Earth System Evolution Program [http://www.ciar.ca, click on Research and then on Earth System Evolution Program]. Applications must be sent by February 27 2005.

E-mail: rbriggs@mail.arc.nasa.gov
NASA Astrobiology Institute
M/S 240-1, Building 240, Room 111
NASA Ames Research Center
 Moffett Field, CA 94035 USA

Results of the competition will be communicated by March 25th. ESP2 abstract submission deadline is April 26th, 2005. For information on the conference and session themes see http://www.geosociety.org/meetings/esp2/.

CIAR: http://www.ciar.ca/
NAI: http://nai.nasa.gov/

SUMMER UNDERGRADUATE INTERNSHIPS IN ASTROBIOLOGY (SUIA), OFFERED BY THE GODDARD CENTER FOR ASTROBIOLOGY
From the NAI Newsletter
22 January 2005

This program was first offered in 2004. In the pilot summer, we accepted five interns and structured the program to ensure maximum exposure to hands-on research. Each student was assigned to work with a specific scientist, spending about 90% of his/her time on the assigned research topic. As a group, they visited one other research activity each week, and they participated in one field trip. A stipend was given and residential housing was provided. Highly positive responses were received from the participants, encouraging us to continue the program.

Accordingly, this summer we will double the size of the SUIA program, offering ten spots to talented undergraduate students who have expressed an interest in gaining research experience related to Astrobiology. The ten-week program consists of one-on-one research with a member of the Goddard Center for Astrobiology team, along with participation in weekly seminars, site visits, and a field trip to the National Radio Astronomy Observatory in Green Bank, West Virginia.


POSTDOCTORAL SCHOLARSHIPS IN ASTROBIOLOGY OFFERED AT CAB
From the NAI Newsletter
22 January 2005

Spain’s National Institute for Aerospace Technology (INTA) is offering 6 one-year postdoctoral positions for researchers within its training program for experts in Astrobiology, with the possibility of renewal contingent on availability of funds and on the quality of the candidate’s scientific productivity. The scholarship is being offered in the following scientific areas:

a) Planetary geology (preferably studies and modelling of planetary atmospheres, interaction of UV/IR radiation with the ground,
geomorphology, bio-signatures in hydrothermal deposits and analysis of planetary images).

b) Microbial evolution and biochemistry (preferably synthetic life and organic chemistry).
c) Advanced computation (preferably bioinformatics, grid, data mining and artificial life).
d) Biogeochemistry (preferably biomarkers and diagenetic degeneracy).
e) Physics of non-equilibrium phenomena (preferably dynamical phase transitions, the renormalization group and membrane formation).
f) Robotics and planetary exploration (preferably artificial vision, navigational systems and fuzzy logic applied to control).

The amount of the scholarship is 2,075 euros per month. The period for the presentation of applications ends on the 10th of February 2005. The full description of the selection procedure, the norms governing the scholarships and the application forms are available from the Secretaría de la Unidad de Formación of INTA.

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Centro de Astrobiologia
Asociado al NASA Astrobiology Institute
INTA: www.inta.es
CAB: www.cab.inta.es
Instituto Nacional de Técnica Aeroespacial

TRAVEL FUNDS AVAILABLE FOR ISSOL ‘05

ISSOL release
22 January 2005

Travel funds will be granted to awarded members of ISSOL to partially cover the transportation costs. Awards are made in such a way as to foster the participation of as many young scientists as feasible at the ISSOL meeting. Applicants must have been accepted to make an oral or poster presentation at the meeting. Applications should include:

- short letter of motivation
- copy of the accepted abstract
- short CV (age, field of research, present position, Institution/University/Laboratory address)

Applications should be sent by March 31, 2005 to:

André Brack
Centre de Biophysique Moleculaire, CNRS
Rue Charles Sadron
45071 Orleans cedex 2
France

INTERNATIONAL WORKSHOP: BIOSPHERE ORIGIN AND EVOLUTION

From the NAI Newsletter
22 January 2005

The International Workshop Biosphere Origin and Evolution will be held on June 26-29, 2005 in Novosibirsk Scientific Center (Russia). The Workshop Scientific Program is comprised of key-note lectures, oral presentations and posters on the following topics:

- Problems of abiogenic synthesis and evolution of the matter under conditions of pregeological stages of the Earth evolution
- Biogeochemical problems of the evolution of the biosphere
- Biomineral systems
- Genetic and ecosystem problems of the evolution
- Mechanisms of anthropogenesis and inhabitation of humans

The official language of the Workshop is Russian and English. Oral and poster contributions on the topics mentioned above are welcome. The abstracts should be submitted by E-mail (zam@catalysis.nsk.su) as attached Word files. The deadline for abstract submission is February 15, 2005. For more information, go to http://www-sbras.nsc.ru/ws/biosphere.

JENAM AND ASTROBIOLOGY IN BELGIUM

From the NAI Newsletter
22 January 2005

This year, the JENAM (Joint European and National Astronomy Meeting) will take place in Liège from 4 to 7th July. (See http://www.astro.ulg.ac.be/JENAM/ for program and registration).

Among the five themes of the meeting, two days will be devoted to "Astrobiology and solar system exploration". This workshop will include three plenary lectures by renowned scientists on hot topics:

- Agustín Chicarro, ESA, "The remarkable achievements of Mars Express";
- Andrew H Knoll, Harvard University, Cambridge USA, "Opportunity, Meridiani, and the astrobiological exploration of Mars";
- Jean-Pierre Lebreton, ESA/ESTEC and Dennis Matson, JPL, "The Cassini-Huygens mission to Saturn and Titan: highlights and main results".

As an extension of JENAM, on July 8th 2005, a workshop will be dedicated to "Astrobiology in Belgium". The objective of this workshop is to group Belgian researchers interested by astrobiology (or exobiology), the study of life's origin, evolution, distribution and destiny in the Universe, and to encourage multidisciplinary and national collaborations in research, teaching and outreach related to astrobiology. The workshop will consist in short scientific presentations (made accessible to scientists of all disciplines) and a round-table discussion about the development of Astrobiology in Belgium. The highlight of this workshop will be a plenary lecture by Professor C. de Duve, Belgian Nobel Laureate. Representatives of the federal and academic authorities, as well as the press will be present as well.

We invite contributions by Belgian scientists on all topics related to astrobiology. Registration is free for this July 9th workshop (https://www.astro.ulg.ac.be/RPub/Colloques/JENAM/registration/Astrobio.html).

Please register before April 15th, 2005 if you wish to propose a talk or a poster. Abstracts for the accepted talks and posters should be sent before June 1st, 2005 to EJ.Javaux@ulg.ac.be. We are looking forward to seeing a strong and exciting participation of Belgian scientists to this workshop and to the JENAM.

THE ROLE OF VOLATILES AND ATMOSPHERES ON MARTIAN IMPACT CRATERS

Lunar and Planetary Institute release
24 January 2005

Sponsored by:
Mars Crater Consortium
Lunar and Planetary Institute
National Aeronautics and Space Administration
Applied Physics Laboratory of Johns Hopkins University
Mars Exploration Program Analysis Group

The Workshop on the Role of Volatiles and Atmospheres on Martian Impact Craters will be held July 11-15, 2005, at the applied Physics Laboratory of The Johns Hopkins University in Laurel, Maryland. For further information regarding the format and scientific objectives of the workshop, please check the full text of this announcement at http://www.lpi.usra.edu/meetings/volatiles2005/.

Further details regarding the program, topics for discussion, opportunities for participation, as well as guidelines for abstract and poster preparation, will be included in the second announcement that will be posted on this LPI Web site in March 2005.

To subscribe to a mailing list to receive electronic reminders and special announcements related to the meeting via e-mail, please submit an electronic Indication of Interest form (available at the conference Web site) by February 24, 2005.
GSA PLANETARY GEOLOGY DIVISION CALL FOR AWARD NOMINATIONS
Geological Society of America release
25 January 2005

It's not too late! There is still time to submit your nominations. Deadlines are January 31, 2005. The Planetary Geology Division of the Geological Society of America (GSA) strongly encourages members to nominate candidates for Division-sponsored awards. Nominations and questions for both the G. K. Gilbert and the Pellas-Ryder awards described below may be sent directly to the Committee Chair:

Dr. Michael S. Kelley
Department of Geology and Geography
Georgia Southern University
PO Box 8149
Statesboro, GA 30460-8149
E-mail: mkelley@GeorgiaSouthern.edu

1) The G. K. Gilbert Award
This award is named for G. K. Gilbert, who 100 years ago clearly recognized the importance of a planetary perspective in solving terrestrial geologic problems. The G. K. Gilbert Award is presented annually for outstanding contributions to the solution of fundamental problems in planetary geology in the broadest sense, which includes geochemistry, mineralogy, petrology, geophysics, geologic mapping, and remote sensing. Such contributions may consist either of a single outstanding publication or a series of publications that have had great influence in the field. Nominations for this career achievement award should include a letter detailing the accomplishments of the nominee. The deadline is January 31, 2005.

2) The Pellas-Ryder Award
This international award is given annually for the best student paper published in planetary sciences. The Pellas-Ryder Award, which is sponsored jointly by GSA and by the Meteoritical Society, is for undergraduate and graduate students who are first author of a planetary science paper published in a peer-reviewed scientific journal. Any first author of a paper published in 2004 on a topic listed on the cover of Meteoritics and Planetary Science who was a student when the paper was submitted is eligible for consideration for this award. Nominations for the Pellas-Ryder Award should include the name of the student, the full citation of the paper, the name and address of the department and university the student was attending at the time of the paper submittal, and a brief description of why this paper is among the best. It should also include information—preferably, in a separate letter from the advisor—that allows the Committee to weigh the student's contribution versus that of others involved in the work. The deadline for nominations is January 31, 2005.

SEEING, TOUCHING AND SMELLING THE EXTRAORDINARILY EARTH-LIKE WORLD OF TITAN
ESA release 05-2005
21 January 2005

On 14 January ESA's Huygens probe made an historic first ever descent to the surface of Titan, 1.2 billion kilometers from Earth and the largest of Saturn's moons. Huygens traveled to Titan as part of the joint ESA/NASA/ASI Cassini-Huygens mission. Starting at about 150 kilometers altitude, six multifunction instruments on board Huygens recorded data during the descent and on the surface. The first scientific assessments of Huygens' data were presented during a press conference at ESA head office in Paris on 21 January.

"We now have the key to understanding what shapes Titan's landscape," said Dr. Martin Tomasko, Principal Investigator for the Descent Imager-Spectral Radiometer (DISR), adding: "Geological evidence for precipitation, erosion, mechanical abrasion and other fluvial activity says that the physical processes shaping Titan are much the same as those shaping Earth."

Spectacular images captured by the DISR reveal that Titan has extraordinarily Earth-like meteorology and geology. Images have shown a complex network of narrow drainage channels running from brighter highlands to lower, flatter, dark regions. These channels merge into river systems running into lakebeds featuring offshore "islands" and "shoals" remarkably similar to those on Earth.

Data provided in part by the Gas Chromatograph and Mass Spectrometer (GCMS) and Surface Science Package (SSP) support Dr. Tomasko's conclusions. Huygens' data provide strong evidence for liquids flowing on Titan. However, the fluid involved is methane, a simple organic compound that can exist as a liquid or gas at Titan's sub-170°C temperatures, rather than water as on Earth. Titan's rivers and lakes appear dry at the moment, but rain may have occurred not long ago. Deceleration and penetration data provided by the SSP indicate that the material beneath the surface's crust has the
consistency of loose sand, possibly the result of methane rain falling on the surface over cones, or the wicking of liquids from below towards the surface.

Titan's soil appears to consist at least in part of precipitated deposits of the organic haze that shrouds the planet. This dark material settles out of the atmosphere. When washed off high elevations by methane rain, it concentrates at the bottom of the drainage channels and riverbeds contributing to the dark areas seen in DISR images. New, stunning evidence based on finding atmospheric argon 40 indicates that Titan has experienced volcanic activity generating not lava, as on Earth, but water ice and ammonia.

Thus, while many of Earth's familiar geophysical processes occur on Titan, the chemistry involved is quite different. Instead of liquid water, Titan has liquid methane. Instead of silicate rocks, Titan has frozen water ice. Instead of dirt, Titan has hydrocarbon particles settling out of the atmosphere, and instead of lava, Titanian volcanoes spew very cold ice. Titan is an extraordinary world having Earth-like geophysical processes operating on exotic materials in very alien conditions.

"We are really extremely excited about these results. The scientists have worked tirelessly for the whole week because the data they have received from Huygens are so thrilling. This is only the beginning, these data will live for many years to come and they will keep the scientists very, very busy," said Jean-Pierre Lebreton, ESA's Huygens Project Scientist and Mission manager.

The Cassini-Huygens mission is a cooperation between NASA, ESA and ASI, the Italian space agency. The Jet Propulsion Laboratory (JPL), a division of the California Institute of Technology in Pasadena, is managing the mission for NASA's Office of Space Science, Washington DC. JPL designed, developed and assembled the Cassini orbiter while ESA operated the Huygens atmospheric probe.

Read the original news release at http://www.esa.int/SPECIALS/Cassini-Huygens/SEMHBB881Y3E_0.html.

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Additional articles on this subject are available at:
http://www.astrobio.net/news/newsarticle1407.html
http://cl.exct.net/?fe5457373630257721-fc28167073670175701e72
http://www.space.com/missionlaunches/titan_update_050121.html
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http://www.universetoday.com/am/publish/titan_familiar_alien.html

OPPORTUNITY ROVER FINDS AN IRON METEORITE ON MARS
NASA/JPL release 2005-018

19 January 2005

NASA's Mars Exploration Rover Opportunity has found an iron meteorite, the first meteorite of any type ever identified on another planet. The pitted, basketball-size object is mostly made of iron and nickel according to readings from spectrometers on the rover. Only a small fraction of the meteorites fallen on Earth are similarly metal-rich. Others are rockier. As an example, the meteorite that blasted the famous Meteor Crater in Arizona is similar in composition.

"This is a huge surprise, though maybe it shouldn't have been," said Dr. Steve Squyres of Cornell University, Ithaca, NY, principal investigator for the science instruments on Opportunity and its twin, Spirit.

The meteorite, dubbed "Heat Shield Rock," sits near debris of Opportunity's heat shield on the surface of Meridiani Planum, a cratered flatland that has been Opportunity's home since the robot landed on Mars nearly one year ago.

"I never thought we would get to use our instruments on a rock from someplace other than Mars," Squyres said. "Think about where an iron
meteorite comes from: a destroyed planet or planetesimal that was big enough to differentiate into a metallic core and a rocky mantle."

NASA's Mars Exploration Rover Opportunity has found an iron meteorite on Mars, the first meteorite of any type ever identified on another planet. The pitted, basketball-size object is mostly made of iron and nickel. Readings from spectrometers on the rover determined that composition. Opportunity used its panoramic camera to take the images used in this approximately true-color composite on the rover’s 339th martian day, or sol (January 6, 2005). This composite combines images taken through the panoramic camera’s 600-nanometer (red), 530-nanometer (green), and 480-nanometer (blue) filters. Image credit: NASA/JPL/Cornell.

Rover-team scientists are wondering whether some rocks that Opportunity has seen atop the ground surface are rocky meteorites. "Mars should be hit by a lot more rocky meteorites than iron meteorites," Squyres said. “We’ve been seeing lots of cobbles out on the plains, and this raises the possibility that some of them may in fact be meteorites. We may be investigating some of those in coming weeks. The key is not what we’ll learn about meteorites—we have lots of meteorites on Earth—but what the meteorites can tell us about Meridiani Planum."

The numbers of exposed meteorites could be an indication of whether the plain is gradually eroding away or being built up.

NASA Chief Scientist Dr. Jim Garvin said, "Exploring meteorites is a vital part of NASA’s scientific agenda, and discovering whether there are storehouses of them on Mars opens new research possibilities, including further incentives for robotic and then human-based sample-return missions. Mars continues to provide unexpected science ‘gold,’ and our rovers have proven the value of mobile exploration with this latest finding."

Initial observation of Heat Shield Rock from a distance with Opportunity's miniature thermal emission spectrometer suggested a metallic composition and raised speculation last week that it was a meteorite. The rover drove close enough to use its Moessbauer and alpha particle X-ray spectrometers, confirming the meteorite identification over the weekend.

Opportunity and Spirit successfully completed their primary three-month missions on Mars in April 2004. NASA has extended their missions twice because the rovers have remained in good condition to continue exploring Mars longer than anticipated. They have found geological evidence of past wet environmental conditions that might have been hospitable to life.

Opportunity has driven a total of 2.10 kilometers (1.30 miles). Minor mottling from dust has appeared in images from the rover's rear hazard-identification camera since Opportunity entered the area of its heat-shield debris, said Jim Erickson of NASA’s Jet Propulsion Laboratory, Pasadena, CA, rover project manager. The rover team plans to begin driving Opportunity south toward a circular feature called "Vostok" within about a week. Spirit has driven a total of 4.05 kilometers (2.52 miles). It has been making slow progress uphill toward a ridge on "Husband Hill" inside Gusev Crater.

Since landing on Mars a year ago, NASA's six-wheeled geologists have been constantly exposed to martian winds and dust. Both rovers have been coated by some dust falling out of the atmosphere during that time, with estimates of the dust thickness ranging from 1 to 10 micrometers, or between 1/100th and 1/10th the width of a single human hair. Of the two, NASA’s Mars Exploration Rover Spirit is definitely the more dust-laden. As a result, Spirit has gradually experienced a decline in power as the thin layer of dust has accumulated on the solar panels, blocking some of the sunlight that is converted to electricity. Spirit took the left image on martian day, or sol, 9 (January 11, 2004), and took the right image nearly a year later, on sol 357 (January 3, 2005), using the panoramic camera. The images show the camera's calibration target, which is used as a reference point for calibrating the colors on Mars. In the later image a semi-transparent layer of reddish martian dust coats the surfaces. The panoramic camera team's analysis indicates that the layer of dust on Spirit's calibration target is about 70 percent thicker than that on Opportunity's. Both images represent the panoramic camera team's best current attempt at generating true color views of what these scenes would look like if viewed by a human on Mars. They were each generated from a combination of six calibrated, left-eye Pancam images acquired through filters ranging from 430-nanometer to 750-nanometer wavelengths. The diameter of the outer ring of the calibration target is 8 centimeters (3.15 inches). Image credit: NASA/JPL/Cornell.

JPL, a division of the California Institute of Technology in Pasadena, has managed NASA's Mars Exploration Rover project since it began in 2000. Images and additional information about the rovers and their discoveries are available on the Internet at http://www.nasa.gov/vision/universe/solarsystem/mer_main.html and at http://marsrovers.jpl.nasa.gov.

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Additional articles on this subject are available at:
http://www.space.com/missionlaunches/mars_meteor_050120.html
http://www.space.com/missionlaunches/mars_meteor_050119.html
http://www.universetoday.com/am/publish/opportunity_iron_meteorite.html
MARS GLOBAL SURVEYOR IMAGES
NASA/JPL/MSSS release
13-19 January 2005

The following new images taken by the Mars Orbiter Camera (MOC) on the Mars Global Surveyor spacecraft are now available.

Dark Sand Dunes (Released 13 January 2005)
http://www.msss.com/mars_images/moc/2005/01/13/

Dust Devils Together (Released 14 January 2005)
http://www.msss.com/mars_images/moc/2005/01/14/

Solis Planum Craters (Released 15 January 2005)
http://www.msss.com/mars_images/moc/2005/01/15/

Layers in Candor (Released 16 January 2005)
http://www.msss.com/mars_images/moc/2005/01/16/

Ganges Rocks and Sand (Released 17 January 2005)
http://www.msss.com/mars_images/moc/2005/01/17/

Mars at Ls 145 Degrees (Released 18 January 2005)
http://www.msss.com/mars_images/moc/2005/01/18/

Modified Valleys (Released 19 January 2005)
http://www.msss.com/mars_images/moc/2005/01/19/

All of the Mars Global Surveyor images are archived at http://www.msss.com/mars_images/moc/index.html.

Mars Global Surveyor was launched in November 1996 and has been in Mars orbit since September 1997. It began its primary mapping mission on March 8, 1999. Mars Global Surveyor is the first mission in a long-term program of Mars exploration known as the Mars Surveyor Program that is managed by JPL for NASA's Office of Space Science, Washington, DC. Malin Space Science Systems (MSSS) and the California Institute of Technology built the MOC using spare hardware from the Mars Observer mission. MSSS operates the camera from its facilities in San Diego, CA. The Jet Propulsion Laboratory's Mars Surveyor Operations Project operates the Mars Global Surveyor spacecraft with its industrial partner, Lockheed Martin Astronautics, from facilities in Pasadena, CA and Denver, CO.

MARS ODYSSEY THEMIS IMAGES
NASA/JPL/ASU release
17-21 January 2005

North Polar False Color (Released 17 January 2005)
http://themis.la.asu.edu/zoom-20050117a.html

Dunes and Clouds in False Color (Released 18 January 2005)
http://themis.la.asu.edu/zoom-20050118a.html

Blue Polar Dunes in False Color (Released 19 January 2005)
http://themis.la.asu.edu/zoom-20050119a.html

False Color Bands (Released 20 January 2005)
http://themis.la.asu.edu/zoom-20050120a.html

Ice Layer Cross-Section in False Color (Released 21 January 2005)
http://themis.la.asu.edu/zoom-20050121a.html

All of the THEMIS images are archived at http://themis.la.asu.edu/latest.html.

NASA's Jet Propulsion Laboratory manages the 2001 Mars Odyssey mission for NASA's Office of Space Science, Washington, DC. The Thermal Emission Imaging System (THEMIS) was developed by Arizona State University, Tempe, in collaboration with Raytheon Santa Barbara Remote Sensing. The THEMIS investigation is led by Dr. Philip Christensen at Arizona State University. Lockheed Martin Astronautics, Denver, is the prime contractor for the Odyssey project, and developed and built the orbiter. Mission operations are conducted jointly from Lockheed Martin and from JPL, a division of the California Institute of Technology in Pasadena.

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