

“Towards an Earth-Moon Economy – Developing Off-Planet Resources”

Moon Miners’ Manifesto

India Quarterly Edition

www.moonsociety.org/india/mmm-india/

#4

FALL 2009



“Life and Work on the Moon” – a painting by **Pratham Karnik**, son of Deviprasad Karnik. He had placed first with the best overall score in High School level in the NASA Lunar Art& design contest June 2009. See photo of Pratham with art on page 3.

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Welcome to Moon Miners’ Manifesto India Quarterly Edition #4

This issue completes “M3IQ’s” first full year of publication. Issues #s 5-8 [Winter, Spring, Summer, Fall ‘10] are scheduled for January, April, July, and October 2010.

Putting these issues together has been a lot of fun and we expect it to continue being so. Response has been overwhelmingly favorable and has led to the **formation of Moon Society India**, being announced simultaneously with release of this issue. The MSI founders have asked us to continue publishing M3IQ through the coming year, at the conclusion of which it may be replaced with a new publication written, edited, and published within India.

For us, this handing over of the reins will be a rewarding and gratifying occasion. *The Editors.*

About The Moon Society

<http://www.moonsociety.org>

Our Vision says Who We Are

We envision a future in which the free enterprise human economy has expanded to include settlements on the Moon and elsewhere, contributing products and services that will foster a better life for all humanity on Earth and beyond, inspiring our youth, and fostering hope in an open-ended positive future for humankind.

Moon Society Mission

Our Mission is to inspire and involve people everywhere, and from all walks of life, in the effort to create an expanded Earth-Moon economy that will contribute solutions to the major problems that continue to challenge our home world.

Moon Society Strategy

We seek to address these goals through education, outreach to young people and to people in general, contests & competitions, workshops, ground level research and technology experiments, private entrepreneurial ventures, moonbase simulation exercises, tourist centers, and other legitimate means.

About Moon Miners' Manifesto

<http://www.MoonMinersManifesto.com>

MMM is published 10 times a year (except January and July). The December 2008 issue will begin its 23rd year of continuous publication.

Most issues deal with the **opening of the Lunar frontier**, suggesting how pioneers can make best use of **local resources** and learn to **make themselves at home**. This will involve psychological, social, and physiological adjustment.

Some of the points made will relate specifically to **pioneer life** in the lunar environment. But much of what will hold for the Moon, will also hold true for **Mars** and for space in general. We have one Mars theme issue each year, and occasionally **other space destinations** are discussed: the asteroids, Europa (Jupiter), Titan (Saturn), even the cloud tops of Venus.

Issues #145 (May 2001) forward through current are as pdf file downloads with a Moon Society username and password. Moon Society International memberships are \$35 US; \$20 students, seniors – join online at:

<http://www.moonsociety.org/register/>

MMM Classics: All the “non-time-sensitive editorials and articles from past issues of MMM have been re-edited and republished in pdf files, one per publication year. A 3-year plus lag is kept between the MMM Classic volumes and the current issue. These issues are freely accessible to all, no username or password needed, at:

http://www.moonsociety.org/publications/mmm_classics/

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About MMM-India Quarterly

<http://india.moonsociety.org/india/mmm-india/>

This publication is being launched with this Fall 2008 issue. The Moon Society was founded as an International organization, but in fact has few members outside the United States, and these are for the most part solitary and unorganized.

Background

The Moon Society and The Planetary Society of Youth (TPSY) in India, <http://www.youthplanetary.org/> in December 2003, put together a "Design a Mission to the Moon" category in TPSY's student design contest -- "A Mission to the Moon and Beyond."

The contest was designed to help students learn about various objects in the solar system as they compete in the design of a mission.

http://www.youthplanetary.org/moon_mission_contest.html

Why an MMM-India Quarterly?

India is a very populous country, and one in which, through the heritage of the British Raj, English is the almost universal medium of higher education. It is likely that English-fluent Indians outnumber English speakers in the United States. More books are published in English than in any other country.

And – *India is going to the Moon!*

In short, we'd like to share with space-interested and space-enthused people in India, our vision of the possibilities for Exploration and Utilization of the Moon, development of lunar resources, not just to support a permanent population on the Moon, but to help better address chronic clean energy supply problems on Earth and to help slow and reverse our home planet's environmental degradation in the process. In short, we would like to share our glimpse of an emerging greater Earth-Moon Economy.

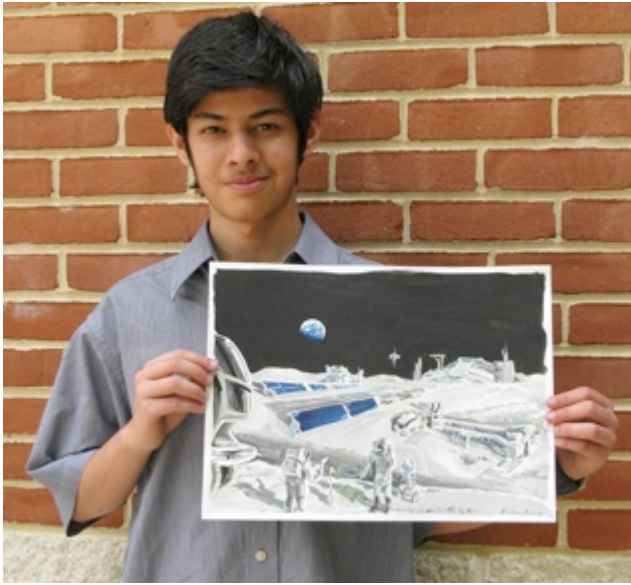
This vision was well-expressed by the former President of India, Dr. A. P. J. Abdul Kalam in a speech at The Symposium on “The Future of Space Exploration: Solutions to Earthly Problems” to mark the occasion of the 50th Anniversary of the dawn of Space Age, Boston University, Boston, MA, April 12, 2007.

In this speech, Dr. Kalam made the point that to fully industrialize and become an equal partner in the future of our planet, India needs to access the unlimited clean undiluted solar energy available in space. We agree with his assertions and want to share that bold vision with the forward-looking people of India.

Free Access:

MMM-India Quarterly issues will be available as a free access pdf file, downloadable from the Internet. We encourage readers to share these files with others freely, and to use this publication to grow and cultivate widespread interest in the open-ended possibilities of space among the people of India, and to encourage the rise of additional citizen support space organizations within the country.

The Story on this issue's Cover Art Piece



Pratham Karnik holds his award winning painting, “**Life and Work on the Moon.**” Pratham is the son of Deviprasad Karnik, Space Counselor at India’s Embassy in Washington, DC. Mr. Karnik writes: “Yesterday the celebration of 40th anniversary of Apollo landing was amazing at National Air & Space Museum with all three Apollo 11 Astronauts present. Meanwhile my son Pratham Karnik stood first with the best overall score in High School level in the NASA’s Lunar Art & Design contest 2009. The award ceremony was also held July 24, at NASA HQ in DC.” Pratham is a student at Walt Whitman High School, Rockville, MD, outside Washington.

The Place of Art in the Space Movement

Commentary By Peter Kokh

“A picture is worth a thousand words” - Confucius

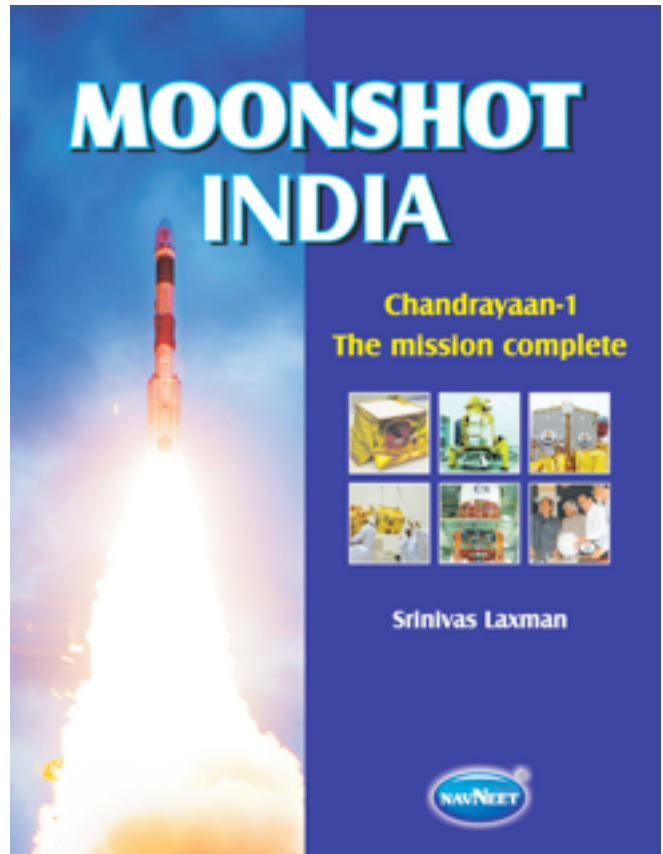
Indeed, for many people, even in this day and age of media science fiction, trying to imagine suggested, proposed or predicted future space settings (Moon and Mars bases and cities, for example) is quite difficult. There are so many features and aspects required by the environments on the surfaces of other worlds, things beyond common experience, that it is hard to get excited by what they read or hear.

Unless! Unless there is accompanying artwork. The heroes here are the illustrators of such magazines as Popular Science, Popular Mechanics, Mechanics Illustrated – all US publications with which I am familiar.

As to “science-fiction” artwork, whether in print or on the big or little screen, perhaps most of it is blatantly unrealistic, ignoring physical facts. A commonplace example is the glass domed city sitting on the surface of a world with no, too little, or unbreathable atmosphere. The internal pressure would blow those domes skyward in minute, no matter how well anchored. Plus they present single point-of-failure opportunities to an incoming meteorite with just enough mass or energy; nor do they protect from cosmic rays and solar flares. Shielding needs are commonly ignored.

In this situation, it is most refreshing to see the artwork of young Pratham Karnik! We look forward to seeing more of his work.

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MOONSHOT INDIA

By Srinivas Laxman

“MOONSHOT INDIA” traces the journey of India’s first Moon Mission, Chdrayaan-1, from conception to its thrilling launch, its sudden termination, to its sensational discovery of water and ISRO’s future space programme. The book also describes the origin of the ‘space race’ and the renewed interest of nations in the Moon exploration and future habitation. Written in readable language and with photographs especially to interest young readers.”

His passion for spaceflight has taken him to NASA’s Kennedy Space centre in Florida, the Johnson Space Centre in Houston, Texas and the European spaceport in Kourou, French Guyana, South America as well as to several major launches at the Satish Dhawan Space Center in Sriharikota, Andhra Pradesh.

As a space journalist in Mumbai, he has interacted with India’s top figures in the field like K. Kasturirangan, G. Madhavan Nair, U. R. Rao, late Satish Dhawan, and renowned astronauts like Neil Armstrong, the first man on the Moon, and Eugene Cernan, the last man on the Moon.

He has also interviewed and authored *Dreams to Reality: A biography of A P J Abdul Kalam*, for children. On numerous occasions, he has also interviewed India’s first astronaut, Rakesh Sharma, as well as Kalpana Chawla.

India's Presence and Activities in Antarctica are a Precedent, first for a Lunar Analog Station, and eventually, a Lunar Outpost

By Pradeep Mohandas

Foreward

For the few months, I've been working on a plan to build a *Lunar Analog Research Station* here in India with the Moon Society. One of the things that came up during discussions with Peter Kokh, President of the Moon Society is how India's experience in Antarctica will help us when we think about building a lunar base.

26 years and 27 expeditions

India has had a presence in Antarctica since 1983 when it was admitted to the Antarctic Treaty. India has already completed 27 expeditions to Antarctica.

In 1989, India took a significant step on the continent of Antarctica by building a permanent research station called Maitri (Sanskrit for Friendship). The station was an all weather station, which means people could live there during the Antarctic summer and winter.



Maitri, India's permanent base in Antarctica, can house some 25 people during winter and up to 45 additional scientists in summer huts built in front of the station. Its laboratories are setup for Earth Science, Environmental Science, Upper Atmosphere, Meteorology and Geomagnetism. Image Credit: NCAOR, Goa, India

India's first station, Dakshin Gangotri was occupied only during the Antarctic summer and is now a supply and transport base for Maitri. By 2020, Indian scientists hope to begin building a similar base on the Moon. Spirited by the success of India's first lunar mission, Chandrayaan-I, planning has begun to define and locate a permanent lunar base.

India's lunar programme got off to a great start with the Chandrayaan-I mission. Chandrayaan-II is undergoing fabrication work and is planning to carry two rovers to the Moon, a 50 kg Russian designed and a 15 kg Indian designed rover. The rovers hope to provide true ground analysis of lunar regolith in chemical and mineralogy analysis. The location for the landing of Chandrayaan-II is likely to be influenced by the location of the future lunar base among other considerations.

In parallel, India is also building up a manned space mission capability with India's Crew Vehicle likely seeing first flight in 2015. Currently, work on launch vehicles is in full swing to carry heavier payloads into orbit. These steps are all likely to culminate in a permanent lunar base within 2020-25.

India's experience in Antarctica may provide a few insights for India's first lunar base. The closed quarter habitation, surviving long winters and summers and transportation and supplying the needs of the crew may provide India with some idea of what would be needed for the manned lunar base. These insights must not be overlooked as India scouts and prepares for her first Lunar Station.

The first lesson that India could learn is the location. India had first erected the Dakshin Gangotri station, but as it became covered with ice, it was abandoned in 1990. Maitri was built in 1988-89 several kilometers away on the all-weather ice free and rocky **Schirmacher Oasis** (brown area on map below), shared with Russia's Novolazarevskaya 3km ESE along with the ALCI airstrip to the south.



As India scouts for a location for the lunar base, it should look for long-term usability of the base. Can we man it throughout the year? Can useful research be conducted? Can it provide a base for frequent transportation, etc.? These are questions that Indian scientists need to address. We should not have to shift out of the lunar base and have to build somewhere else as this could be more dangerous and more expensive being on the Moon than being on Earth. Even as it is being constructed, it will require human presence on the Moon even to build the base.

The experience that India has gained with more than 20 scientists and engineers living together at Maitri and the valuable data collected from these experiences will be useful for India's lunar stay. Design of the living quarters in Antarctica could be replicated on the Moon with design innovations to suit the shielding requirements on the Moon. Moreover, these experiences can also help India decide on the broad layout for living quarters and working sections and the relation between them. Besides the psychology and working culture that needs to be created in such a base to enable its smooth functioning can be better tested here in Antarctica than lakhs of kilometers away on the Moon. These inputs are vital to understand how human beings react to enclosure with a large number of people in close quarters.

The importance of safely recycling water and waste on Antarctica has been stressed. There is also the question of unrecyclable waste and its disposal. Working in Antarctica

where disposing of waste is banned, India carries back its waste generated in Antarctica throughout the year. The waste can be of many forms and needs to be individually recycled as per material properties. In its 25 year Antarctic programme, there would certainly have been many lessons learnt on making maximum use of available quantities and recycling technologies. Also, similar to going to the Moon, you can only carry a limited amount of material - that which you can take on the ship. So, there is always stress on making maximum utilisation of the things you carry to Antarctica and over the years, surely the list of things that one carries to Antarctica would have been refined. Unrecyclable waste is reduced or it needs to be carried back to India for disposal.

Transportation is another issue that has parallels for the situation in both Antarctica and the Moon. As stated earlier, what we can carry to both the Moon and to Antarctica is limited by the carrying capacity of the ship. So, the instrumentation and cargo to be installed at the base, needs to be taken as per priority and most goods must be recyclable to be used again or to be used for long time periods. The management of supply of various requirements is also a useful experience. Recently, Maitri has also enabled various entertainment avenues for scientists and technologists to enjoy - TV, Internet etc. Will similar entertainment be provided for lunar scientists as well? If not, what substitutes can be provided for relaxation. India's Antarctic programme could have insights.

Looking at the future of the Antarctic programme, India has plans for an Antarctic Data Archive, and for a third station to be named **Bharti**, which will be built some 3,000 km to the east, on a promontory on the coast. Bharti will focus its research on the surrounding Antarctic Ocean rather than on the continent itself.

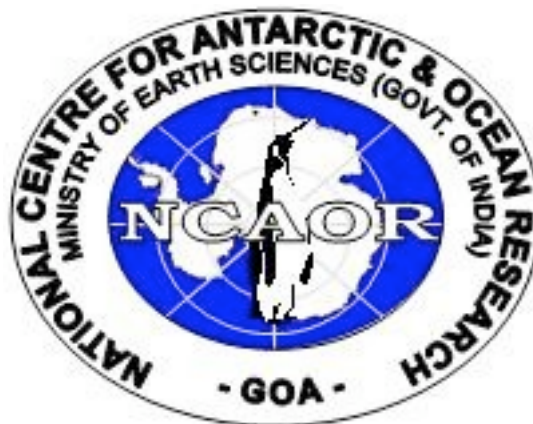
<http://timesofindia.indiatimes.com/city/chennai/Bharti-to-be-3rd-Indian-station-in-Antarctica/articleshow/4861655.cms>

There are many questions and solutions that have been found as India has continued to implement her Antarctic programme that could be useful to her in India's Space Programme.

Summary

Here is a list of **Aspects of India's Antarctic Experience** that relate to needs of a Lunar Analog Research Station as well as to an outpost on the Moon:

- ✓ Overwintering will have a parallel in "overnighting" on the Moon during two-week long periods in which solar power is not available.
- ✓ Operating waste water recycling systems that do not contaminate the environment
- ✓ Operating a station that must be self-reliant for long periods between resupply
- ✓ Operating in environments requiring special suits.
- ✓ Maintaining morale in a station with little real contact with the rest of the world in a barren, life-hostile setting
- ✓ Organizing crew mixtures of scientists and staff
- ✓ Experience with the logistics of remote operations
- ✓ Through its Antarctic experience, India is building a reputation for respect for special environments.



<http://www.ncaor.gov.in/>

NCAOR - National Center for Antarctic and Ocean Research, Goa, India



Activities and projects at Maitri are determined by the National Center for Antarctic & Ocean Research in Goa, India, 580 km (360 mi) south of Mumbai. An Antarctic Data Center linked to similar centers in Britain and Australia, and a Polar Museum are being built here.



On the map above the **Maitri** Station is indicated by the red • sign, and lies due south of South Africa. India is in the direction indicated by the arrow. **Dakshin Gangotri** (orange •) was the 1st scientific base station of India in Antarctica, set up during the third Indian expedition to Antarctica in 1983-84. It was abandoned in 1990 and converted into a supply base. The two stations are only a few kilometers apart.

Trivia It is about 35 times further from Bangalore to the Moon than from Goa to Maitri Station Antarctica. ###

“A Shining Success!” Chandrayaan-1 Report

New Hints of Water on the Moon

By David Dunlop – dunlop712@yahoo.com
Moon Society Director of Project Development
November 9, 2009

Post-Apollo Wisdom of the Dry Moon

The Moon has been characterized as a parched world devoid of that essential commodity for terrestrial life: water. The post Apollo view of the desiccation of the Moon's surface is from the extensive heating of the material flung into orbit during the collision of a Mars sized impactor with the Earth. This hot excavated material having formed a ring around the Earth out gassed its volatiles in the vacuum conditions of orbit. This material then re-coalesced as our Moon.

The newly formed body was also heated by heavy accretion bombardment of other impactors. At the 2009 LPI conference evidence was presented to indicate that the number of basins thus far identified might only represent one third of the actual number of basin forming impacts sustained by the Moon.

The coalescing Moon became a differentiated body as high-density radioactive thermal elements sank into the center formed a presumed small core, and lighter density anorthosite material floated to the top and formed the crust. Evidence of an early heavy bombardment suggests that it also formed a magma ocean.

In the absence of sufficient gravity to accumulate an atmosphere like Earth's as the magma out-gassed, the solar wind swept gases into the vacuum. This is the picture of lunar formation and evolution developed after the Apollo expeditions and is a process explanation and rationale for the Moon desiccation and the absence of water on the lunar surface. (1) In summary a significant result of the Apollo program was that the Moon was found to be really really dry!

Some hope for water on the Moon however was entertained by the thought that polar craters which never see the sun might be cold traps and therefore places where water molecules delivered to the Moon by cometary impacts might have accumulated.

I. Harvesting Solar Wind Volatiles for Hydrogen

The absence of lunar water is not a trivial matter for creatures like ourselves that have evolved on a water planet. Water is both a biological necessity and the best candidate for obtaining in situ propulsion with the LOX/liquid hydrogen rocket engine technology of the present. The hope for obtaining water on the lunar surface has been based on the “slim thread” scenario of harvesting of hydrogen implanted by the solar wind at a ppm level of occurrence. The liberation of oxygen which is approximately 44% of aluminosilicate lunar materials is the remaining trick. A large number of processes have been identified for extracting lunar oxygen. (2) With these two gases we have the first essential capability for sustaining human presence on the hostile surface of the Moon.

II. New Hints of Water

The earlier **Clementine** lunar orbiter on the early 1990's and the Lunar Prospector orbiter of the later 1990's showed indications of elevated hydrogen in the polar regions. These missions boosted the credibility of the polar crater cold trap theory and focused attention that perhaps the best places to start a human presence would be at the poles.

A new fleet of lunar orbiters was dispatched to follow up on these early indications by almost all the space faring nations. The first to follow these American missions were the Europeans with ESA's **SMART-1** launched in 2003 and deorbited in 2006. There was hope that SMART-1 would provide evidence of water ice from an ejecta plume resulting from its impact but this ice was not confirmed.

Then the pace picked with JAXA's **Kaguya-Selene** launched September 14, 2007 and followed in quick succession by CNSA's **Chang'e-1** October 24, 2007. Kaguya's cameras provided fantastic digital lunar landscapes and movies from its 100 km orbit. ISRO's **Chandrayaan-1** followed a year later on October 22, 2008) and NASA's **LRO / LCROSS** mission was launched on June 17, 2009)

III. Chandrayaan-1's contribution

Now however we have new hints of water from two differing sources as reported in sessions at the LPI 40th Annual Science Conference. First, On the **Chandrayaan-1** lunar orbiter Dr Paul Spudis, principal investigator for the **mini-SAR** radar instrument reported that radar returns from the permanently shadowed regions of Peary Crater. These suggest ice because these returns differ from those of the sunlit regions of this crater on the lunar North pole. As the crater has a smooth bottom surface this might be interpreted to infer water ice in the shadowed area. The sunlit portion of the crater showed radar returns similar to those of sunlight mare areas however the shadowed area showed a return which could represent the signal dispersion of very rough highland terrain or of ice deposits.

Findings such as those with the mini-SAR add evidence for a case for ice in permanently shaded craters. The larger more powerful SAR radar to be flown on the Lunar Reconnaissance Orbiter, should further illuminate this early finding from Chandrayaan-1's mini-SAR.

A plan to utilize both LRO and Chandrayaan-1 together to address this issue was lost when the Chandrayaan-1 spacecraft apparently overheated and its electronics failed, but happily, not before ISRO's probe had accumulated the bulk of the evidence to make the case for water on the Moon.

IV. Moon Mineralogy Mapper & Pyroclastic Deposits

http://www.isro.org/Chandrayaan/htmls/mmm_nasa.htm

Second, Alberto Saal of Brown university and others reported finding water deposits in the picritic glass from Apollo 15 and 17 samples (3). These small pyroclastic particles (between 100-300 um (for Apollo 17 sample 74220,864) and 200-400 um (for Apollo 15 sample 15427,41) are known to have solar wind volatiles on their exterior. Using an electron probe microscope he examined only the interior composition and found “water in concentrations ranging from 4 -46 ppm (+/- 2 ppm) for water and 6 ppm CO₂ and pressure in the ion probe sample chamber was 6 x10⁻¹⁰ torr during the analyses.

They report: “The association of a fire-fountain mechanism of eruption with condensation and enrichment of volatile glasses suggests the existence of a deep mantle source comparatively enriched in volatiles. The implication that follows this view is that, contrary to prevailing ideas, the bulk Moon is not uniformly depleted in highly volatile elements.” ”To our knowledge this is the first definitive confirmation of the presence of “magmatic” H²O in primitive lunar basalts. Our results suggest that, contrary to prevailing ideas, the bulk Moon is not uniformly depleted in volatile elements, and the presence of water in particular must be included to constrain models for the thermal and chemical evolution of the Moon's interior.”

These finding also indicate that at least 2 billions years ago or more at least some portion of the lunar interior held water which was expelled in these pyroclastic eruptions. These findings could substantially increase the water yield of mining lunar pyroclastic deposits of both solar wind hydrogen plus water trapped in the interior of these particles.

Many Questions

This raises new questions about the depth understanding of the process of desiccation and water retention during the evolution of the Moon's current structure and composition.

- A. If there is now evidence for water in the lunar interior when the Moon was volcanically active to what extent could this water be accessed in the interior today?
- B. Could reports of visual “transient lunar events” be possible gas release events yet containing water and what with instrumentation should be sent to the surface in the coming international fleet of landers to address this possibility?
- C. Could the voids in mare basalt resulting from buried lava tubes have trapped gas pockets from subsequent volcanic episodes? The coming era of lunar surface exploration may well provide the answers to these speculative questions. Affirmative discoveries could be of great significance for establishment of sustainable lunar settlements and of the economic foundations of human presence on the lunar surface. Can both solar wind implanted volatile on pyroclastic volatiles represent an enriched opportunity for harvesting water.

Addressing these questions would also expand the hunt for water not only to the polar areas where to solar wind deposited volatiles are greatest but also to identified pyroclastic deposits areas.

If volcanic vents exist which are even sporadically active they might represent a bonanza for human utilization. Lava tubes may have trapped gas pockets, which could also hold resources which would have immense value. Drilling for such resources might involve the risk of a blowout and the squandering of priceless resources so the lure of “easy gold” will need to be restrained by exploration strategies that do not rise

The design of exploration equipment in pyroclastic area may differ considerably from the polar areas where cold traps operations are involved. The supposition of such lunar resources especially if fueled by additional discoveries brings with it a likely increase in momentum in lunar exploration

activities. To Utilize Dennis Wingo's phrase a “Moon Rush” might be triggered by additional findings. This could result in a competitive positioning for “squatter's rights” in the utilization of such resources.

Alternatively, such prospects lend even more urgency to an approach with shares costs, risks, and benefits such as the **Lunar Economic Development Authority** proposal of Declan O'Donnell, the **International Lunar Research Park** proposal of the Moon Society, or Buzz Aldrin's similar recent appeal for a **Lunar Infrastructure Development Corporation**. <DD>

References:

- (1) **New Views of the Moon:** Reviews in Mineralogy and Geochemistry Volume 60, Mineralogical Society -Society of America-Geochemical Society Copyright 2006. Editors: Bradley L. Jolliff, Mark A Wierczorek, Charles K. Shearer, and Clive R. Neal, pages 3 &4 “New Views of Lunar Geoscience: An Introduction and Overview” by Harald Hiesinger and James W. Head III, Department of Geological Sciences, Brown University, Box 1846, Providence, Rhode Island, 02912, USA
- (2) **Oxygen Production on the Moon:** An Overview and Evaluation,” Lawrence, L.A. Taylor and Carrier, W.D., III, 1993 In Resources of Near -Earth Space, (Lewis, Mathews, & Guerrieri, Editors), University. Arizona Press, 69-108.
- (3) **The Volatile Contents (CO₂, H₂O, F, S, Cl) OF the Lunar Picritic Glasses**, A.E. Saal, E.H. Hauri, M. LoCasio, J. Van Orman, M.J. Rutherford and R.F. Cooper, Department of Geological Sciences Brown University, 324 Brook St. Box 1846, Providence Rhode Island 02912, Department of Terrestrial Magnetism, Carnegie Institution of Washington, 5241 Broad Branch Road, NW Washington, DC 20015. Department of Geological Sciences Case Western Reserve University, Cleveland
- (4) www.nasa.gov/topics/moonmars/features/moon20090924.html
- (5) <http://www.sott.net/articles/show/192577-One-partner-stumbles-in-lunar-probe-pas-de-deux>

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[Note: Chandrayaan-1 stopped sending radio signals on 29 August 2009 shortly after which, the ISRO officially declared the mission over. The orbiter had operated for 312 days as opposed to the intended two years, but the mission achieved 95 per cent of its planned objectives.]

ISRO is to be congratulated for one of the most successful lunar missions yet to flown!

- The Moon Society



Elsewhere in Asia

CHINA - CNSA

Chinese Shenzhou may be invited to “visit” ISS

In preparation for U.S. President Barack Obama’s visit to China, lower level talks between the two countries have raised the possibility of US support for eventual Shenzhou visits to the International Space Station.

<http://www.spaceflightnow.com/news/n0911/02china/>

China could provide interim period ISS access

With the delivery of the full report from the U.S. Human Space Flight Review Committee (Augustine Report), the potential for a substantial, multi-year gap in U.S. manned spaceflight capability has drawn increased attention. The idea has been raised ... that the United States should expand its cooperation with the People’s Republic of China (PRC) and leverage Chinese space capabilities.

<http://www.heritage.org/Research/Space/wm2670.cfm>

China’s First Mars Orbiter Mission Delayed

Designed to hitch a ride to the vicinity of Mars with Russia’s Phobos-Grunt (Phobos “soil”) Mission, **Yinghuo-1** would have been China’s first mission beyond the Moon. But the joint effort has now been set back two years from October 2009 until November 2011. Launch windows from Earth to Mars open up every 25 plus months on the average,

The Russian Space Agency Roskosmos decided that a postponement was necessary “to enhance reliability of the mission.” Apparently, tests could not be completed in time to assure the Phobos-Grunt’s readiness for launch. Russia’s two previous Phobos 1 and Phobos 2 missions in 1988 and 1989 had failed en route.

For China, the delay could mean added expense, as some of Yunghuo-1’s components may need to be rebuilt or retested to insure that they will still operate as performed.

China currently lacks a booster rocket sufficiently powerful to have launched the Mars probe by itself. This is yet another lesson that international cooperation can bring disadvantages as well as advantages.

http://www.marsdaily.com/reports/China_First_Mars_Mission_Delayed_999.html

<http://www.spacenews.com/civil/russia-delays-phobos-grunt-mars-mission-until-2011.html>

If China’s next booster, the **Long March 5 (LM-5 CZ-5, or Changzheng 5)** should be ready in time, China may accept another 2-year launch window delay to send Yinhuo-1 to Mars in 2013 on its own, which would be recognized world-wide as more of an accomplishment.

http://en.wikipedia.org/wiki/Long_March_5_rocket_family

JAPAN - JAXA

Japan to build First Solar Power Satellite?

Sept. 1 -- Mitsubishi Electric Corp. and IHI Corp. will join a 2 trillion yen (\$21 billion U.S.) Japanese project intending to build a giant solar-power generator in space within three decades and beam electricity to Earth.

http://www.bloomberg.com/apps/news?pid=20601101&sid=aJ529JsdK9HI&goback=.nvr_1780167_1

<http://www.treehugger.com/files/2009/09/japan-space-based-solar-power-satellite-21-billions.php>

<http://www.inhabitat.com/2009/09/01/japan-plans-21-billion-solar-space-post-to-power-294000-homes/>

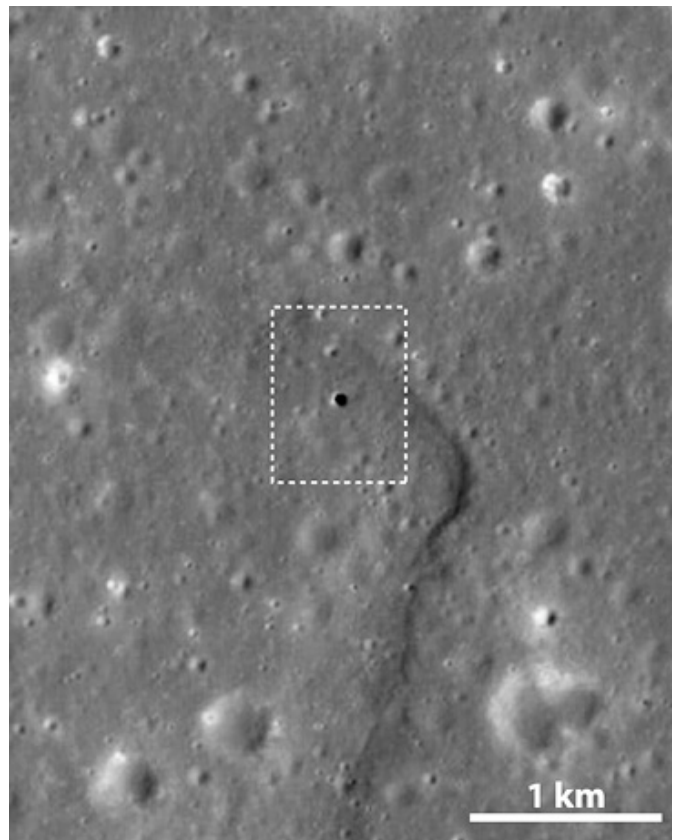
Japan’s Kaguya Lunar Orbiter Snaps Photo of Lavatube Skylight

<http://www.planetary.org/blog/article/00002173/>

<http://www.newscientist.com/article/dn18030-found-first-skylight-on-the-moon.html>

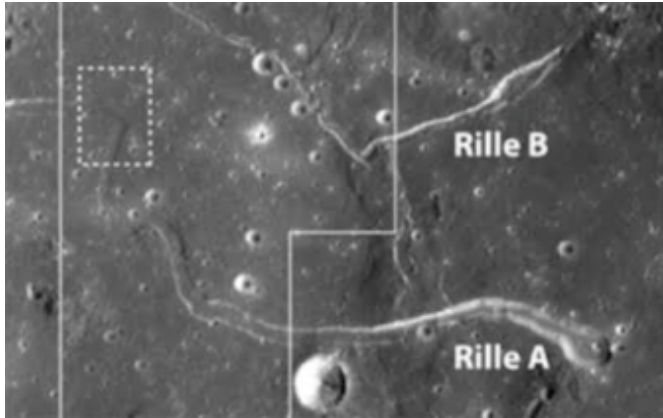
<http://news.nationalgeographic.com/news/2009/10/091026-moon-skylight-lunar-base.html>

<http://lunarnetworks.blogspot.com/2009/10/living-in-lunar-lava-tubes.html>



This 65-metre-wide hole in the lunar surface extends at least 80 meters down. It was found by the Kaguya orbiter, in the Marius Hills area of the Ocean of Storms, Oceanus Procellarum. The Marius Hills abound in volcanic domes, rilles, and probably lavatubes. Pyroclastic glasses hint at possible subsurface voids that may be filled with gases of volcanic origin, a possible industrial gold mine. Some writers, e.g. Dave Dietzler, think that this may be the

place to set up an industrial settlement, not the S. Pole. Had the Apollo 18 mission not been cancelled by the Nixon Administration, this area may have been visited.



The area defined by the box in both photos is the same.

Celebration among lunar settlement advocates

The news of Kaguya's find has been received with great enthusiasm by those who look beyond lunar exploration outposts to genuine settlement, as lava tubes provide *ideal shelter from the cosmic elements that wash the lunar surface: cosmic rays, solar flares, micrometeorite rain, and the thermal extremes of the dayspan heat and nightspan cold.*

Lavatube & Lunar Lavatube Links:

Lava Tube – Wikipedia

http://en.wikipedia.org/wiki/Lava_tube

12 Questions about Lavatubes

<http://www.asi.org/adb/06/09/03/02/100/12-questions.html>

Possible lava tube system in a hummocky lava flow at Daund, western Deccan Volcanic Province, India

<http://cat.inist.fr/?aModel=afficheN&cpsid=16867673>

Lavatube formation

<http://www.asi.org/adb/m/04/02/01/02/lava-tube-size.html>

How lavatubes form (with animated graphic of how such tubes form on the flanks of shield volcanoes)

<http://www.asi.org/adb/02/01/lava-tube-formation.html>

Uses for Lunar Lavatubes

<http://www.asi.org/adb/02/01/lavatube-use.html>

Sinuuous Rilles and Lavatubes on the Moon

<http://www.asi.org/adb/m/04/02/01/02/>

What do lavatubes look like?

http://www.lunar-reclamation.org/papers/lavatube_pix.htm

The Uses of Lunar Lavatubes

http://www.lunar-reclamation.org/papers/lavatubes_ccc.htm

Lunar Lavatubes

<http://www.asi.org/adb/06/09/03/02/025/lavatubes.html>

A Search for Intact Lava Tubes on the Moon: Possible Lunar Base Habitats: Cassandra Coombs, Ray Hawke

<http://www.nss.org/settlement/moon/library/LB2-208-LavaTubes.pdf>

Lunar Lava Tubes: A Resource that should be mapped today for use as habitation structures

www.cnsa.gov.cn/n615708/n984628/n984631/72078.html

Lunar Lavatube Base Construction

<http://cedb.asce.org/cgi/WWWdisplay.cgi?0000601>

Lavatubes: The Moon's "Hidden Valleys"

By Peter Kokh

We have suspected that lava tubes abound on the Moon for some time. Hadley Rille, a section of which was explored by the Apollo 15 crew, the first Moon Mission to be equipped with a rover, is universally interpreted to be a collapsed lavatube.



Lavatubes abound on Earth in two types of geological settings: shield volcanoes such as Mauna Loa and Mauna Kea on the island of Hawaii, and large lava sheet flows such as those that cover much of Oregon and possibly in India's Deccan Flats. On Earth these tubes are typically 10-30 m wide and up to a few kilometers in length.



http://en.wikipedia.org/wiki/File:Classic_lava_tube_passage.jpg

Inside a terrestrial lava tube

On the Moon, apparently as a result of the much lower gravity (1/6th Earth normal) these features, as indicated by the size of Hadley Rille, are much larger in cross-section (100 meters and up) and in length (up to a hundred km plus). Lavatubes on Mars, given the planet's intermediate gravity (3/8ths Earth-normal) will be of intermediate size, still extremely useful. "Skylights" of several have been found.

The best "direct" evidence we have had to date of lunar lavatubes is the evidence of "breaks" in several long lunar rilles, best interpreted as "uncollapsed" sections of original tubes, now preserved as rilles. Lavatubes with insufficient ceiling thickness (ratio to internal width) would not withstand meteorite bombardment over the aeons.



Yellow circles mark "uncollapsed" sections of Hyginus Rille

Some lunar maria, such as Mare Crisium, which show very few ghost craters (formed on the basin floor prior to lava flooding) have relatively thick lava sheet thickness which may be the result of a series of lavasheet flows. Lava tubes are formed as part of the process by which non-viscous lave flows. Mare Crisium, then, and perhaps some other maria may have several layers of lavatube ridden flows.

Some writers have proposed pressurizing lunar lava tubes to house sizable settlements in “Earthlike” settings. But unless the lavatube is deep, the pressure could rupture its ceiling. Furthermore, the surrounding bedrock is likely to be fractured, and invasion of water vapor from atmospheric humidity inside could cause problems such as spallation if there are cycles of frost/thaw within the surrounding rock.

However, lunar lavatubes individually and collectively provide thousands of square kilometers of radiation-shielded settings, ideal for industrial parks, warehousing, and, yes, settlements. But these features, mostly inferred and yet to be discovered are not on any lunar map! Many will expect the Moon to have been thoroughly mapped by Kaguya, Chang’ é 1, Chandrayaan-1, and Lunar Recon=naissance Orbiter. But for some many decades to come, we will need to keep publishing ever newer editions of lunar maps. The surface having been well mapped for a long time, important new map features will be predominantly come from the discovery, surveying, and exploration of new lavatubes, of lavatube extensions and connections, of lover level tubes and so on. Indeed, some of the deeper tubes may not be found for centuries. This growing square and cubic kilometer count of known usable tubes reserves will all have a considerable economic significance.

Special legend maps will be color-coded to indicate the relative density or paucity of the subsurface maze. The latest maps, with their "upwards revisions" of the real expanse of "Terra Habitabilis Cognita", will be on hand in quantity at space frontier development trade shows on Earth or elsewhere, to acquaint would be developers, investors, and settlers, with the ever expanding opportunities.

Meanwhile, one of the more interesting possible lavatube uses would be to house “**the Grand Archives of Human Civilization**”: not only records but sample artifacts: the ultimate conceivable museum of human civilization and of Earth’s geology, flora and fauna.

- Artifacts and Art Treasures and Libraries: Just consider how much has already been lost forever: the Mayan Codex, the Library at Alexandria, the art treasures of Florence ruined by flooding of the Arno, architectural treasures destroyed by wartime bombing, earthquakes, acid rain, etc. Books whose doomed high-acid content pages might have been stabilized in cold, dry, radiation-free vacuum. And films!
- Collections of Biological Specimens: Sperm and Seed and Pathogen Banks
- Collections of Antique Furniture Treasures
- Collections of motor and other Equipment that will never rust or be attacked by corrosive vapors
- Genealogical Files
- Cryogenic storage of bodies, for burial, for future medical science, or even for future revival.

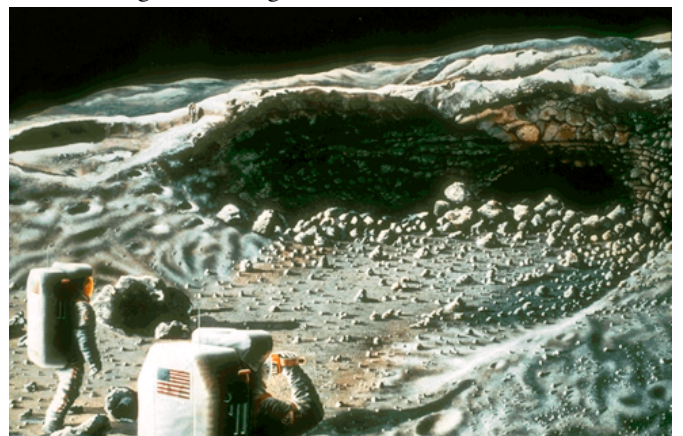
Those tubes that are still intact, were formed when the great impact basins were flooded with lava flows over three and a half billion years ago. They should last billions of year more. Any similar repository anywhere on Earth will have been erased by weather and our active geology in a few hundred thousand years, or a few million years if deep underground.

Now for more fun! If you are one who thinks other civilizations might have sent survey crews this way, recently or in the remote past, lunar lavatubes will have presented them the best location choice in the entire solar system to leave a calling card of any form guaranteed to last hundreds of millions of years or more!

Many people look at the Moon as a dusty rubble pile, but the Moon has its sheltering “Hidden Valleys.” Again, lavatubes will be found only in the maria or lunar seas (they once, briefly, were seas of runny hot lava!) or other lava sheet flows. Thus we will find none proximate to either of the Moon’s poles, both of which are in highland areas. The nearest mare shore to the Moon’s south pole is more than two thousand kilometers north. To the Moon’s north pole, only about a thousand kilometers south – *better*. One more reason why neither of the poles offers the ideal place to launch a genuine lunar frontier, or even from which to explore all the truly representative lunar terrains, surface or hidden.



In the late 1980s and early 1990s, the Oregon L5 Society chapter of the National Space Society did lunar base simulations in this lavatube outside of Bend, Oregon, US. The editor was privileged to have a guided tour of these tubes as a guest of Oregon L5 in 1992. *Incredible!*



Explorers finding a tube entrance – (NASA art S88-33546)

Lavatubes are Features in Basaltic Terrain

Early Basalt Industry on the Moon

Cast Basalt

An Industry Perfect for a Startup Lunar Outpost

By Peter Kokh

[Previously published in MMM #135M, May 2000]

Perhaps a decade ago, I read a one-liner in an encyclopedia about a “cast-basalt industry in central Europe.” Immediately the need of early Lunan settle-ments to hit the ground running with appropriate-technology industries came to mind.

Basalt! There is plenty of it on the Moon. The great flat lava flow sheets that fill the maria basins are essentially basalt. The regolith surface of these “Seas” is but meteorite-impact-pulverized basalt.

There is plenty of basalt on Mars as well. The whole Tharsis Uplift area (Arsia Mons, Ascraeus Mons, and Pavonis Mons) is basaltic, as is Olympus Mons. And there are other lava sheet and shield volcano areas on Mars rich in basalt.

The idea of just melting the stuff with a solar concentrator furnace and then pouring it into molds to make useful products seemed a no-brainer. Even if cast basalt had (an assumption) low performance characteristics, there would be plenty of things needing to be made in the Moon settlements for which high performance would not be an issue. Table tops, planters, paving slabs came to mind.

But for years, I could find nothing more than that teasing one liner. Five years ago, I asked friends in the basalt-rich Pacific Northwest if they knew of any such industry in their area. This did not turn up any new leads. That was then. Today we have the Internet, and I finally returned to the issue and did a simple web search. Voilà!

There is a thriving cast basalt industry here on Earth, and like most “materials” industries these days, it is vigorously reinventing itself. “And the envelope, please!”

Cast Basalt’s Abrasion Resistance

Casting basalt in itself is not something new. People began to experiment with it in the 18th century. Industrial manufacturing with this material began in the 1920s when Cast Basalt began to be used as an Abrasion-resistant, Chemical-resistant lining. The material is crushed, and heated until it becomes molten at 1250°C [2280°F], then cast in molds (e.g. tiles), or centrifuged into pipe shapes. The cast items are then heat treated so that the material crystallizes to take on extreme hardness (720 on the Vickers scale where mild steel is 110; 8-9 on the Mohs scale where diamond is 10). The density is 2.9 g/cm³.

Two companies in Europe produce abrasion-resistant items for use in material handling (think of handling abrasive regolith moon dust on the Moon!): pipes, pipe fittings, cyclones, conveyor parts -- the list of applications is quite long. Both companies ship worldwide.

• Kalenborn Kalprotect, Vettelschoss, Germany

<http://www.bulk-online.com/YD/Data/Co/09254.htm>

This company’s trade name for its cast basalt product is ABRESIST “one of the most tried-and-true materials for wear protection. It is high sliding, has a low coef-ficient of friction, good impact resistance, and very good chemical-resistance. More than 1 million of meters of pipe have been lined by Kalenborn with fused cast basalt.” Kalenborn also makes specially resistant products out of other materials such as fused cast carborundum (a form of Alumina, Al₂O₃) and high alumina ceramics, both of which can also be derived from the lunar regolith.

• Antidesgast, S.A. Barcelona, Spain

<http://www.antidesgast.com/english/castbasalt.htm>

This company makes a similar line of products under the trade name of Basramite, “the world standard for ash slurry pipework at fossil fuel power stations. An all round cost effective, adaptable lining material, extending the life of equipment subject to erosion.”

Abrasion-Resistant Materials on the Moon

One of the strongest misgivings frequently expressed about the feasibility of industrial operations on the Moon is the very abrasive and “hard to handle” nature of regolith or moon dust.

Cast basalt, as a material up to the job of handling moving regolith in industrial and construction operations, is a “lunar” solution made-in-heaven.

Are there any qualifications? The chemical analysis of the basalt used by Kalenborn includes the expected aluminum, silicon, iron, and titanium oxides, but a higher than typical percentage (on the Moon) of manganese, sodium, and potassium oxides. These elements *are* found on the Moon, however, in parts per thousand, not in parts per hundred.

What we need is a lab test of the performance characteristics of a similarly melted, cast, and annealed small Apollo sample of real lunar mare basalt regolith. This research would make a great *thesis* for a student majoring in inorganic materials.

An early lunar cast basalt industry producing abrasion-resistant pipes, troughs, and other parts of sundry regolith-handling equipment would seem to take priority over everything else.

We have to handle regolith to produce oxygen, to produce iron and steel, to produce aluminum, to produce ceramics, to produce glass. Regolith-handling equipment will be necessary to emplace shielding, to excavate, to build roads. It will be needed to handle regolith being heated to harvest its gas load of hydrogen, helium, nitrogen. Yes, we could use imported items for this purpose. Yes, we could use non-resistant items and keep replacing them as they break down and wear out. But that does not seem to be “logical.”

If we are to diversify lunar industry in a logical progression, cast basalt seems the place to start, with an *in situ* demonstration as task # one.

Cast Basalt Flooring Tiles

Two companies, one in Britain, one in the U.S., use cast basalt to make “durable but decorative” flooring tiles in a variety of shapes.

- Greenbank Terotech Ltd., Derby, UK
<http://www.greenbanktl.demon.co.uk/>
- Decorative Cast Basalt Sales, Inc. Webster Springs, WV
<http://www.decorativebasalt.com/>



Cast Basalt Tiles are durable and abrasion-resistant, with a natural slate-like hue. They can be put on floors, walls, table- and countertops in lunar habitat interiors. As an earlier lunar frontier industry, cast basalt tiles may first be used in outfitting inflatable modules, then pressurized modules made on the Moon.

Greenbank Terotech and DCBS import Czech basalt to produce “Volceram [volcanic ceramic] Flooring Tiles” of “natural beauty and practicality.” Cast Basalt is now being used extensively by architects and designers for use both as a industrial floor covering in heavy industry and as decorative flooring in commercial, home and retail settings. The skillful 16-21 hr annealing process brings out all the natural beauty that gives the basalt tiles a unique appeal and a natural shine without added glazing.

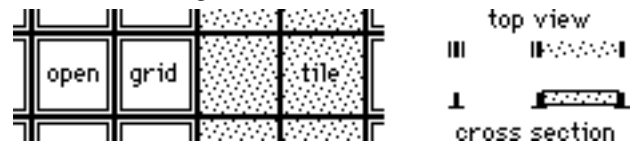
For commercial and industrial use, their hardness (“four times harder than rock, one of the hardest ceramic materials known”) and impervious-ness to acid and chemical attack make the 25 mm (1”) thick tiles very attractive. They “take a beating”, retain their appearance, require little maintenance.

This nonporous “industrial strength” tile is nearly indestructible, and chemical-resistant. Yet in the annealing process they acquires a natural beauty that rivals more common ceramic tiles that have to be glazed. This makes them equally perfect for kitchens, bathrooms, halls, patios, etc. Tiles are produced in standard squares, florentine, charlotte, hex and other shapes, and in several sizes to allow a great diversity of floor and patio patterns.

Role of Tiles in Lunar Settlements

Modular habitat structures, will have to have circular vertical cross-sections to distribute the stresses of pressurization equitably, whether their overall shape be that of a sphere, cylinder, or torus. This means a flat floor will have to be constructed over a bottom cavity. this dead space could be used for storage, water reservoirs, utilities, and utility runs, etc. -- an efficiently compacted “basement”.

An open-spaced flanged-grid subfloor, of some no rust alloy or of glass composite, could rest on metal, concrete, or glass composite joists. The thick cast basalt tiles could then be set into the grid without mortar, as illustrated below.

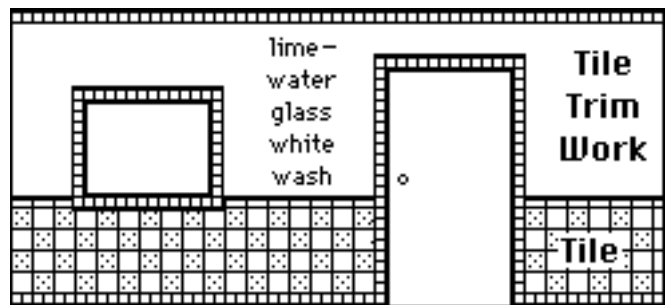


Larger cast basalt tiles could be used for floors of factories, commercial enterprises, schools, etc. And why not also outside, set upon a graded and compacted bed of sieved regolith, to serve as a sort of porch or deck at EVA airlocks, both personalizing such entrances and helping curb import of dust into the interior. One can think of many uses!

Cast Basalt Tiles for Walls and More

The floor tile possibilities and applications seem endless. But cast basalt tiles could be used for more than flooring. Without wood for the customary “woodwork”, plain, textured, and/or decorative tiles could be used, in the role of jamb, casing, baseboard, ceiling cove moldings, even wainscoting. In MMM #76, June, 1994, we suggested the use of “ceramic” tiles for these applications:

In the illustration below, ceramic tiles are used to provide trim borders. While the seemingly endless variety in color, pattern, and glazing now available on Earth could not easily be produced on the Moon, a variety of hues from the lunar palette (regolith grays, oxide colors, stained glass colors) should be available either unglazed or in soft satin glazes. Tile in contrasting sizes, and coor-dinated colors and patterns, would make a good companion wall finish, as would simple white-wash or waterglass-based paint.



Cast basalt then seems to be the right material with which to kick-start diversified lunar industries. On the Moon, where the regolith particles are quite sharply angular because they’ve never been subject to water- or wind-weathering, we will need a family of abrasion-resistant regolith handling items before we launch our lunar concrete, ceramics, metal alloy, our glass, and glass composite industries. Cast Basalt looms as a cornerstone of lunar industrializaion.

Once we have advanced to the processing and manufacturing of these other building materials, we will be able to start providing habitat expansion space from made-on-the Moon materials. Then once again, cast basalt, this time molded into durable and decorative tiles, will help in furnishing the interior spaces of these new “elbow room” modules. Cast basalt will be a cornerstone lunar industry.

<MMM>

Carved Basalt

By Peter Kokh

[Previously published in MMM #185M, May 2005]

In a number of past articles through the years, we have talked about art forms that might be available for Lunan Pioneers, supportable by materials processed locally on the Moon. The Moon will not be a source of granite, marble, soapstone, sandstone or other materials favored through the ages by sculptors on Earth. Without an economical source of copper, brass, bronze, and pewter will not be available media. But Lunan sculptors, we noted, could work with concrete, glass, and various metals. Art du Jour temporary sculptures could be created by children from various garden stuffs. More recently, we introduced AAC, autoclaved aerated concrete, as a possible medium.

All this time we were ignoring an obvious sculpting material abundant on the Moon: basalt. Basalt has been carved into objects small and large throughout the ages by many peoples. Basalt carving continues today, with newer tools such as titanium tipped chisels and various abrasives. Now we had indeed written about "cast basalt" as a hard durable material that could be shaped into all sorts of useful and decorative items. But casting and carving are two different things.

The lunar maria or seas consist of congealed lava flows: basalt. But all available surface basalt has been pre-pulverized to several meters down by repeated meteoritic bombardment. That is why the use of basalt as a carving material never occurred to us; we thought only of casting it.

But significant quantities of non-pulverized, non-fragmented basalt should be available for quarrying from the walls of the numerous lava tubes to be found below the surfaces of the various maria. Lavatubes are a natural feature formed by the way the lava sheets flowed across the lunar surface, filling the major nearside impact basins.

We did a Google search on carved basalt and on basalt carving methods and tools. This is indeed a promising medium for future pioneers, one that will yield many decorative objects for frontier homesteads. Perhaps more importantly, carved lunar basalt items could become a significant source of export income for the settlements.

To see for ourselves what promise this material holds, we ordered a 3" Scarab of basalt carved in Egypt, for about \$30 plus shipping. This item was on display at the Lunar Reclamation Society Meeting, October 8th. 2005.



Basalt **blocks** hewn from solid basalt (exposed in road cuts e.g. through a lava flow edge) and a carved basalt **Scarab**

Basalt in India

The Deccan Plateau Lava Sheet

By Peter Kokh



The vast volcanic basalt beds of the Deccan were laid down in the massive Deccan Traps eruption, which occurred towards the end of the Cretaceous period, between 67 and 65 million years ago. Layer after layer was formed by the volcanic activity that lasted many thousands of years, and when the volcanoes became extinct, they left a region of highlands with typically vast stretches of flat areas on top like a table. Hence it is also known as the Deccan Plateau.

- http://en.wikipedia.org/wiki/Deccan_Plateau



A slab of Indian gray "basalt stone."

In Gujarat at M .S. Univ., Kalabhavan, Baroda, basalt fibers are used as a reinforcing material for fabrics, having better physicomachanical properties than fiberglass, but significantly cheaper than carbon fibre. www.fibre2fashion.com/industry-article/3/256/new-reinforced-material1.asp

This application may be useful on the Moon!

###



**ILOA Seeks India Colleague
to Collaborate on Lunar Missions**
<http://www.iloa.org/>

The International Lunar Observatory Association (ILOA) is seeking an enterprising person from India (preferably an India national) who is interested in the International Lunar Observatory (ILO) -- a pioneering project to land a multi-function observatory on the Moon through international cooperation.



We are looking for someone with a "NewSpace / commercial space" background with a special focus on the communications and/or observation functions of the ILO.

This is not a paid position, but rather an opportunity to engage at a top level with a dynamic, cutting edge organization focused on permanent human lunar buildout.

CONTACT THE ILOA:

International Lunar Observatory Association
65-1230 Mamalahoa Highway D20
Kamuela, HI 96743 USA
Ph: 808-885-3474
Fax 808-885-3475
Em: info@iloa.org

Links: Telescopes on the Moon

NASA Scientists Pioneer Method for Making Giant Lunar Telescopes
http://www.nasa.gov/centers/goddard/news/topstory/2008/lunar_telescopes.html

New telescopes planned for the Moon
<http://www.sciencedaily.com/releases/2008/02/080219132146.htm>

MIT to lead development of new telescopes on the Moon
<http://web.mit.edu/newsoffice/2008/moonscope-0215.html>

Short of the Lunar Surface, the next highest telescope on solid ground is in India !

**The Himalayan Chandra Telescope
(Indian Astronomical Observatory)**



+32° 46' 46.00" , +78° 57' 51.00"



"It takes a good ten hours of steady driving from Leh, the district capital of Ladakh, to reach the facility in the vast Nilamkhul Plain of Changthang Ladakh region of Jammu and Kashmir State, very close to the Chinese border."

http://www.space.com/SpaceReportersNetworkAstronomyDiscoveries/Rao_Indianastronomy_012202.html

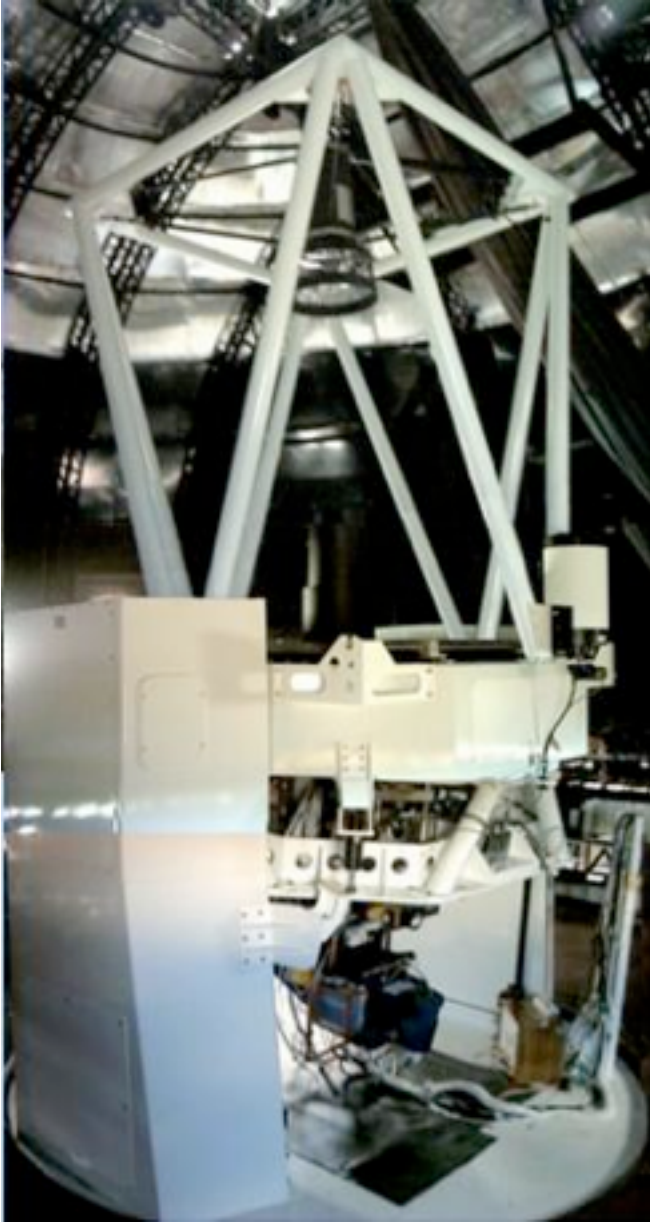
Video about this Observatory

<http://www.ustream.tv/recorded/1337466>

Description:

The Indian Astronomical Observatory's Himalayan Chandra Telescope (HCT) is the world's highest optical-infrared telescope. Situated at Hanle, Ladakh, in the state of Jammu-Kashmir, it is located some 250 km (155 mi) SE of Leh on a rugged road. The night skies are exceptionally dark. The HCT was built in 200X.

V.S. Ramamurthy, Secretary of the Department of Science Technology in New Delhi, indicates the plan is to further develop the site as "a high altitude experimental park, housing "multi-disciplinary research teams.



Above: The 2-meter “Chandra” Optical-Infrared Telescope.

At 4,500 meters altitude (14,763 ft.) there is low atmospheric absorption and low atmospheric turbulence. The instrument was designed and built by IAA scientists working with EOS Technologies of Tucson, Arizona, USA. [The famous Kitt Peak observatory cluster is operated out of Tucson.]

Operation is handled remotely with signals and feedback routed via India’s **INSAT domestic communications satellite** from Hoskote, near Bangalore.

Networking

This instrument allows continuous studies covering half the globe, from the Canary Islands (20 degrees west longitude) to Eastern Australia at (157 degrees east.)

Research

Observations focus on **stars and stellar systems**, including star forming regions in remote galaxies, supernovae, high redshift radio galaxies, gamma ray burst sources, large scale structure of the universe and cosmology. ###

NAME GAMES FOR PLANETS AROUND OTHER SUNS

By Peter Kokh

[First Published in Moon Miners’ Manifesto #46, June 1991]

As of October 20, 2009, astronomers had identified some **400 “exoplanets”** – planets around other stars (suns) – ranging from five times the mass of Earth to several times the mass of Jupiter. And the pace of discovery, if anything, is quickening. In another decade, we should know of literally thousands of worlds beyond our own Solar System.

In the June 1990 issue of Astronomy, Deborah Byrd, the creator of the “Star Date” radio program, expresses her unease at the very real near term prospect that we will soon (at long last!) be discovering one new planet after the other - *around other stars* -and feel ourselves compelled to give names to these exo-worlds. Names *are* how we prefer to handle things. We can use grid and/or cataloging numbers, of course. And for many objects literally too numerous to name, this is the only designation we ever give them.

Adam’s Privilege

Traditionally, the “right of naming” belongs to the discoverer. Some delight in this ritual sharing in “Adam’s privilege”; some do not, and gladly leave the job to others. Our naming talents rely generally on naming the new after the familiar. Only seldom do we invent new names from scratch. It is easier, too, to follow precedents and soon practice becomes tradition. Most lunar seas (maria) are named after states of mind or weather, lunar craters after past astronomers. On Venus, we are naming the large features after mythical women, the small craters revealed by *Magellan’s* imaging radar, after historic women.

The exceptions grate - like two lunar seas named after persons (Humboldt and Smyth) and one for a city (Moscow). And there are unfortunate cases of missed opportunity. The asteroids discovered to be orbiting in formation with Jupiter in the L4 and L5 Lagrangian points, 60o preceding and trailing Jupiter in its orbit about the Sun, have been named after heroes from Homer’s tale of the Trojan Wars. But the chance to reserve L4 objects for the Greek heroes (the first discovered was designated #588 Achilles) and L5 for the Trojan heroes, was lost forever through the sloppy lack of forethought by one person.

A problem arises when the existing pool of names nears exhaustion. The asteroids were at first given names taken from Greek and Roman mythology - we had no idea how many we were about to discover! - until these began to run out. Now we find such whimsical names as “#1625 The Norc” (named after a computer), Most traditional name-pool sources have been already severely drained by the big flood of surface features revealed by space probes from *Luna 3* ’s historic first photos of the Moon’s previously unseen farside hemisphere in 1959, to *Voyager II* ’s recent grand finale at Neptune/Triton.

Nowadays, the IAU, International Astronomical Union, has a committee to oversee the naming backlog and to guarantee that there is a semblance of pattern and appropriateness. But even so, we have had to dip into much more recent mythology to name the newly found moons of Uranus, with characters from Shakespeare's "Midsummer Night's Dream".

So what will we do if we discover exo-planets in great numbers?

I think this time we ought to prepare for the flood with some helpful ground rules. First, please note that only a few of the very brightest stars visible from Earth (and the Solar System) have names - those being given by early Arab astronomers. **Vega, Deneb, Altair, Capella, Sirius, Rigel, Canopus, Alcor and Mizar, Betelgeuse** - all these beautiful, venerable names are phonetic corruptions of millenium-old Arabic namings.

A few more stars have 'name-like' Bayer designations, combinations of Greek letters and a constellation name: **Alpha Centauri, Tau Ceti, and Sigma Draconis**, to name just three favorites of Science- Fiction. Next in line of name-like handleability are those with Flamsteed numbers like **66 Orionis**, and special catalog numbers such as **Wolf 359** and **Groombridge 34**. But then we are left with the vast majority which at best have such unpoetic anti-mnemonic handles such as AC+41o19-173 (which *does* speak to the initiated!).

Now it would seem silly to name a planet that circles a still nameless star!

RULE 1. Only exo-planets around named stars (and those with Bayer letters or Flamsteed numbers etc.) shall have names. Planets found around stars with catalog designations only, and all exo-planets at first, can be referred to using small Roman letters, in the pattern of *starname/I.D>#-a*, in the order of discovery within the system. As it is highly improbable that the first planet discovered within a system (likely the local equivalent of Jupiter) will conveniently also be the nearest its sun, a number designation would be premature. (Spica-a may turn out to be Spica VII)!

Remembering which new planets belong to which old stars may be a welcome bit easier for all if the following pro-mnemonic device is employed.

RULE 2. The first planet to be discovered around a named star will be given a name starting with the first letter of that star's name and so on. Thus in order of discovery, the planets around Rigel would be named R----, I---, G-----, E---, and L---, then R-- again etc.

To avoid hesitation, deliberate levities that will all too soon cease forever to be amusing, or ideological mischief, the choice could be left up to a *computer program* operating within the guidelines above, which *would pick names from a two-tiered hat*.

Into the first tier could go *names of make-believe planets from science-fiction literature and films published or released before a certain cut-off date such as the date of the discovery of the first exo-planet (imminent)*. Some of these S-F names would be very familiar: **Pern, Arrakis, Trantor,**

Tatooine, Vulcan. Others would be less well-known. Names of any fictional planets mentioned only in passing (mere name-droppings, not really part of the story) might be excluded, however. Collecting all these treasures would require a labor of love by a team of science-fiction fans. Such a project *has* sufficient appeal to be realized.

The hat's second tier could hold a *pool of computer-generated random names* that follow set rules of phonetic composition and spelling to be decided by a committee, filtered to remove those with chance objectionable connotations (e.g. Shat, Shet, Shot, Shut would pass but the i-variant might not). If names from 1-4 syllables are allowed, this pool should supply many thousands of choices. Beyond that, our compulsive naming appetite might be sated, and no one would care.

It is unlikely that we'll also tele-discover moons around any of these planets, or any surface features, until and unless we receive return data from actual interstellar probes, such as the *Star Wisp* suggested by Dr. Robert Forward. So for the foreseeable future, we needn't worry about naming such system-local details. Maybe they're better left to future inter-stellar pioneers themselves - if ever!

And for planet-laden, previously unnamed stars?

But back to the hordes of nameless stars! We might well consider giving names to at least some of those around whom we detect planets, in due recognition of that paternity, if you will.

This can be done quite simply by the use of a formula that gives phonetic alphabetic value to the components of a current numeric catalog designation.

For example, a, e, i, o, u, ai, au, eu, oi, ui could render 1 through Ø. Consonants could be chosen from alternating groups of ten: b, ch,, d, f, g, h, j, k, l, m and n, p, r, s, sh, t, th, v, z, zh.

Given the example above, **AC+41o19-173**, ignoring the AC and using a 2-part form to reflect the celestial latitude/longitude information, and using the first consonant group for northern stars (+), the second for southern stars (-), we get **Fa-Buinaud** -

suitably alien, suitably romantic, and above all, suitably back-translatable to the original location-cuing catalog designation.

Ignoring the catalog prefix DM, DM-53o117 becomes **Ri-Bath. Te-Ditha** translates -62o3371, **Mau-Lusi** +07o9533, etc. *Catch the flavor?*

Colorless number designations may be fine for stay-at-home astronomers with a wanderlust quotient somewhere near zero. But *for those of us headed one-way outbound*, Something more *Adamic* would be a definite psychological crutch.

*Wouldn't you rather explain to some waning flame that you're leaving her/him, Earth, and the Solar System itself, to colonize **Cha-Zhula IV** (four) - instead of "BD+21o0581-IV"?*

Science-Fiction writers *could* begin such a custom of translating #s to names *now*, leaving the IAU to follow. *Engage!* <<< MMM >>>

PIONEER QUIZ: The Moon's Surface

[From Moon Miners' Manifesto #23, March 1989]

Questions

- [1] What evidence is there to the naked eye that the Moon's entire surface is covered with a fine dust layer on a centimeter (half-inch) scale at least?
- [2] Were any exposed outcroppings of unfractured lunar bedrock spotted by the Apollo astronauts?
- [3] Do we have any idea of the source of the meteorite material that has bombarded the Moon?
- [4] What is the "regolith"? How uniform is it?

Answers

- [1] The disk of the Full Moon appears to be of similar brightness edge to edge. If the surface was bare rock, the edges would be much darker.
- [2] Lava flow outcroppings, both massive and thin-bed (less than 1 meter) were spotted in the west slope of Hadley Rille (Apollo 15 mission).



- [3] All sites show a soil component (1.5-2% by weight) derived from meteorite bombardment with the volatile enriched element abundance characteristic of type 1 carbonaceous chondrites (C1). Signatures of other meteorite classes are rare.
- [4] Regolith (we predict settlers will abbreviate this to 'lith) is a continuous debris layer which blankets the entire surface of the Moon from a few centimeters to several meters thickness, and ranging from very fine dust (the portion finer than 1 millimeter being called soil or fines) to rocks meters across. Below this are many meters of fractured bedrock, and finally solid bedrock. About 50% of the regolith at any site originates by impact debris from within 3 kilometers, 45% from 3-100 kilometers, 5% from 100-1000 kilometers, only a fraction of a percent beyond that. About 10-30% of any given maria soil sample is of highland type. Most of the fine pulverizing comes from on-the-spot micrometeorite bombardment, a very slow process taking some 10 million years to thoroughly 'garden' the upper first centimeter. [Effectively, the Moon has been pre-mined, in the sense that most every element we need to produce can be found in this pre-puverized layer. Thus "mining the Moon" will not involve deep pit mining or even subsurface mining. Tailings can be redistributed, and the appearance of the Moon from Earth or even an approaching space ship will be unchanged by mining operations. The regolith is rich in Oxygen, Silicon, Iron, Aluminum, Magnesium, Calcium, Titanium, and more.]

Books & Book Reviews about the Moon

Non-Fiction Books about the Moon (40)

<http://www.moonsociety.org/info/moonbooks.html>

Categories:

- Mapping the Moon, and Naming Features on the Moon
- The Apollo Program
- Lunar Science
- Lunar Outposts
- Astronomy from the Moon
- Observing the Moon
- Return to the Moon
- Photographic Atlases of the Moon
- Children's Books about the Moon
- Moon Book Purchasing Links

With *Book Cover photos* where available

Ken Murphy's Lunar Library

<http://www.outofthecradle.net/categories/lunar-library/>

Categories:

- *In English* (40)
- *In Spanish* (10)
- *In French* (11)
- Moonbases (23)
- Selenology (Geology) (22)
- Selenography (Mapping) (23)
- Selenospheres (Globes) (7)

Books for Children

www.moonsociety.org/info/moonbooks.html#childrens

Home on the Moon by Marianne Dyson

<http://www.mariannedyson.com/hotmreviews.htm>

Moon (National Geographic Children's Books)

http://www.educationoasis.com/ch_book_reviews/reviews2/moon.htm

Books Published in India

Destination Moon: India's Quest for the Moon, Mars and Beyond

www.harpercollins.co.in/BookDetail.asp?Book_Code=2029

Science Fiction involving the Moon – Book Lists

http://www.biblioinfo.com/moon/sf_moon.html

Lunar Study & Observing Certificates

<http://www.moonsociety.org/certificate/>

http://www.amlunsoc.org/lunar_certificate.htm

<http://www.astroleague.org/al/obsclubs/lunar/lunar1.html>

<http://www.rasc.ca/williamson/index.shtml>

Lunar Calendars

http://www.moonsociety.org/info/moon_calendars.html

http://www.lunar-reclamation.org/papers/mooncalendar_paper.htm

Will we go to the Moon, only to Trash it as we have Mother Earth?

By Peter Kokh

Monday, November 9, 2009 – This is a question that came to me indirectly from a woman reporter in Britain. I decided to answer it in depth. There follows my “essay.”

I have the unique perspective of having been a lifelong ardent and dedicated environmentalist as well as a lifelong ardent supporter of mankind's move off-planet and beyond. That is a combined perspective rarely seen.

One must appreciate that we began in Africa, and have pioneered one new continent after another over the past 100,000 years. Pioneering new frontiers is in our blood. It is what we do.

Now we are poised to make the leap from an intercontinental species to an interplanetary one. The Moon is one more continent across a different kind of sea.

I like to tell this story. On an isolated Pacific Island, the people have relied exclusively on farming and livestock from time immemorial.

The population has grown and they are no longer adequately able to provide for themselves from island resources only. A bright young man approaches the King and asks, "why don't we fish in the sea?" "Because we have never done that," replies the King. "It is not in our tradition to do so."

We all can sense the King's ignorance and flawed attitude.

Earth is an Island. Let's go fish in the sea!

What is to be gained from developing lunar resources?

One attractive option is summed up in one word, Helium-3. He-3 is a very rare isotope of Helium, with two protons as usual, but with only one neutron instead of two.

Why is that of any significance? For decades atomic scientists have been getting closer and closer to realizing the dream of Nuclear Fusion Power in contrast to the dirty Nuclear Fission plants we now have with the enormous problem of dealing with their wastes.

One standard plan for fusion would combine deuterium (heavy water) and tritium to produce power.

But if we used Helium-3 instead, we would have a reaction that produced only charged particles from which electricity can be produced directly (not through heat as with all other nuclear reactions) and NO radioactive particles. None, Zero, Nada, Zip. One could live inside a Helium-3 fueled fusion reactor and get less radiation than we all do now from the soil beneath us.

But here is the catch. The only source of Helium-3 on Earth is as a byproduct of nuclear weapons manufacture. It is estimated that we have only a few tons of it world wide!

After the Apollo missions, one scientist, experimenting with Apollo moon rock and dust samples, was surprised to see that when he heated the samples, they gave off a noticeable amount of gas. This proved to be mostly hydrogen, but with an appreciable amount of helium and other gasses.

It turns out that the Solar Wind blowing off the sun in all directions, while it cannot get past Earth's atmosphere, this wind has been buffeting the Moon's surface for billions of years. Some of these particles become affixed to the talcum powder sized fine particles that make up much of the moon dust. And one helium atom in 4,000 is Helium-3.

How much Helium-3 is there on the Moon? It is estimated that if you took one of those orange shuttle External Tanks to the Moon, and filled it with liquid Helium-3, had we the fusion plants to burn it- would supply all the electricity the United States uses in a single year. And? And there is enough of this unique resource on the Moon to bring all of Earth up to our standard of living and keep it there for hundreds of years. When that supply is exhausted, there is enough in the stratified atmosphere of Uranus to keep the lights on for millions of years more. Totally clean pure energy! No more dirty coal, gas, oil! Earth would quickly be restored to a healthier state. So the Energy and Environmental benefits would be enormous.

But this is not the only scenario! Some 97% of moon dust is composed of various mineral combinations of Oxygen, Silicon, Aluminum, Magnesium, Titanium, Iron, and Calcium.

Imagine that as a Pie Chart. So maybe the Moon *is* "Pie in the Sky" but oh, what a recipe!

These are the ingredients we need for metal alloys, ceramics, glass, fiberglass, glass-glass composites, concrete and cement, and ceramics. We can make useful building materials on the Moon and that means that we will have to bring much less up there from Earth.

Now consider how big the Saturn V was that sent astronauts to the Moon. Then consider how small was the ascent vehicle that let them leave the Moon.

The Moon's gravity is only 1/6th that of Earth.

Now it makes no sense to ship building materials from the Moon to Earth. But if we are to build out Low Earth Orbit (orbiting industrial and research parks, tourist complexes, etc.) and Geosynchronous Earth Orbit 36,000 kilometers up (giant platforms each of which can hold hundreds or more Earth-sensing, meteorological, Global positioning, Communications satellites) - keep in mind that by treaty, there are only 180 available slots in this orbit, 2 degrees apart.)

Bringing up building materials from Earth to do this would require thousands of heavy lift launches, consequent pollution of the upper atmosphere, and at enormous fuel expense. All these environmental and economic consequences are removed if we bring building materials down from the Moon. From Earth to GEO is 36,000 km. From the Moon to GEO is ten times further, but requires only 1/20th of the fuel, with no pollutants for Earth's atmosphere.

One of the things we can build in GEO with lunar materials at much less cost and environmental impact is Solar Power Satellites. In Space, the sun shines full force, 24/7/365 - no clouds, no haze, no nighttime unavailability.

Yes, we can build enough solar panels on Earth's surface to provide our needs! In the US that might mean

paving over the entire states of Arizona and New Mexico with solar panels: you can imagine the real estate costs !

The point is that developing lunar resources is a way to not only halt deterioration of our home planet's environment, but a way to let the environment restore and heal itself.

Can we develop lunar materials and products from them without trashing the Moon?

Well, as a result of continual micrometeorite bombardment of the Moon's surface over billions of years, the surface has been "gardened" to a depth of 2-10 yards everywhere on the Moon. This layer of moon dust and rock bits is called the regolith, Greek for rock powder.

Essentially, the Moon is already pre-mined by nature, and everything we need to extract can be found in this top blanket. So no open pit mining, no deep shaft mining. Harvestors can roam the surface extract what they need, and lay the rest down behind them. Little craters a yard or so smaller would be obliterated. Larger craters you would want to steer around. Thus this activity and its "scars" would be invisible not only from Earth, but from descending space craft. You would have to be right on top of an area, on the surface, to notice the only difference: *absence of craterlets*.

Humans will not go to the Moon alone. We are encradled by our biosphere, supported by plant and animal life. On the Moon, we will have to create "mini-biospheres" in which to live and in which to re-encradle ourselves. Given the size of such mini-biospheres, one per settlement or base, lunar pioneers will forever live "*immediately downwind and downstream of themselves*." They won't pollute because if they did, they would feel the effects immediately, not their children or grandchildren. On Earth we pollute because given our enormous atmosphere and hydrosphere and surface, we can get away with it. Lunar Pioneers will have to learn immediately a whole new nature-respecting way of life. And some of the technologies and methodologies they develop will be brought back to Earth to help begin the healing of the Mother Planet.

Because of the high threshold of efficiency in manufacturing and re-use of products and byproducts and discards on the Moon, it will be economically necessary to manufacture everything so that all of an item's components are easily separated so as to be properly recycled. No more use of adhesives and bonding agents through which unlike materials mutually contaminate one another.

Over the past 23 years, I have written many an article about environmentalism on the Moon, as an economic necessity as well as the only healthy and survivable lifestyle.

I have recently collected these articles in two pdf file volumes entitled "**Eden on Luna 1**" and "**Eden on Luna 2**"

You can download these from this directory
http://www.moonsociety.org/publications/mmm_themes/

We cannot "do the Moon" alone!

Another point I'd like to make. I pointed out that we cannot "do the Moon" alone. We must bring a viable bit of "Gaia" with us. The corollary is that "Gaia" does not have the capacity to spread beyond Earth's atmosphere.

To do this, to implant "Gaiacule" colonies on other worlds across the barrier of space, has required that Gaia give birth to a technologically capable custodial and stewarding

species. Some people are queasy when I suggest that Human-kind is ultimately the reproductive organ of Gaia.

It is simple and beautiful.

We won't pollute because we can't. We won't trash because it would be economic suicide. We won't go with token houseplants - "humans hosting plants" but establishing living environments to "host ourselves."

Now a small science base could survive on an umbilical cord of constant shuttles from Earth. But no larger settlement could do that.

The Moon is a life-squelching hostile dreadful place.

Each time humans have pioneered a new frontier, they found that they had to rely on a different set of plants and animals, a different set of resources, in a different set of conditions. Each time we mastered the new conditions and dangers "as if by second nature" and learned to make ourselves truly at home.

It will be no different on the Moon. We will develop new arts and crafts from lunar materials to give lunar homes a distinctive lunar feel, new forms of sports, and dance (!) that play to the lower gravity. We will learn not to be afraid of the long lunar nights, to handle the cosmic weather, etc.

All these themes are developed in my writings cited above. In time, pioneers will be as much at home as we are here. It's the way we have always adapted.

A plan to protect the Moon?

One project I have in mind is in collaboration with amateur astronomers who enjoy observing the Moon through telescopes, and others, is to develop a plan that would provide special protection to areas of significant scenic, historic, geological, and scientific interest, with a grade of protections. National Parks, Monuments, Historic Preserves and rules to constrain development sprawl. That would serve to keep most of the Moon's surface pristine and to channel development to less sensitive areas. But so far, no one has expressed any interest.

A Tale of Two Blankets

As lunar installations and settlements need to be covered or buried beneath a blanket of moondust 2-4 meters thick for protection against the cosmic elements (cosmic rays, solar flares, ultraviolet, micrometeorites - and the thermal extremes of the 2-week long dayspans and nightspans) they will largely blend into the moonscape. Here and there, an office building or hotel might "stand proud" above the surface, yet with an architecture that says "Moon."

Note that if Earth's atmosphere were to be frozen out, we'd have a 5-meter thick blanket of Nitrogen and Oxygen snow! Our atmosphere and this protective overburden of moondust provide analogous protection.

As a passionate environmentalist I feel passionately about brainstorming how we can do the Moon in a way that puts to shame how we have treated the Earth.

So I invite you to download these two volumes (85 and 69 pages respectively) and then get back to me with any questions or input. Feedback is essential if we are going to improve on these volumes. Note: these volumes collect material from the first 20 years only. So there is more on the subject that I have written in the three years since. ###

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Introducing M3IQ's New Co-editors

In their own words

Srinivas Laxman

"I have been a special correspondent with The **Times of India** for the last 35 years and the main focus of my coverage has been space. I have covered the Chandrayaan-1 mission right from its inception, launch and till the discovery of water.

"I have covered several launches at the Satish Dhawan Space Centre in Sriharikota including the famous Space Capsule Recovery Experiment. I have visited several Isro centres, Nasa's Kennedy Space Centre, the Johnson Space Centre and the European spaceport of Kourou in French Guyana, South America.

"I have interviewed Neil Armstrong, Eugene Cernan, Rakesh Sharma, Kalpana Chawla and Sunita Williams. I have also interacted with India's top space figures which includes, K. Kasturirangan, G. Madhavan Nair, U.R. Rao and the late Satish Dhawan

"I have written a bio Dr APJ Abdul Kalam, **"Dreams To Reality,"** which again targets the younger generation.

"The Mumbai launch of my book, **Moonshot India**, is set for this Saturday November 14th, marking the first anniversary of India landing on the Moon."

Pradeep Mohandas

"I'm a Mechanical Engineering under-grad student at Mumbai University. I co-founded SEDS' India chapter in 2005. That chapter now has chapters in about 6 campuses and is known to be the largest SEDS chapter in the world as of May 2009. I conceptualised and worked on an international collaboration cubesat mission called SEDSSat-II, which is still going on. The project has team members from every continent in the world except Antarctica and South America.

"Most of my work then was focused on building the SEDS India chapter. I briefly assisted with the formation and running of the Student's Chapter of the Astronautical Society of India. After my stint at SEDS, I went on to Planetary Society, India (not related to the The Planetary Society) as Director, Space Science Projects where currently I'm helping shape a national character for the Society and enabling it to grow beyond Andhra Pradesh where it has been operating successfully for 11 years.

"For the lunar connection, SEDS India organised one of the first Moon Rover Design Competitions hosted in India for Indian students in 2007. I then helped Planetary Society, India organise one for school students in 2008. SEDS India returned with a rover competition using actual rovers in 2009.

"I joined the Moon Society in July, 2009. While my immediate focus is to build a Moon Society chapter in India with a stable organisational structure, my long-term goals include a lunar analog station in India which is run and operated by students under the aegis of Moon Society.

"I have my own Blog, Pradeep's Blog, providing insights into my ideas, dreams, and projects." f###

November 14, 2009
The 1st Anniversary of

Chandrayaan-1's Moon Impact Probe reaching the Lunar Surface with the tricolor Flag of India painted on all four sides. - India was on the Moon!

This date was chosen to honor former Prime Minister Jawaharlal Nehru's Birthday. In his term, India's Space Program was launched in 1962.



Today, we are pleased to announce
The formation of
The Moon Society of India

As an Autonomous Affiliate of The Moon Society (International)

The founding Executive Committee has elected Jayashree Sridhar (Chennai) as President, with Pradeep Mohandas (Mumbai) as Secretary.

Also involved are Srinivas Laxman (Mumbai), Avinash Siravuru (Vellore)

We will also be forming a Board of Advisors; in addition to prominent Indians, , Peter Kokh, David Dunlop, and Madhu Thangavelu from the International Moon Society International will be included.

Our priorities include starting a network of chapters throughout India, both city- and campus-based, and in the coming year, to assume publication of the MMM-India Quarterly, which publication has made this event possible.

We will be involved in conferences, contests and competitions, and hope to build and operate an Indian Lunar Analog Research Station - LARS-India.

And, of course, our efforts will focus on building public support within India for the ISRO's Space Exploration and Manned Space Programs.

Watch upcoming issues of "M3IQ" for more news and progress reports.

Interview with Krishnaswamy Kasturirangan, former ISRO Chief and Father of Chandrayaan-1

Special for M3IQ By Srinivas Laxman

Krishnaswamy Kasturirangan, who was ISRO chairman from 1994 to 2003, said that the coming years will see the Moon attracting increasing attention globally since it was the Earth's nearest celestial object offering a lot of advantages. "As a result of this, I see an increasing fascination for the Moon and I am confident that organizations like the Moon Society will play a vital role in spreading knowledge and awareness about the Moon," he told M3IQ in an interview.

He welcomed the launch of the Indian chapter of the Moon Society on November 14, 2009, in the wake of India's successful lunar mission, 'Chandrayaan-1,' and the next moon flight, 'Chandrayaan-2,' which is slated for lift off in 2012-2013. The inauguration of the Indian chapter coincides with the first anniversary of India's successful landing on the Moon: it was on November 14, 2008 at 8.31 p.m. (IST) that Chandrayaan-1's 29-kg Moon Impact Probe (MIP), a brain child of former President and rocket scientist, A.P.J. Abdul Kalam, successfully landed in the Moon's South Pole region. During its 30-minute descent towards the Moon's surface, and after detaching from the main orbiter, the impactor videographed the landing, and more importantly detected water.

The discovery of water on November 14, 2008, by the Indian probe was kept under wraps for 10 months until September 24, 2009, when NASA announced that its payload on board Chandrayaan-1, the Moon Mineralogy Mapper (M3), had found traces of water. Former ISRO chief, Madhavan Nair, explained that there was a deliberate 10-month delay in announcing MIP's important discovery because it was a brief flight by the MIP. Consequently, ISRO needed more evidence about the sensational find by MIP which it got.

"Any object which has the capability to provide resources also becomes an object of claims."

- Krishnaswamy Kasturirangan

Asked if he foresaw the development of what is called "Moon Politics," in the future considering that there was a some sort of a competition now among nations to find water on the lunar surface, Kasturirangan replied: "Any object which has the capability to provide resources also becomes an object of claims. In the days ahead I do see access to the Moon's resources by various nations increasing. Once this happens, the question will automatically arise as to who had the access earlier. Remember, the Moon not only possesses water but also different minerals which is catching world attention. Such a situation can trigger fierce competition among nations which in turn could possibly lead to lunar politics," he told M3Q

Said Kasturirangan: "Such a competitive situation which turned into a political issue happened when countries

began to set up stations in the Antarctica, and also when India detonated its nuclear weapon at Pokhran."

"when visits to the Moon become commonplace, the chances are that private enterprises could perhaps have a role in such projects"

To a question whether he envisaged the possibility of launching privately-funded missions to the Moon from India in the long run, Kasturirangan, said that initially the possibilities are slim. "But, when visits to the Moon become common place, the chances are that private enterprises could perhaps have a role in such projects," he said.

" this country could instead participate in an international human Moon mission which will undoubtedly prove more economical "

About India planning manned missions to the Moon, the former ISRO chief felt that instead of going alone because of the exorbitant costs involved in such a huge project, he said that this country could instead participate in an international human Moon mission, which will undoubtedly prove more economical.

"According to me the human expansion to the Moon has to be there. But in the present context in India one needs to study the national priorities first and adopt a cautious approach towards a manned mission to the Moon. While a human lunar mission is definitely important, I feel that India at this stage should be a party to an international human flight to the Moon," he said.

That an Indian manned mission to the Moon was definitely on the cards, was amply evident from a presentation made by V.Adimurthy, a top Isro scientist, at the International Astronautical Congress-2009 in South Korea last month. At this conference, Adimurthy was one of the speakers at a session on manned missions to the mission. He made a power point presentation about this project clearly suggesting that India has not all together given up the idea of embarking on a manned mission to the Moon.

In fact many space scientists say that the manned Indian flight to the low Earth orbit in 2014-2015 could be a possible precursor to a human lunar mission around 2020. This is the year when countries like the US, China and Japan are also exploring the possibility of launching manned Moon flights.

Asked whether the success of Chandrayaan-1 will prove an advantage to India in the international commercial launch market, the father of the Indian Moon mission said that the success of the country's first lunar mission, had considerably enhanced the prestige not only of India's space sector, but the whole country. "It has clearly indicated the reliability of India's launchers to the whole world. When nations evaluate options to choose a rocket to fly their payload, they will know that India possesses the right credentials thanks to the success of Chandrayaan-1," he said.

What according to him was the significance of the success of Chandrayaan-1 in the global context keeping in view NASA's Clementine and Lunar Prospector missions which had also claimed that they discovered water? Replied Kasturirangan: " I think this was the first time that there has been something really decisive about the discovery of water on the Moon."

SL

GREAT BROWSING

How the Moon produces its own water
www.astronomy.com/asy/default.aspx?c=a&id=8718

POLL: Is Earth Ready to Meet an Alien Civilization?
<http://www.space.com/common/forums/viewtopic.php?f=14&t=20907>

Messenger sees changing seasons on Mercury
<http://www.space.com/scienceastronomy/091103-mercury-new-images.html>

Space Hotel Takes Reservations for 2012 Opening
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Water Geysers on Enceladus
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<http://www.colonyworlds.com/2009/11/almost-star-trek-ebf3-tech-could-help-replicate-tools-for-lunar-settlers.html>

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'Trash Can' Nuclear Reactors Could Power Human Outpost On Moon Or Mars
<http://www.sciencedaily.com/releases/2009/10/091004020806.htm>

Paul Spudis: The Not-So-Barren Moon
http://lunarnetworks.blogspot.com/2009_05_01_archive.html (written before the recent NASA-ISRO find)

JAXA-Kaguya rotating Moon image
http://picasaweb.google.com/lh/photo/6QKKo25GVCQP-Cijxh53Ow?authkey=Gv1sRqCMqB_pO06K3EEg&feat=embedwebsite

How NASA Hopes to Mine Water on the Moon
<http://www.space.com/business/technology/090930-tw-tapping-moon-water.html>

VASIMR Engine could cut Mars trip to 39 days
<http://www.physorg.com/news174031552.html>

Nuclear Reactors for Space
<http://www.world-nuclear.org/info/inf82.html>

Where life may have formed first: Mars? Europa?
<http://www.space.com/missionlaunches/091012-mm-mars-europa.html>

Solaren's Plans for SBPower demo unit for PG&E
<http://cleantech.com/news/4361/solarens-plan-outer-space>

Dynamic View of Moon's Composition
www.psrdr.hawaii.edu/Nov05/MoonComposition.html

Gigapan the Apollo Landing Sites
<http://www.universetoday.com/2009/07/30/gigapan-the-apollo-landing-sites/>

GREAT SPACE VIDEOS

MOON COLONY VIDEOS - The Moon Society

30 plus thought-provoking videos, produced for the Moon Society by Chip Proser (Celestial Mechanics, Inc.) can be found at.

<http://www.moonsociety.org/video/>
or at:

<http://www.mooncolony.tv/>
<http://www.stickymedia.com/>

ASSORTED SPACE VIDEO

Geyser in Space: Cold Faithful on Enceladus

http://www.space.com/common/media/video/player.php?videoRef=Enceladus_web

Video of NASA's new Star Trek like "Replicator"

<http://www.colonyworlds.com/2009/11/almost-star-trek-ebf3-tech-could-help-replicate-tools-for-lunar-settlers.html>

Robotic rover that can drill on Moon

<http://www.sciencedaily.com/videos/2008/0309-moon-rover.htm>

Earth's Magnetosphere charges Moon monthly

http://www.sciencedaily.com/videos/2008/1007-preparing_for_a_walk_on_the_moon.htm

YouTube - NASA Press Conference, "A New Moon"

<http://discoveryenterprise.blogspot.com/2009/09/water-on-moon.html>

A 1961 Glimpse of Spaceflight & Space Stations

www.archive.org/details/way_stations_in_space

Robotic Astobiology in Chile's Atacama Desert

<http://www.frc.ri.cmu.edu/atacama/videointro.html>

Masten Space Systems qualifies for 1st place in

Northrop Grumman Lunar Lander Challenge

<http://spacefellowship.com/2009/10/30/masten-space-systems-qualifies-for-1-million-prize/>

Triton Flyby 1989

http://www.space.com/common/media/video/player.php?videoRef=SP_090902_triton

Short film about the Settlement of Space

<http://www.youtube.com/watch?v=e14LDWt-Q1k>

NASA D-RATS field test 2 man pressurized rover

<http://www.technologyreview.com/video/?vid=435>
www.technologyreview.com/computing/23481/article

The Moon Again 1

http://www.space.com/common/media/video/player.php?videoRef=SP_090720_MoonAgain

Water on the Moon: Hydrogen, Oxygen and Energy

http://www.space.com/common/media/video/player.php?videoRef=SP_090728_MoonAgain-02

Slate TV - If Man Walked on the Moon Today

<http://slate.com/player.html?id=30020544001>

National Geographic living on the Moon - trailer

http://channel.nationalgeographic.com/series/naked-science/4253/Overview?#tab-Videos/06893_00

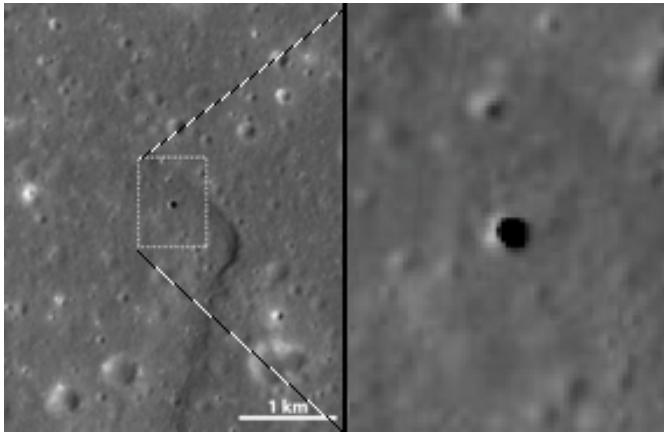
We Choose the Moon

<http://www.wechoosethemoon.org/>

Video on Gerard O'Neill and his Ideas

<http://www.youtube.com/watch?v=e14LDWt-Q1k>

MMM-INDIA PHOTO GALLERY



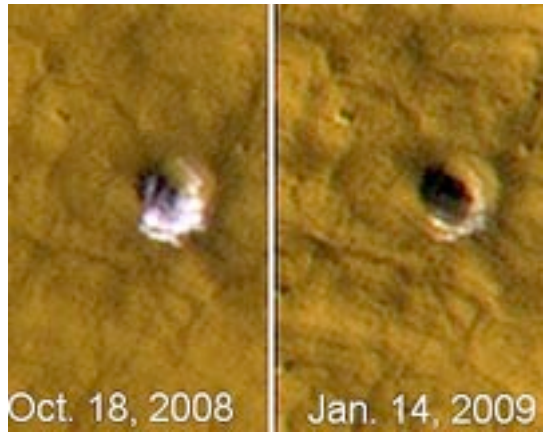
Kaguya spots a “skylight” - at 303.3°E [56.7°W] and 14.2°N in the Marius Hills region of the Moon almost certainly over a lunar lava tube, likely to be a common feature in this area.

See pages XX-YY above for more.

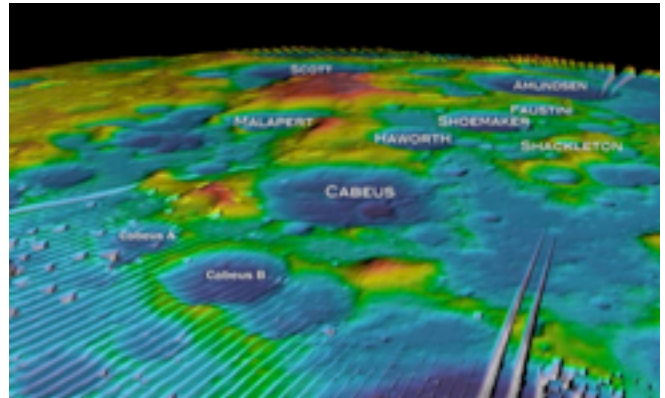


Above: a good shot of Mercury’s northern hemisphere Note the volcanic mare-like plains. Photo Sept 29, 2009. MESSENGER is the acronym for **M**ercury **S**urface, **S**pace **E**Nvironment, **G**Eochemistry, and **R**anging. This was Messenger’s last (3rd) flyby. It will go into orbit around Mercury in 2011.

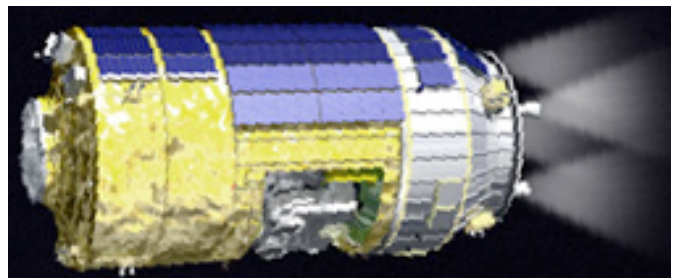
Below is a fresh photo of an unnamed impact basin never seen before. Thw outer ring is 260 km (160 mi) wide. The inner ring is 200 km (125 mi) wide.



A fresh, 6m-wide, 1.33-m-deep crater on Mars photographed on Oct. 18, 2008, and Jan. 14, 2009, by Mars Reconnaissance Orbiter's HiRISE camera. The bright material is ice, which fades from Oct. to Jan. because of sublimation and obscuration by settling dust. This is sub-surface water ice 99% pure, halfway between the north pole and the equator.



The Shaded portion of Cabeus (60 mi, 98 km wide) was location of the 2-part LCROSS Impact Oct 9, 2009



JAXA’s new HTV Cargo Vessel made its first trip to ISS September 11, only to burn up on way home: one use only.



Russian Mobile Nuclear Plant – suitable for Moon or Mars?
<http://englishrussia.com/?p=23558>

Moon Miners' Manifesto Resources

<http://www.MoonMinersManifesto.com>

MMM is published 10 times a year (except January and July. The December 2008 issue will begin its 23rd year of continuous publication.

Most issues deal with the **opening of the Lunar frontier**, suggesting how pioneers can make best use of **local resources** and learn to **make themselves at home**. This will involve psychological, social, and physiological adjustment.

Some of the points made will relate specifically to **pioneer life** in the lunar environment. But much of what will hold for the Moon, will also hold true for **Mars** and for space in general. We have one Mars theme issue each year, and occasionally **other space destinations** are discussed: the asteroids, Europa (Jupiter), Titan (Saturn), even the cloud tops of Venus.

Issues #145 (May 2001) forward through current are as pdf file downloads with a Moon Society username and password. Moon Society International memberships are \$35 US; \$20 students, seniors – join online at:

<http://www.moonsociety.org/register/>

MMM Classics: All the “non-time-sensitive editorials and articles from past issues of MMM have been re-edited and republished in pdf files, one per publication year. A 3-year plus lag is kept between the MMM Classic volumes and the current issue. **As of November 2009, the 1st twenty years of MMM, 200 issues, are preserved in this directory**, These issues are freely accessible to all, no username or password needed, at:

www.moonsociety.org/publications/mmm_classics/

MMM Classic Theme Issues: introduced a new series to collect the same material as in the Classics, but this time organized by theme. The first MMM Classic Theme issue gathers all the **Mars** theme articles from years 1-10 in one pdf file. A second pdf file collects all the Mars Theme issues from year 11-20. The 2nd Classic Theme is “**Eden on Luna**,” addressing environmental issues underlying lunar settlement. **Asteroids** and **Tourism** have been added and **Research** and **Select Editorials** are underway. New Theme Issues will be coming): Lunar Building Materials, The Lunar Economy, The Lunar Homestead, Modular Architecture, Modular Biospherics, Frontier Arts & Crafts, Frontier Sports, Other Solar System Destinations, and so on.

www.moonsociety.org/publications/mmm_themes/

MMM Glossary: The publishers of MMM, the Lunar Reclamation Society, has published a new Glossary of "MMM-Speak: new words and old words with new meaning" as used in Moon Miners' Manifesto.

www.moonsociety.org/publications/m3glossary.html

The initial addition includes over 300 entries, many with illustrations. Additional entries are under construction. It is hoped that new members will consider this to be a "Read Me First" guide, not just to Moon Miners' Manifesto, but to our vision and goals.

All of these resources are available online or as free access downloads to readers of MMM-India Quarterly

Help Wanted !

MMM-India Quarterly Advisors, Liaisons, Contributors, Correspondents, Illustrators

If this publication is going to help spread the word about Space in India, among the public at large, and especially among the students and younger generation, it must become a truly Indian publication. We need people from many fields in India to join our team

If you think that you can add to the usefulness and vitality of this publication, in any of the ways listed above, or in fields we had not thought of, write us at:

mmm-india@moonsociety.org

[This email address goes to the whole editorial team]

Tell us about yourself; your interest in space, and how you think you can make this publication of real service in the education of the public in India, and in the education of young people on whom the future of India and the world will rest.

Guidelines for Submissions

This publication is intended for wide public distribution to encourage support for space research and exploration and development.

It is not intended to be a scholarly review or a technical journal for professional distribution.

Submissions should be short, no more than a few thousand words. Longer pieces may be serialized

Editorials and Commentary, reports on actual developments and proposals, glimpses of life on the future space frontier, etc.

Articles about launch vehicles, launch facilities, space destinations such as Earth Orbit, The Moon, Mars, the asteroids, and beyond, challenges such as dealing with moon dust, radiation, reduced gravity, and more.

Help Circulate *MMM-India Quarterly*

If you know someone who might enjoy reading this publication, send us their email address(es) so that they receive notice when a new issue is published.

Readers are encouraged to share and to distribute these issues widely, either as email attachments, or via the direct download address (for all issues):

<http://www.moonsociety.org/india/mmm-india/>

MMM-India Quarterly will remain a free publication.

We will set up an online subscription service so that each issue is emailed to your email box directly, if you wish.

Printing this publication in the US would not be costly, but mailing it overseas to addresses in India would be.

If anyone in India wishes to become a Moon Society agent and publish and mail hardcopies of *MMM-India Quarterly* to addresses on a paid-subscription basis, please contact us at mmm-india@moonsociety.org

Student Space Organizations in India

The Planetary Society of Youth (TPSY)

<http://www.youthplanetary.org/>

Shri: R.V.Burli, President

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Opp. VRL Office - Bagalkot - 587101
Karnataka - India
Tele: (R) +91-8354-222725
(M) +91-9343110567

E-mail: president@youthplanetary.org

Mr. Amrut Yalagi, Secretary

The Planetary Society of Youth
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Bagalkot - 587 102, Karnataka - India
Tele: (R) +91-8354-233911
(M) +91- 9880071339

E-mail: amrut@youthplanetary.org
amrut1243@gmail.com

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Astronautical Soc. of India Student Chapter (ASISC)

<http://www.indianspace.in/>

Astronautical Society of India Student Chapter
175 Bussy St, Pondicherry 605 001 175, India.
Phone: +91 0413 3246999,
email: mail@indianspace.in

Fax: +91 0413 3000222.

Head Office: ISRO Satellite centre, Airport Road,
Vimanapura, Bangalore - 560 017. India.

Phone: +91 080 25205257. Fax: +91 080 25082122.

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SEDS-India - <http://india.seds.org/>

(Students for the Exploration & Development of Space)

National Headquarter - SEDS VIT,

C/O , Dr. Geetha Manivasagam,
Room No. 403 , CDMM Building ,
VIT University,
VELLORE-632014, Tamil Nadu
Phone No. : +91-9952281231
Anmol Sharma (Director, Chapter Affairs)

SEDS-India Chapters:

1. SEDS VIT - Vellore Institute Of Technology University (Vellore)
http://www.vit.ac.in/seds_vit/index.html
2. National Institute Of Technology (Suratkal)
3. National Institute Of Technology (Trichy)
4. Jawahar Lal Nehru Technical University (Hyderabad)
5. Kumaraguru College Of Tech.(Coimbatore)

**The Moon Society has both
Campus-based & Community Chapters**

Pro-Space Organizations in India

Astronautical Society of India

<http://www.asindia.org/default.aspx>

[IndianSpaceTalk@groups.indianspace.in](http://www.indianspace.in)

National Space Society Kolkata chapter

<http://www.nss-kolkata.org/>

Dr. Satadal Das
drsdatdas@hotmail.com 91-33-24683336
76 Satyen Roy Road
Kolkata, , 700 034 India
Meetings: 547 Raja Rammohan Roy Road (First Floor)

National Space Society Pune Chapter

Mr. Sandeep Joshi
Guardian Holidays
101 Citi center Karve Road Pune, MAH, 411 004 India
mazabharatmahan@yahoo.com
91-20-30224216

Planetary Society of India

[Organisation for promotion of astronomy]

<http://planetarysocietyindia.blogspot.com/2008/08/space-camp-india-astronaut-training.html>

<http://planetarysocietyindia.blogspot.com/>

<http://planetarysocietyindia.org/>

Space India - ISRO Newsletter - twice a year

<http://isro.gov.in/newsletters/newsletters.htm>

Aeronautics & Aerospace Journals & Magazines Published in India

(Stress on AEROSpace)

International Aerospace Magazine India

<http://www.internationalaerospaceindia.com/default.htm>

Vayu Aerospace Review – India

<http://www.vayuaerospace.in/>

Miscellaneous Resources

LPOD – Lunar Photo of the Day

<http://www.lpod.org/>

* Directory of Lunar Place Names*

<http://www.lunarrepublic.com/gazetteer/index.shtml>

* Lunar Glossary & Dictionary*

<http://www.lunarrepublic.com/info/glossary.shtml>

* The Full Moon Atlas*

<http://www.lunarrepublic.com/atlas/index.shtml>

** Our listing of these pages does not imply endorsement of the Lunar Republic's land/property sales program.*

From now on, we live in a world where men have walked on the Moon. And it wasn't a miracle! We just decided we wanted to go.

Jim Lovell, in "Apollo 13"

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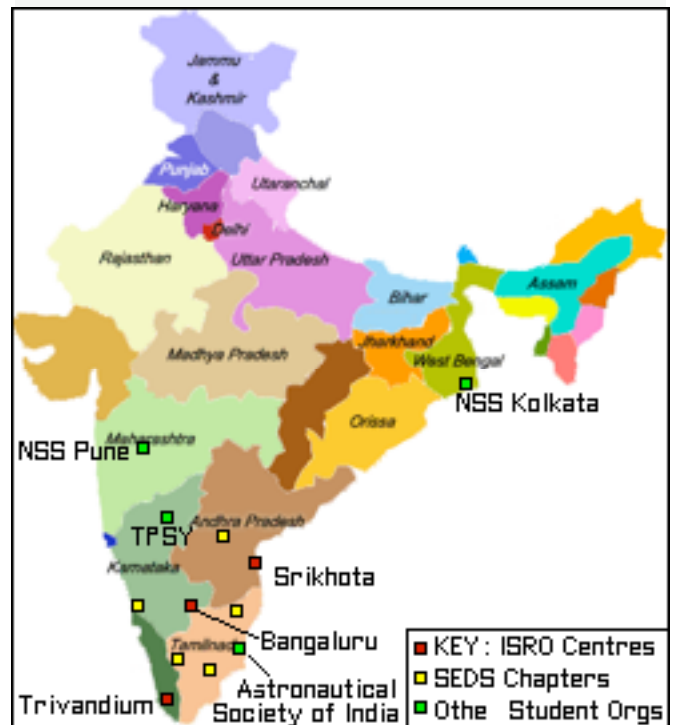
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"All options were considered, and the Moon was found to be most enabling to the overall exploration of our Solar System. *The Moon is where humanity first established itself as a multi-planet species*, and it is where humanity will resume the pursuit of extending its presence across the Solar System and beyond."

Former NASA Administrator *Mike Griffin*

"Is the Moon a wasteland?" - *Walter Chronkite* CBS
"There is no such thing as waste, there are only resources we are too stupid to know how to use."
- *Arthur C. Clarke* - to Cronkite at Apollo 13 launch



Engage! And Enjoy!