"Towards an Earth-Moon Economy - Developing Off-Planet Resources"

Moon Miners' Manifesto

& The Moon Society Journal www.MoonMinersManifesto.com

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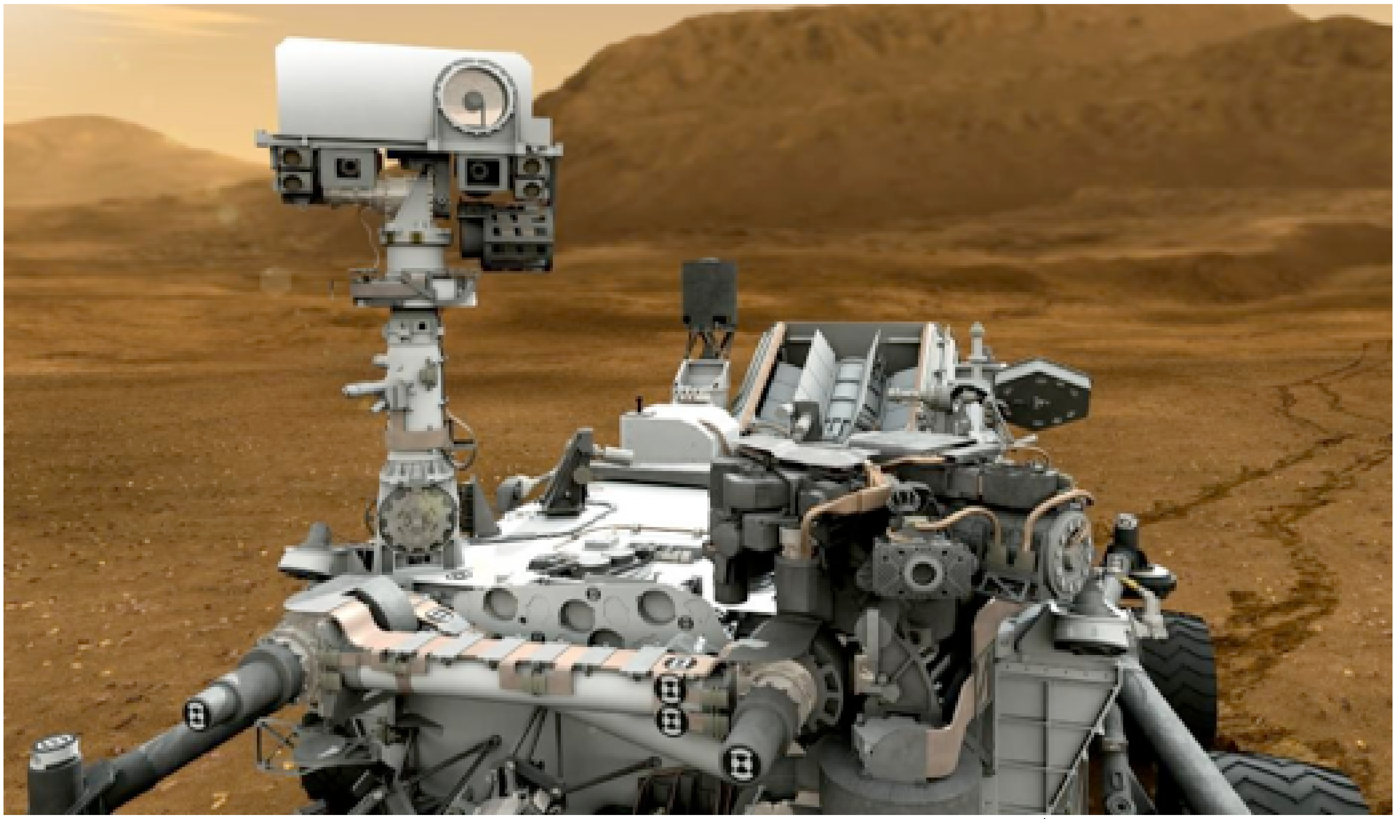


"Compact car-size" Curiosity Rover as it might look on Mars, launched November 26th, due to arrive August 2012

Feature Articles in This Issue

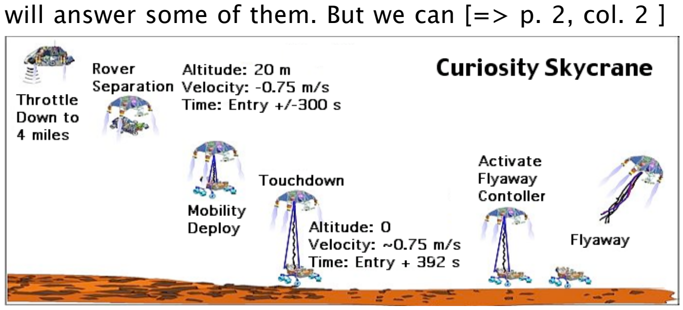
The Curiosity Sky Crane Landing System ->

In order to keep the landing spot as pristine as possible, that is, not swept clean by lander engine exhaust, Curiosity will be "landed" by a hovering sky crane, part of the package. The system has been tried in the laboratory, and fingers will be crossed that it works as planned on arrival on Mars. This feature added significantly to the mission price tag, but may set a precedent for other complex landers to come.

Curiosity Paper Model: http://jleslie48.com/jj_marssl/MarsScienceLab-Rover_v3.pdf

In Focus Curiosity heads for Mars, while Phobos-Grunt is bound for limbo

It has been a long wait, with threats of cancellation, but at last the one-ton **Mars Science Laboratory,** now christened **Curiosity,** is at last on its way. An impressive series of orbiters and rovers has flooded us with detailed knowledge of the Red Planet, but raising new questions. It is hoped that Curiosity will answer some of them. But we can [=> p. 2, col. 2]



Moon Miners' Manifesto

Published monthly except January and July., by the **Lunar Reclamation Society** (NSS-Milwaukee) for its members, members of participating **National Space Society chapters**, members of **The Moon Society**, and individuals worldwide.

• **Moon Miners' Manifesto CLASSICS:** The non-time-sensitive articles and editorials of MMM's first twenty years have been re-edited, reillustrated, and republished in 21 PDF format volumes, for free downloading from this location:

www.MoonSociety.org/publications/mmm_classics/

• **MMM Glossary: new terms, old terms with new meanings:**
http://www.moonsociety.org/publications/m3glossary.html

• **MMM's VISION:** "expanding the human economy through off-planet resources"; the early era of heavy reliance on Lunar materials; early use of Mars system and asteroidal resources; and establishment of permanent settlements supporting this economy.

• **MMM's MISSION:** to encourage "spin-up" entrepreneurial development of the novel technologies needed and promote the economic-environmental rationale of space and lunar settlement.

• **MMM retains its editorial independence.** MMM serves many groups, each with its own philosophy, agenda, and programs. Participation in this newsletter, while it suggests overall satisfaction with themes and treatment, requires no other litmus test.

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• **The National Space Society** is a grassroots pro-space membership organization, with 10,000 members and 50 chapters, dedicated to the creation of a spacefaring civilization.

National Space Society, 1155 15th Street NW, Suite 500
Washington, DC 20005 -- Ph: (202) 429-1600 - www.NSS.org

• **The Moon Society** seeks to overcome the business, financial, and technological challenges to the establishment of a permanent, self-sustaining human presence on the Moon." - Contact info p. 9.

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• **Publication Deadline:** Final draft is prepared ASAP after the 20th of each month. Articles needing to be keyed in or edited are due on the 15th, *Sooner is better!* - ***No compensation is paid.***

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⇒ In Focus Editorial continued from p. 1.

also expect Curiosity to leave us with even more questions in turn. That is the nature of science!

Meanwhile, Russia's impressive Phobos-Grunt probe lies in orbital limbo about Earth. We may never know what flaw prevented this probe from continuing its journey to Mars. Its launch had already been postponed 25 months from the original slated date. Such failures are also part of the quest for knowledge.

But no matter how much new knowledge and understanding of Mars we will harvest from Curiosity (of course, expecting it to land safely!) this rover's turf will be very local. Mars has as much land as Europe, Asia, Africa, Australia, North America, South America, and Antarctic put together. Even with very high resolution photography from Mars orbiters, there will remain many gaps in our knowledge of Mars, some local, many global. And here is where the Phobos-Grunt mission failure really hurts.

Phobos-Grunt hoped to return samples of this mini-moon to Earth for analysis. But the hope that its composition might prove kindred to carbonaceous chondrite asteroids that could be turned into fuels, and into methane and ammonia for shipment to the Moon has already been shot down. Even so, Phobos-Grunt could have photographed and mapped Phobos in minute detail, perhaps finding the ideal spot for a manned outpost, form which a virtual army of surface probes and robonauts could have been teleoperated in virtual near time to multiply our knowledge of Mars a thousandfold, nay, a millionfold. At stake would be a much better idea of the most promising sites at which to locate a starter human outpost.

Could this not be done from an orbiting manned vehicle or mini-station? Keep in mind that the orbital space surrounding Mars is not protected by Van Allen belts, as is Earth. Humans would be fried if not properly shielded (but of course, that need is there for humans in transit from Earth to Mars as well.) On Phobos, however, the loose rock powder can provide ample shielding. Indeed, we expect sizable voids within Phobos itself.

For those in a hurry to deploy a manned outpost on Mars, and dismissing the need to know the planet in greater depth in order to identify a short list of the most promising sites, this is not a consideration worth the delay. But, given how hostile a planet Mars is, (it only looks like Arizona), such a rush could prove fatal. Impatience almost always shoots one in the foot!

Whether a 2nd Phobos-Grunt mission will be flown is a good question. The Russians can be excused for feeling discouraged. But we hope that they are not, and that they will try again next opportunity, 25+ months from now. **PK**

No MMM Newsletter next month

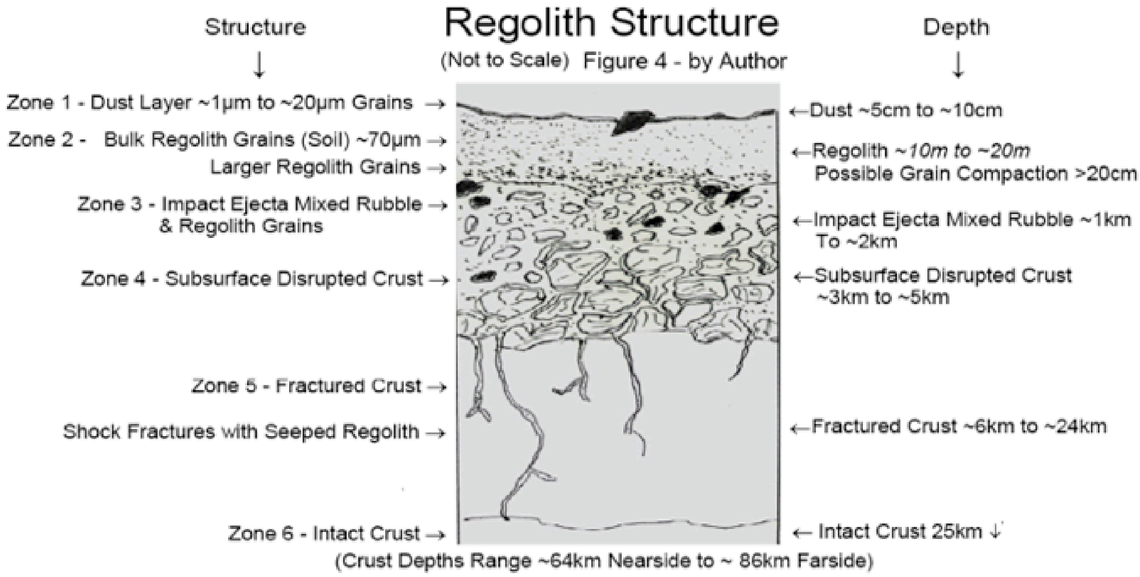
Our schedule is 10 issues a year,
*with a break **in January and July** –*
*the editor's **burnout prevention breaks,***
*and **time to renew and refresh**.*

MMM returns in February with issue #252

Rock, Rubble, and Regolith Part II

By
Ron Brooks

Part I was published in MMM #250 November 2011 Pages 7-9



Zone 1. (Dust layer) The dust layer is the finest of all regolith and consists of grains sized from ~ 1_m to ~20_m (ultra-fine to 0.01 _m _m) of covering the top 5cmto 10cm of the surface.

Zone 2. (Bulk layer) consists of regolith grains averaging ~70 _m (lunar "soil"). This upper surface varies widely across the lunar surface, but averages somewhere between ~10m to ~20m thick. Maria regolith can range from ~1m to ~5m, and highland regolith averages ~10m to ~20m or more.

Zone 3. (Mixed Rubble) Consists of a mixed bag of larger rubble from impact ejecta and intermixed regolith grains. This zone lies~1km to ~2km below the surface. This zone is generally protected from weathering.

Zone 4. (Disrupted Crust – Megaregolith) A layer of disrupted (broken) blocks ~ > 1m in size with regolith grains dispersed throughout. The result of impacts that fractured and broke the crust into large size blocks that has not been exposed to weathering. This zone is referred to as the megaregolith and lies ~3km to ~5km below the surface.

Zone 5. (Fractured Crust) Lunar crust that has been fractured but is firm. Most likely grains of regolith will have seeped into the fractures or cracks. The fractured crust averages ~6km to ~24km below the surface.

Zone 6. (Intact Crust) Part of the lunar crust not affected by impacts and is generally intact. The intact crust slabs lie at ~25km and below from the surface.

The structure configuration such as in in Figure 4 may also not remain in a static condition in any one discrete location. A meteoritic impact of varying magnitude could bring about a fragmentation of any compaction, overturn or bury the existing regolith structure, and virtually destroy what was achieved over time. Nevertheless, as the aeons pass, cosmic weathering and soil mechanics would again most likely return the site to a similar structural pattern.

6. Regolith Compaction through Meteoritic Impact and Moon Quakes

Some additional points need to be made in regards to better understanding of the regolith structure. It is also interesting to note that, below the top 20cm, the grains are thought to be strongly compacted.. Taylor believes the compacting is brought about by shaking during impacts (1982). It does seem likely that large regional impacts could produce sufficient violent shock waves and shaking to jar the abrasive, jagged grains into an interparticle linking, producing a strong compaction. However, it seems likely that in addition to impacts, Moon "quakes" would be a significant contributor to regolith compacting.

During the Apollo excursions, seismometers were placed on the lunar surface. The seismometers clearly detected Moon quakes of various magnitudes at varying durations. In his paper, "The Importance of Establishing a Global Lunar Seismic Network," C. R. Neal states that some "quakes" detected by the seismometers registered up to 5.5 on the Richter scale and lasted up to ten minutes. He also expresses that the quakes can make the moon "ring like a bell" (2005).

Three types of Moon quakes have been identified:

(1) thermal quakes, which are caused by the extremes of lunar cooling and heating,

(2) shallow moonquakes, which occur relatively near the moon's surface, and

(3) deep moonquakes, which take place more than 600 miles under the surface. This is about halfway to the center of the Moon much deeper than any quakes on Earth. The vibration and shaking produced by stronger moonquakes would definitely seem to be a strong factor in compaction of the regolith lying on the surface above.

7. Cosmic Weathering of the Lunar Surface through Meteoritic Impact

The most visual and impressive weathering of the lunar surface is that by meteoritic impacts. "Meteoritic" is an inclusive generalization of the surface impacts made by asteroids and comets or fragments thereof. (For more information on meteorites, asteroids, and comets, see Note 2.) Impacts on the Moon's surface have formed structures ranging in size from .01_m (assigned the name of a "zap pit") to the multi-ringed basins that can measure over 1000km across, e.g., the South Pole Aitken (SPA) Basin.

However, what we are not considering here are the events that took place in the young solar system of three billion years ago in which heavy blankets of impact ejecta were produced by great bombardments and the lava emplacements of the maria. What we are considering is the meteoroid flux comprising mainly of dust-like particles that constantly strike the Moon. In our maturing solar system, larger objects, say, the size of a compact car, strike the Moon every century or so.

This small but constant hammering away at the Moon's surface by meteoroid flux produces three primary physical weathering mechanisms that have altered surface features. The impacts have produced rock and mineral fragments derived from what is called "comminution," or the breaking of rocks and minerals into smaller particles, and "agglutination," which is a fusing of mineral and rock fragments forming impact-produced glass particles and vaporization of grains.

With vaporization of grains, the lighter materials escape while the heavy materials usually condense on nearby grains. So what we have is a process of constant **pulverization, dissipation, and reassembly.** The ultimate outcome, however, is the diminution of the lunar surface material. The three mechanisms above are impact-based. However, space weathering also consists of almost imperceptible actions caused by solar wind, solar flares, and cosmic rays.

8. Lunar Surface Weathering through Ionizing Radiation from Solar Winds, Solar Flares, and Cosmic Rays

As mentioned earlier, the Moon has a tenuous atmosphere and no magnetosphere; it has no protection from outside forces. The weathering through solar wind, solar flares and galactic cosmic rays (Taylor, 1982 b) is very subtle and beyond sensory detection. However, the effects are real and need to be considered.

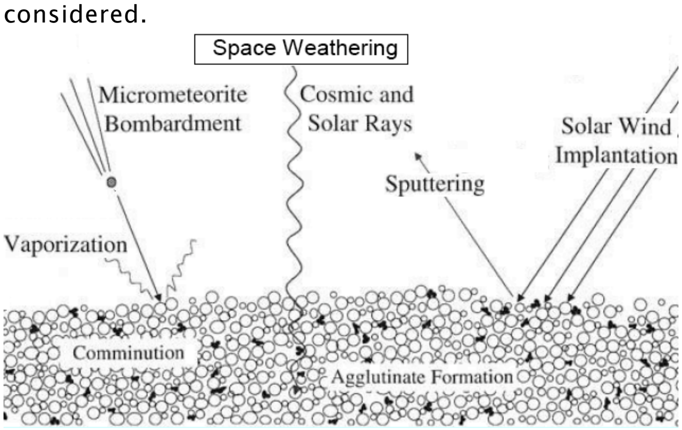


Figure 5 Wikipedia® (2011) Creative Commons Attribution-ShareAlike License

As the solar wind hits the unprotected lunar soil it causes an implantation of ions into the surface materials. (The solar wind is a steady stream of mostly protons and electrons that is constantly emitted from the Sun's upper atmosphere at about 400 km/s.) The solar wind also generates radiational surface damage that produces some fine-scale rounding (Taylor, 1982c). At the same time, the effect of solar wind produces an amorphous coating of ions at about 400Å (angstrom or nanometers) (Taylor, 1982d) on the adjoining grains of dielectric crystals (especially in grains of plagioclase) (McKay, et al., 1991c), producing granular changes.

Solar flares have even higher energy than the solar wind and produce three occurrences:

(1) the implanting of ions into the surface grains,

(2) the production of cosmogenic nuclides and

(3) radiational tracking (Taylor, 1982e; McKay, et al., 1991d). Solar flares, as with solar wind, implant ions into the surface grains. Solar flares also produce cosmogenic nuclides when high-energy cosmic rays from the solar flares interact or collide with the nucleus of an atom.

When the atom is struck, an erosional effect occurs through **spallation** [expulsion of nucleons (protons and neutrons)] from the nucleus of an atom] and **sputtering** (atoms are ejected from a surface particle) leaving behind **cosmogenic nuclides** (or cosmogenic isotopes), a rare form of isotopes.

The third effect of the flares is **radiational tracking,** which occurs within the mineral crystal structures in the lunar soil. The crystals are preferentially dissolved or tracked (i.e., an etched channel is generated) as the ion from a high-energy ray passes through the crystal (Krätsghmer & Gentner, 1977). The track lengths (or etching) of the crystal within the grains differ in differing minerals, usually in order of feldspars > pyroxenes > olivine (Taylor, 1982 f). The radiational tracking is considered "damage" in that it changes the structure of the crystal grain. The grains affected are usually found within the upper ~1mm of the lunar regolith.

Cosmic rays (Especially Galactic Cosmic Rays (GCRs) and Solar Energetic Particles SEPs) also produce radiational tracking and can generate rare isotopic species through spallation, as previously explained, with solar flares. They do not, however, implant ions into the surface grains due to their high energies.

The damage and changes made by the solar winds, solar flares and cosmic rays to the lunar soil grains may seem minor to the informal observer. However, it is a significant factor in lunar weathering and needs to be studied for a better understanding of the forces affecting our Moon's surface. It is a point of interest that the process of lunar weathering, such as sputtering, also contributes to the Moon's exosphere, but that is a story for another day.

A visible side-effect of continuing space weathering is the slow darkening and reddening of the regolith. As an impact strikes the lunar surface, the underlying lighter-colored regolith, which has not been darkened through weathering exposure, is ejected outward, forming the lighter ejecta rays overtop the weathered, darker regolith. Eventually, the impacts that produced the spectacular bright ejecta rays of the craters Kepler and Tycho will darken through weathering and blend into the surrounding regolith, as have the rays of older crater ejecta.

9. Regolith Mineral Composition

There have been about 100 minerals identified on the Moon, in comparison to Earth, where approximately 2,000 have been identified (Rickman & Street, 2008). In general, the major mineral compo-sition of regolith is of plagioclase feldspar, clino-pyroxene, orthopyroxene, and olivine (Schrader 2010). However, there are noteworthy additional minerals in most regolith samples. It appears that the major differences in mineral make-up lie within the two distinct lunar topographic forms, the highlands and the maria.

The major mineral composition of the lunar regolith generally holds throughout the surface. However, the regolith found in the highlands is additionally rich in aluminum and silica and poor in iron, as are the highland rocks. In contrast, the regolith covering the maria is rich in iron and magnesium and is silica-poor because of the basaltic rock (from lava flow) from which the regolith covering the maria was formed. The mineral differences between the highlands and maria seemed to have been maintained over billions of years with a relatively small amount of lateral mixing (mixing from one surface area to another). Spudis believes up to 95% of all material in the regolith is locally derived and that usually this percent is upheld within a few kilometers of any one sample (1996). McKay, et al., also concludes that the general mineral composition of any given distinct sample of regolith reflects the composition of the bedrock underneath (1991e; Taylor, 1982g).

There is some mutual mixing from the maria basalt layers and highland locations. This mixing is especially true within the sloping plains that lie between areas of the maria and highlands. Nevertheless, it is not enough to suppress the basic regolith differences between the two distinct topographies. The mixing that has taken place seems more contingent from highland impact ejecta being transported to the maria than the reverse (Li & Mustard, 2005).

Nonetheless, due to repeated meteoritic impacts and the possible contiguous traveling lateral spread of ejecta radii from one location to another, especially impacts such as Copernicus or Tycho, any given sample of regolith may reveal mixed-in material from anywhere on the Moon.

10. Regolith Depth

Regolith depth anywhere on the Moon has to do with the results of crater formation. The oldest surfaces in the solar system including that of our Moon are characterized by a topographical condition called maximal cratering density. This means that one cannot increase the density of craters because there are so many craters that, on average, any new crater is formed over the top of existing craters by obliterating all or part of older craters, leaving the total number visible for a realistic density count unchanged. Some regions of the Moon, especially the highland regions, exhibit nearly maximal cratering density.

In contrast, the original lunar crustal formations of the maria regions were struck with colossal impacts followed by extensive lava emplacement, which destroyed the original crustal formation and any accumulated regolith. The regolith blanket that covers the ancient highland regions, where maximal cratering density has been maintained, would logically be thicker than that covering the lava-emplaced maria.

However, the average depth or thickness of the regolith in both the highland and maria regions varies widely, as has been confirmed by research. The average measurements seem to range from approximately 1 to 5 meters thick over the maria to an average of 10 to 15, even up to 20 meters or more in some highland regions. This reflects the true inconsistencies in the regolith depths from one discrete location to another. It seems to have been difficult to determine exact measurements of regolith depth over a few or several kilometers in a given discrete area in both the highlands and maria.

However, regolith depths are continuously being confirmed by research. One such research technique is called equilibrium diameter depth measurements. A key to this type of regolith measurement is hypothesized from crater counts using the solar incidence angle of the crater image(s) with crater counts determined by sun angles, which helps reveal craters with diminutive features, as proposed by Young and most recently by Wilcox and Ostrach (Young, 1975; Wilcox, et al., 2005; Ostrach et al., 2011).

The equilibrium diameter is a measured discrete topographical area where the function of crater mechanics has created a steady state between the formation of new craters and the removal of old craters. The total number of craters visible for a realistic density count seems to remain unchanged, as with the function of maximal cratering density, keeping in mind that the presently visible craters are less than the total number of craters that existed in the given area at any one time.

Two major mechanics are in action to create this steady state. First, craters start as voids in the lunar surface, and as they age their protruding rims erode and their interiors slowly fill in with regolith, making them almost indistinguishable from the surrounding landscape. Secondly, a number of aging craters become even less visible when the lunar surface is impacted and a new crater is formed, obliterating all or most signs of the old crater(s) within the impact zone. Hence, the topographical area in which the total number of craters that can be identified on a discrete lunar surface area remains the same, but is less than the number that was actually there at any one time is the equilibrium diameter.

The result of such mechanics in turn has significant implications for inferred regolith depth. Measured regolith depths increase with the size of an equilibrium diameter. In other words, when new craters, which produce additional surface pulverization, are consistently formed over and near old craters in an increasing proportion, the regolith grows in depth. It would be obvious to the observer that the depth of the regolith, especially in the highlands, could not have been produced by the existing visible craters alone.

There are exceptions and extremes in regolith depths. In one lunar location, the Taurus -Littrow Valley on the southeastern edge of Mare Serenitatis, extreme depth variations have been detected ranging from 6.2 to 36.9 meters (Taylor, 1982h) In a few exceptional instances, regolith has not accumulated to any significant degree or not at all on some inclines along crater walls or on sheer rocky outcrops. **RB**

Look for Part 3, in our next issue, MMM #252, February 2012

Lunar Development in the 21st Century
The “Planet Moon Project”

By David Schrunk

The spectacular advances of science, engineering, and the humanities in the 20th century established the basis for creating permanent human settlements in space in the 21st century. Since the Moon is our closest celestial neighbor and is in orbit around the Earth, it will logically be the next principal focus of human exploration and settlement. The Moon is an unparalleled platform for astronomy and other scientific investigations, and for technological development. It also has access to the virtually unlimited energy and material resources of space, which can be applied to the global exploration and expansion of the Moon. Excess solar-electric power that is generated on the Moon can potentially supply the Earth with all of its future needs for clean, low-cost energy. These opportunities, combined with the universal desire of humanity to explore and settle new lands, assure that the global transformation of the Moon into an inhabited sister planet of the Earth will become a reality in this century.

A major impediment to the exploration of space is the high cost of delivering cargoes from the surface of the Earth into space. For example, the cost of launching a payload into low earth orbit by the Space Shuttle is approximately $10,000 per pound, and that figure will be an order of magnitude higher for missions to the Moon. Thus it appears that even limited lunar projects will be prohibitively expensive, even with the design of an improved lunar transportation system. However, there are three emerging technologies that may delimit the cost of lunar industrial and scientific activities.

First, new generations of more cost-efficient, less complex launch vehicles will become available for space missions in the decades ahead. **Second**, advances in micro-device technology and the miniaturization of complex optoelectromechanical systems toward the nanotechnology regime will mean that increasingly smaller, yet more capable payloads can be delivered to the Moon. **Third**, and most important, methods will be developed for using lunar resources to manufacture everything that is needed on the Moon itself, rather than shipping goods from the Earth. This process of “in-situ resource utilization,” or ISRU, will herald the most dramatic reduction in the cost of lunar projects. **Finally**, global economic reces-sion, climate change, overpopulation, and excessive exploitation of Earth’s resources, may motivate humanity to utilize more space resources and to benefit from offworld enterprise.

Industrial processes on our home planet use energy, raw materials, labor, and machines to manufacture sophisticated products such as computers, medical imaging devices, launch vehicles, and communication satellites. Within the next two decades, it will become possible to use lunar regolith (Moon dirt) as feedstock to manufacture equally sophisticated products (such as wires, pipes, machined lunar rocks, and bricks) in lunar factories. Few of the processes or tools for doing so yet exist in a mature form - they will have to be developed from existing technologies as we go, essentially “bootstrapping” from small caches of Earth-manufactured machine tools, communications devices, and other portions of payloads yet to be defined. Once these technologies and innovations beyond Earth have been developed for lunar purposes, they will have ubiquitous applications in outer space on asteroids, planets, and moons throughout the solar system.

The Moon has a reliable source of energy in the form of sunlight, and the lunar regolith contains abundant supplies of iron, silicon, aluminum, and oxygen. The regolith also contains helium-3, an isotope that holds promise as the ideal fuel for future fusion reactors, and traces of other light elements such as carbon. In addition, the past *Clementine* and *Lunar Prospector* satellite missions detected and mapped increased hydrogen concentrations in the north and south polar regions, suggesting the presence of water-ice in these areas. Scientific data will be gleaned from these lunar materials and resources, and they will then become the feedstock for manufacturing processes and other lunar base activities.

Thus a significant reduction in the cost of space projects can be achieved by simply transporting the basic components of Earth's industrial base, such as mining and processing equipment, lathes, drills, ovens, robots, and electro-mechanical control devices, to the Moon. The *lunar* industrial base will then use solar energy and indigenous materials to manufacture the tools and products that are needed to begin the global transformation of the Moon into an inhabited planet. Through many iterations using a "learn as you go" approach, increasingly sophisticated tools and products will be manufactured on the Moon. By this means, the costs associated with transporting materials from the Earth to the Moon will be reduced drastically, and large-scale, economically viable space projects will become a reality. The process will also begin the development of a twin-planet economy between Earth and its sister Moon.

Initially, the "labor" component of lunar Industrial processes will be performed by teleoperated and autonomous robotic devices that have been delivered to the Moon. Tele-operation is the process by which remotely located devices are controlled using visual and haptic feedback systems. It is widely used on the Earth for diverse applications such as mining, undersea projects, and even certain surgical procedures (telemedicine). It is fortuitous that the Moon always has the same face directed to the Earth and that the round-trip time for communications between the Earth and the Moon is less than three seconds. Telemedicine is another application of such communications technologies, so that medical treatment and procedure that originate on Earth can be applied to lunar dwellers. These conditions will allow Earth-bound operators of lunar tele-robotic devices to have a virtual presence on the Moon 24 hours per day, 365 days per year. Robots will become vital surgical helpers.

The site for the first unmanned base will likely be on the Earth-facing side of the south polar region of the Moon. There are several promising sites in the south polar region that always have the Earth in view for continuous telecommunications, and that receive over 300 days of sunlight per year for the generation of solar electric power. A south polar base will have access to increased concentrations of hydrogen (possibly water-ice) that will be useful for industrial operations and eventual human habitation. The tall peaks and deep depressions of this region also offer the opportunity for the placement of long line-of-sight telecommunication links and power beaming facilities.

Many countries currently have rocket launch systems that can be modified to place payloads on the Moon. In one scenario for the establishment of a lunar base, one or more of these rocket systems will be used to transport solar panels, communication systems, scientific equipment, and other payloads from the Earth to the south polar region of the Moon. When these components are in place, tele-operated rover vehicles will explore the lunar surface and transmit data back to Earth for analysis. Protocols for the preservation of unique features of the lunar environment will be observed, and scientific data will be obtained before local materials are utilized for experiments. When surveys and analyses have been completed, the rovers will then assist with experiments in the production of bricks, wires, transistors, and glass products from lunar regolith materials. These pioneering activities will be ongoing 24 hours per day, and there will be opportunities for direct participation by virtually anyone on Earth via the internet.

Since abundant, reliable electrical power is the key to any large-scale development, priority will be given to the fabrication of solar cells from lunar materials. The generation of electric power on the Moon from the first lunar-made solar photovoltaic cell will be a milestone in space exploration because it will prove unequivocally that human enterprises can be self-supporting in space. From that beginning, lunar-made solar cells will be added to the electric power system of the lunar base. As electric power levels then grow, additional scientific and manufacturing equipment will be delivered from the Earth, and the lunar base will expand in all of its capacities.

Within a decade after the first unmanned base has been established, humans will return to the Moon on short-duration missions (60-90 days) to service and maintain complex machinery and to supervise operations. Initially they will live and work in lunar lander spacecraft evolved from present-era technology. During the build-up of the first lunar base, controlled ecological life support systems (CELSS) will undergo continued research and development on Earth and on the International Space Station. Work will also commence with the development of reusable rocket systems that can ferry people between the Earth and the Moon. When a reliable lunar electric power system is in place and pressurized underground habitats (for protection from radiation, temperature extremes, micrometeorites, and lunar dust) have been constructed, regenerative life support systems and agricultural modules will be delivered to the lunar base. Humans will then return to the Moon for longer periods, and all aspects of lunar base activities will be expanded until the lunar industrialization and settlement is sufficiently mature, to enable further planning for human missions to Mars and its moons.

In this same time frame, the solar-electric power system will be expanded in east and west directions from the lunar base to create a circumferential electric grid. The advantage of a solar powered electric grid that is placed around the circumference of the Moon is that 50% of the solar panels will always be in sunlight, thus delivering continuous electric power to the grid. Energy in the grid can be transferred from the sunlit side of the Moon to the dark side (and eventually into the interior) so that consumers - new arrivals - can simply “plug and play” into an extant electric power system.

The construction of the lunar power system will give rise to the need for an efficient surface logistic system that can deliver tools and building materials between manufacturing facilities and construction sites without disturbing the cohesive abrasive dust of the lunar surface. To meet these needs, a rail road system is proposed. The "lunar railroad" would be an effective, efficient, and simple (mostly automated) logistic system on the Moon, and it would avoid most of the problems of lunar dust accumulation that plague "off-road" vehicles. Iron rails for the railroad could be made from lunar iron, for example, to construct a simple two-track rail line from the first base to other areas in the south polar region, including the geographic south pole.

A "southern rail line" would greatly expand the ability to carry out exploratory missions and would facilitate the growth of all lunar projects. The challenge of building the circumferential rail system would be similar to the challenge of building the solar-powered electric grid, and both construction projects could thus be undertaken simultaneously. Since communication systems and pipelines for thermal management and the transport of fluids will be needed on the Moon, these infrastructure elements would also be constructed in parallel with the railroad and electric power networks. As the railroad and other infra-structure elements grow and eventually become linked together, the first circumferential utility network, extensive geologic expeditions will be carried out in the south polar region. The lunar industrial base will produce products and scientific instruments, including optical and radio telescopes, that will initially be placed at the south pole and the far side of the Moon, respectively. The rail line and other utilities will be extended northward to the mare / equatorial regions of the Moon, and then to the north pole.

Power levels in the circumferential grid will rise to the multi-megawatt range as construction of the utility infrastructure continues, and experiments will be conducted with the first microwave beaming of electric power from the Moon to the Earth. With continued growth, it will become possible to supply the Earth with terawatt levels (one terawatt = one trillion watts) of clean, low-cost solar electric power. Lunar development will thus contribute to increased living standards on Earth and to the "greening" of

Earth's biosphere through less need and usage of fossil and fission fuels. Revenues from the sale of electric power to Earth, Moon, and cis-lunar markets will support the expansion of the lunar power system and other utilities.

Hundreds of people will then be able to live permanently in each of several large underground habitats and a tourism industry that operates between the Earth and the Moon someday will be established. Given the wide and growing range of lunar activities, a broad cross section of humanity will participate in creative and economic pursuits on the Moon. Sculptors, artisans, athletes, and musicians will join entrepreneurs, technicians, and scientists in the unique conditions of the "Planet Moon" to create a rich, diverse, and desirable cultural environment for people to work, live, and even retire there. The Moon can become a human laboratory for meeting the challenges and hazards of off-world existence. This knowledge, learning, and experience can then be transferred to development of other celestial bodies, beginning with Mars and near-by asteroids. Going offworld enables humanity to fulfill our evolutionary potential through the creation of a new type of being - *spacekind*!

With proper planning and execution, the "Planet Moon Project" will reflect upon our highest aspirations, and provide significant benefits for the people of the Earth. It will emphasize international cooperation and draw upon the expertise of all interested parties, including governments, entrepreneurs, investor-supported commercial enterprises, and non-profit institutions, such as universities and schools. As experience with lunar operations increases, the scientific and industrial capability of the Moon will approach parity with the Earth, perhaps within three to five decades after the founding of the first base. Widely separated, permanent human settlements will be established, and the only cargo that will need to be transported from the Earth will be humans - the scientists, technicians, tourists, and immigrants who will explore, develop, and eventually inhabit the Moon.

When humans permanently inhabit the Moon, they will explore the mountain ranges, mares, craters, and rilles of the Moon, and investigate lava tubes that have been sealed for billions of years. By then the Moon will be our principal platform for making astronomical observations. Thousands of lunar-made telescopes will be placed at regular intervals on the Moon so that objects of interest in the universe, including the Earth and the Sun, may be observed continuously under ideal viewing conditions. People will live and work in extensive underground spaces that have Earth-like living conditions, including luxuriant vegetation and large lakes of water (without poisonous snakes or mosquitoes!). A wide range of research projects will use the unique conditions of the Moon to advance knowledge in such areas as materials science, superconductivity, power beaming, and bioscience.

Advances in existing technologies will accelerate the phased development of the Moon, and it may be expected that new, as-yet-unimagined innovations will greatly enhance our evolution into a space-faring species. A magnetic levitation rail system will provide high-speed access to all areas of the Moon, and abundant supplies of solar electric power will be beamed from the Moon to the Earth and other locations in space by the lunar power system.

Before the end of the 21st century, thousands of spacecraft will be manufactured on the Moon and launched by electromagnetic "mass drivers" to all points of interest in the solar system, and robotic missions from the Moon to nearby stars will be underway. Communication, power, transportation, and life support systems that have been manufactured on the Moon will be launched to Mars and other locations in space in support of the exploration and human settlement of the solar system. Asteroids and "burned out" comets in Earth's orbital vicinity, especially those that pose a threat of collision with the Earth or the Moon, will be moved out of harm's way and mined for their hydrocarbons, water, metals, and other constituents. These resources will then be delivered to the Earth, Moon, or cis-lunar locations as needed. The binary Earth-Moon planetary system will thus draw upon and benefit from the vast capital of space. More important, lunar settlement will challenge us to transform ourselves, extending knowledge, disciplines, and cultures into new dimensions.

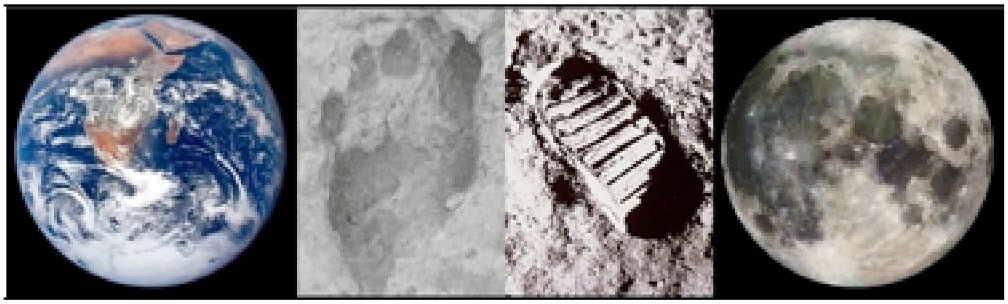
The terraforming of the Moon into an inhabited sister planet of the Earth is an achievable and highly beneficial objective that can be realized in the coming century. The first robotic missions will establish a permanent unmanned lunar base, short-duration human missions will follow, and, with continued experience and growth, permanent human settlements will be established. The "Planet Moon Project" will result in a substantial expansion of scientific knowledge, advance all engineering disciplines, and it will create a higher awareness and appreciation for the Planet Earth, her environment, and ecology. It will provide high quality job and business opportunities, improve living conditions on Earth, and lead to a greatly expanded program of solar system exploration. When the first lunar base is commissioned, the accumulated technological and cultural expertise of humanity will become linked to the virtually limitless energy and material resources of space. The space-faring epoch of human existence will thus be firmly established and the entire solar system will be open to in-depth exploration and human settlement. **DS**

NOTE: "**The Planet Moon Project**" article is part of the introduction to **Phil Harris' book, "Lunar Pioneers**." The article is republished in this issue of MMM with Dr. Schrunk's permission at Phil Harris' suggestion.

Schrunk, a Moon Society member and Advisor, is the author of **The Moon: Resources, Future Development and Settlement,** (co-authors Burton Sharpe, Bonnie Cooper, Madhu Thangavelu) to which we were invited to contribute our own look forward (Appendix T: "Beyond Our First Moonbase" http://www.moonsociety.org/publications/mmm_papers/beyond_moonbase_1.pdf) *We highly recommend this book for your reading, and library.*

Raised in Iowa, the author now lives in the San Diego area. **MMM**

From Africa to the Moon, the Human Epic, told in footprints, Continues to the Stars!



Our Goal is Communities on the Moon involving large scale industrialization and private enterprise.

Objectives of the Moon Society

Our objectives nclude, but are not limited to:

- Creation of a spacefaring civilization, which will establish communities on the Moon involving large-scale industrialization and private enterprise.
- Promotion of interest in the exploration, research, development, and habitation of the Moon, through the media of conferences, the press, library and museum exhibits, and other literary and educational means
- Support, by funding or otherwise, of scholarships, libraries, museums and other means of encouraging the study of the Moon and related technologies
- Stimulation of the advancement and development of applications of space and related technologies and encouragement their entrepreneurial development
- Bringing together persons from government, industry, educational institutions, the press, and other walks of life for the exchange of information about the Moon
- Promoting collaboration between various societies and groups interested in developing and utilizing the Moon.
- Informing the public on matters related to the Moon
- Provision of suitable recognition and honor to indivi-duals and organizations which have contributed to the advancement of the exploration, research, develop-ment, and habitation of the Moon, as well as scientific and technological developments related thereto.

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, 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, competitions & contests, workshops, ground level research and technology experiments, private entrepreneurial ventures, moonbase simulation exercises, tourist centers, and other means.

Interested in having input? Any member may ask to join the Leadership Committee and attend our Management Committee meetings held twice monthly. You may even express opinions. Decisions are often made by consensus, so this input has value. Write president@moonsociety.org

Moon Presentations

By Ken Murphy, Moon Society President

In prior articles I talked about marketing the Moon and arranging presentations about the Moon in your local community. This month, I challenge the members of the Moon Society to make the next step happen: the creation of some basic tools that chapters, outposts and even individual members can use for presentations in their community.

There will be five presentations:

- **Observing the Moon**
- **Science of the Moon**
- **History of the Moon** (cultural history)
- **Where We Are Now** (current knowledge)
- **Grayfields for Commercialization**

Each presentation will be 20 to 30 slides, and will be accompanied by a script that highlights parti-cular points about each slide. Once complete, the presentations will be available for download on our website.

Step one is to **define the outline** for each presentation.

Step two is to **flesh out each slide** based on the outline.

The first step is a guide to make sure we capture the most relevant information. The second to make sure that the information is conveyed in a way that provides maximum impact. The scripts will make sure that the speakers have all of the data to answer most questions.

Some of the presentations will be easy. The **Observing presentation** can draw from the American Lunar Society's **Lunar Observing certificate**,

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

as well as the AL Lunar Observing pins, Chuck Wood's **Lunar 100** (www.skyandtelescope.com/observing/objects/moon/3308811.html), etc. The **Science presentation** can draw from the National Academy of Science paper on The Scientific Context for the Exploration of the Moon. The **History presentation** can cover ancient history through modern probes and the Apollo program.

The **Where We Are Now presentation** is conceived as a state-of-the-art overview, giving the most recent data from probes, and efforts underway to get back to the Moon.

Lastly, the **Grayfields of the Moon presenta-tion** will cover commercialization of the Moon, and ways to make it happen, giving an outline of current commercial and public/private endeavors.

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There are many things to consider in the preparation of each slide and its accompanying script. We can only use publicly available images, as from NASA or those we have specific permission to use. Since these slides will be available for use by the public, we can't be stepping on any copyright toes. The slides have to be simple, yet be able to convey many dimensions of information. They need to look slick and modern, with a Lunar color scheme. They can reference particularly important works, like The Lunar Sourcebook, and notable and authoritative websites, for example the homepages for the different Lunar probes.

Call to Action!

Running the basic numbers, this project will involve the creation of between 100 and 150 slides. This is not something that your president can do alone. All members are called upon to consider how they may contribute their skill sets, and then do so. The greater the division of labor, the easier and faster will the process be.

Each of you joined the Moon Society to help build a human future on the Moon. We can change the dialogue, and help propel the future by taking this information and knowledge to our communities in large and small ways.

- Your local Rotary, Kiwanis and Lions clubs are always looking for speakers.
- Community libraries are always happy to host educational talks.
- Sci Fi cons are invariably looking for some spacey Sci Fact to fill out the program.
- Regional and national space conferences offer opportunities to give a presentation.
- Look into specialty clubs in your area, like the Tall Club, or MENSA, or a Young Professionals Group. The more you look, the more you'll find that people are interested in and want to hear about the Moon.

And that's why these slide presentations are so important as a ready tool to allow anyone in the membership to give a talk about our Moon.

If you want to take part on a particular presentation, please drop a line to:

president@moonsociety.org

Same thing if you want to be on the team for a particular presentation. If you have a specific slide to submit, please do so. There are a myriad of ways to participate, and I want this to be a team effort.

Let's see what we can do! *Ken Murphy*

No MMM Newsletter next month

*Our schedule is 10 issues a year, with a break **in January and July** – the editor's **burnout prevention breaks**, and **time to renew and refresh.***

MMM returns in February with issue #252

Growing Your Chapter by Collaboration

By Peter Kokh

In last month's issue, we talked about the value of starting and maintaining a chapter scrapbook, something my chapter in Milwaukee started 25 years ago but failed to keep up. While we have had many successes over the years, it is time past do to revitalize ourselves, and we need to take another look at the things that worked in the past.

Potential Collaborating Organizations

- **Local science fiction societies** – these multi-faceted groups can help stage public events like conferences. They include artists and writers, people good at public relations and advertising, skilled in producing "fanzines", tying in with vendors, art shows, dealers, etc. I wouldn't dream of putting on a regional or national conference without enlisting their support. They can take care of "Operations" and hospitality suites, and green rooms for speakers, and much more.

  Science-fiction/fantasy artists can help a chapter with its own art needs. Fan conventions are produced by persons who love doing just that and they are eager to help you put on your events.
- **Local astronomy clubs** – We are blessed with four in the metro Milwaukee area. If your chapter has one or more persons who enjoys public speaking, and can address a topic of mutual interest, these clubs are always looking for speakers for their meetings. Even if you do not succeed in getting a new member or two, volunteering to speak will help you polish your presentations. If you put on a conference, these clubs can organize nighttime observing sessions, and show off their equipment.
- **Local geological societies** – these people might be interested in presentations about the very different geology of the Moon, Mars, the asteroids, etc. and about "moondust" aka "regolith." And you just might attract one or more "rock hounds" to join the chapter.
- **Mensa chapters** these are organizations of intellectually gifted persons with an A-Z spread of interests. They will be fascinated by your presentations and some of them may even become intrigued enough to join, or at least pop in on one of your meetings. They may bring talents and connections that could strengthen your chapter.
- **Other local space chapters** – No matter how cozy or strained relations between your National organization and other national space-interest organizations may be, you will find that individual members are largely disinterested in such non-productive politics. You can trade presentations with other local space groups, put on joint exhibits and events, and share talents. In Milwaukee, all space fans are welcome to attend our annual anniversary party and help in our public efforts. Most of us are interested in all things space.

What's at Stake?

- **Gaining members** or associates with talents your chapter needs
- **Increasing your opportunities** for public events, exhibits, workshops, conventions

Continued next page, column A

- **Gaining helpful experience** in all kinds of chapter activities
- **Increase your connections** to the Media and politicians and others
- **Gain chapter friends** willing to trade favors and share assets
- **Tap talents your chapter is lacking** for new or stalled projects

Making the first move

In Milwaukee, our local library maintains a list with contact information about local associations, clubs, and groups with a kaleidoscope of interests. You might have such a Directory of listings in your community as well. You can start by attending a meeting or two of any group, which might have some overlapping interests, objectives, or experience.

If they are looking for speakers – *every group is!* – put out a feeler and pick a topic that has aspects that might appeal to them. I'll bet you a $10 gift card that you will find "something." If your talk is favorably received, and they invite you back, accept that invitation, and invite their members to attend one of your events.

Get acquainted with their movers and shakers and with the talents they have. This could lead to your chapter cosponsoring one of their events, and with their group returning the favor.

Keep a detailed contact directory/address book of each group's leaders, specifying role, and useful talents. Offer to exchange courtesy newsletters and publications. Put them on your mailing list for your chapter's events and efforts.

Undoubtedly, you will find some groups to have less collaboration potential than others. But becoming known to any group can turn out to be an asset someday, when they realize that you have something of value for them.

Study each group's successful ventures for clues about how to improve your chapter's efforts. In other words, become acquainted with your community's amateur talent pool and their activities.

Divide and Conquer

Do not take it upon yourself alone to explore potential local collaborations in your community. See first what connections to other groups other chapter leaders and members maintain, and ask them to do at least a preliminary report for the next meeting. That can lead to group brainstorming of any effort to establish working connections with this group. The more brains exploring the options, the more likely you will come up with a promising "first contact" plan.

And as your chapter is undoubtedly looking for meeting speakers as well, do invite speakers of other clubs to tell your members all about themselves and their activities. This is a two way street. You want them to be as helpful to your chapter as you are hoping to make your chapter to them.

"Undiscovered Country" – to borrow the title of a Star Trek film – is waiting for you to explore it!

Heads-up information about an interesting project in the works

"Lunatics" – an animated web series about Settlement on the Moon

Terry Hancock and Rosalyn Hunter, as **Anansi Spaceworks**, and long-time space advocates, have been working for some time on what will be an **animated web series about settlement on the Moon, called "Lunatics": – http://lunatics.tv**

"Somebody has to be crazy enough to go first!"

"Lunatics is the story of eight people who establish the first permanent human settlement on the Moon. Politics are inevitable, physics is implacable, and the colonists are indomitable fanatics (who else would do it?)"

"We are in the pre-production phase for a pilot episode, titled "No Children in Space", and we are currently starting a crowd-funding campaign using the "Kickstarter" service:

http://www.kickstarter.com/projects/2144275086/lunatics-web-series-characters-and-pre-production

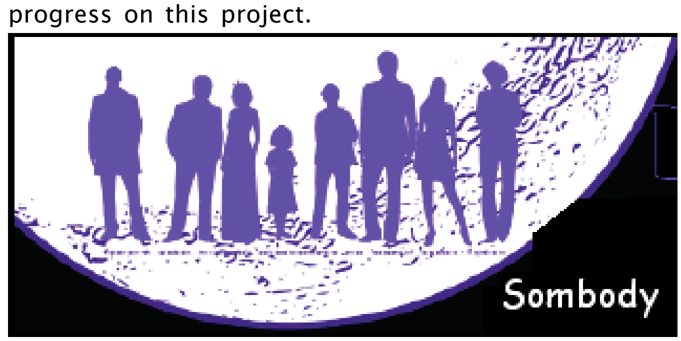
"Come check it out -- promote space development; support new media free culture artists; and get cool stuff in the process!

"This "Phase I" Kickstart is primarily about funding a commission for character design work, as well as technical design we need to get to the production phase. We'll be producing a design book and writers' guide (sort of a "Lunatics Technical Manual" if you will as well as a "Lunatics Character Guide" and "Lunatics Writers' Guide") -- you can get a print or electronic copy of this content by supporting the Kickstart.

"We would certainly appreciate your passing the information on to anyone interested in lunar settlement and space development. :-)

Cheers, Terry Hancock
digitante@gmail.com

http://lunatics.tv/ includes a Video, news, FAQs, and much more for those who want to keep abreast of progress on this project.



Chapters & Outposts

November Reports

Moon Society St. Louis Chapter

http://www.moonsociety.org/chapters/stlouis/

Contact: Robert Perry surfer_bob@charter.net

Meetings 3rd Wed monthly at Buder Branch Library
4401 S. Hampton, in the basement conference room

Next meetings – Dec 21st, Jan 18th, Feb 15th

The St. Louis chapter of the Moon Society had its regular meeting on Wednesday, November 16th. Karl Strassman, Tom Kulhman, Dave Dietzler, Keith Wetzel, Jim Merriman, Mark Rode, and Bob Perry attending. Dabney Tolson provided some of the DVDs from his collection. Karl played the DVDs on his laptop and Mark showed them with his projector. We watched three of the documentaries provided by Dabne from the "NASA Collection Vol.2" DVD set: "Jupiter Odyssey" (Pioneer 10 & 11), "The Planet Mars", and "A New Look at the Old Moon": only a few features from the multi pack. We may see more of these at a future date.

"Jupiter Odyssey" included appearances by Dr. Carl Sagan (the famous plaque), Dr. J. A. Van Allen (yes, that Van Alllen), Dr. J. D. Anderson (principal investigator for Celestial Mechanics), Dr. Kilgore (U. of Arizona Center for Data Enhancement), and Charles Hall (Pioneer Project Director). One notable sequence in the documentary about early Mar probes included the photo cut and paste assembly of a man-sized Mars globe. The documentary about the Moon got us wondering when the "big smack" theory of the moon's formation was proposed – it was after the isotope ratios of the Apollo moon rocks indicated that the Earth and Moon had to have formed in the same part of the original solar nebula. That theory has now been extend to a second, smaller moon that crashed into the Moon in such a way that the large craters and lava plains dominate one side and the highland the other.

Before we adjourned, Bob mentioned that he met people from "ArchReactor" at Archon and has gone to several of their "open meetings". They are "hackers" in the good sense, sharing software and hardware, including a MakerBot, a RepRap Mendel, a laser cutter, and a CNC router. Indeed, the future is getting here faster.– Report by Bob Perrry

Moon Society Phoenix Chapter

http://www.msphx.org

Contacts: Craig Porter portercd@msn.com

Meeting the **3rd Saturdays of the month**
At **Denny's**, 4403 South Rural Road, Tempe

NEXT: Dec 21st, Jan 21st, Feb 19th

Our monthly meeting Saturday 11/19/11 at 3:00 pm.
1) The Space Forum that was discussed a couple of months ago for our area was never off the ground, too short of a notice for proper planning and publicity.
2) We were asked to fund a Rocket Shoot for the youngsters at LepreCon on April. We are considering it but we want more information on the "Shoot", like location, equipment, safety precautions and some background on the person leading the "Shoot".

I e-mailed a request to the person in question with request for answers but have not yet received an answer. We have enough time before the event.
3) We discussed the News Report that the IEEE had suggested that NASA should be eliminated. And it appears that one of the proponents for this is a Professor at ASU and one of our members knows him and may be able to invite him to speak next meeting.
4) We are attempting to update our table display to gain the attention of Conventiongoers to stop, look and ask questions about us and the Moon. We may add one or more dioramas, add some equipment models, and other items as the become available.
5) We apparently will have one or more panels for the Convention in April, more on them later.
6) Chapter Elections are next month. Be thinking about who you want to have each office. Bring your nominations and be ready to participate in the process.
7) Eight members and one guest wew – Craig Porter

Clear Lake NSS/Moon Society Chapter (Houston)

http://www.moonsociety.org/chapters/houston/

Contact: Eric Bowen eric@streamlinerschedules.com

The Clear Lake Area NSS/Moon Society chapter next regular meetings is set for **Mondays, Jan** (date TBD) **at 7:00 pm** in the conference room of the Bay Area Community Center at Clear Lake Park. – Eric.

Chapters & Outposts Map (North America)

www.moonsociety.org/chapters/chapter_outpost_map.html

Chapters & Outposts Events Page

www.moonsociety.org/chapters/chapter_events.html

===== Moon Society Outposts =====

Bay Area Moon Society, CA Outpost – South Frisco Bay
http://www.moonsociety.org/chapters/bams/
Contact: Henry Cates hcate2@pacbell.net
Meeting the 1st Tuesday of the Month at Henry's home

Moon Society Nashville Outpost – Central Tennessee
Contact: Chuck Schlemm cschlemm@comcast.net

Moon Society Knoxville Outpost
Contact: Jason Tuttle tuttlepc@gmail.com

Rockford, IL Outpost
Contact: Bryce Johnson lesausl@sbcglobal.net

Moon Society Milwaukee Outpost (MSMO)
www.moonsociety.org/chapters/milwaukee/msmo_output.htm
Contact: Peter Kokh kokhmmm@aol.com

Moon Society DUES with *Moon Miners' Manifesto*
Electronic MMM (pdf) $35 Students/Seniors: $20
Hardcopy MMM: U.S/Canada **$35**, Elsewhere: $60
Join/Renew Online – www.MoonSociety.org/register/

Moon Society Mail Box Destinations:
Checks, Money Orders, Membership Questions
Moon Society Membership Services:
PO Box 940825, Plano, TX 75094-0825, USA

Projects, Chapters, Volunteers, and Information
Moon Society President's Office,
5015 Addison Circle #420, Addison, TX 75001
Moon Society Publications – Chapters Co-ordinator
PO Box 395, Milwaukee, WI 53208

GREAT BROWSING

INTERNATIONAL SPACE STATION

http://news.yahoo.com/**china-succeeds-first-space-docking-2-spaceships**-181409074.html

Propellant depots: the fiscally responsible and feasible alternative to SLS http://www.thespacereview.com/article/1955/1

COMMERCIAL SPACE

http://www.cfnews13.com/article/news/2011/november/344110/**Live-your-childhood-dream:-Apply-to-become-an-astronaut**?cid=rss

Virgin Galactic Selects 1st Commercial Astronaut www.spaceref.com/news/viewpr.html?pid=35054

Photos of Spaceport America Terminal Dedication http://www.thespacereview.com/gallery/29 http://www.thespacereview.com/article/1957/1

TECHNOLOGY & ROBOTICS

NASA Solicitation: Development of an On-Orbit Robotic Servicing Capability for Spacecraft www.spaceref.com/news/viewsr.html?pid=38956

MEDICAL ISSUES

NASA-sponsored study describes how microgravity space flight impacts astronauts' eyes and vision www.spaceref.com/news/viewpr.html?pid=35133

ANALOG STATION RESEARCH

https://sites.google.com/site/**internationallunarresearchpark/ilrp-reference-documents**

THE SUN

Five years into STEREO Solar Mission
www.spaceref.com/news/viewpr.html?pid=35056

THE MOON

http://www.physorg.com/news/2011-10-**paul-spudis-sustainable-lunar-base**.html

http://www.space.com/13559-**moon-rocks-magnetic-field-lunar-dynamo**.html

http://www.space.com/61-**inside-earth-s-moon-infographic**.html

http://www.space.com/12030-**moon-photos-nasa-lunar-reconnaissance-orbiter**.html

http://gizmodo.com/5860618/**nasa-has-completed-the-highest+resolution-map-of-the-moon-ever**

http://gizmodo.com/5860561/**now-you-can-download-the-original-lunar-rover-manual**/gallery/1

Will China Claim the Moon? http://www.thespacereview.com/article/1959/1

Two sides of the Moon: here is what's on them http://www.space.com/9859-sides-moon.html

MARS

http://news.discovery.com/space/**mars-feels-suns-wrath**-111026.html

http://news.yahoo.com/**ancient-mars-water-may-flowed-underground**-181409892.html

http://www.marsdaily.com/reports/**Mars_How_Watery_a_World**_999.html

http://www.cosmosmagazine.com/news/5002/**mars-sand-dunes-caught-motion**

http://thecourieronline.co.uk/2011/11/**feigned-mars-trip-a-success/**

http://www.space.com/13689-nasa-**amazing-mars-rover-curiosity-science**.html

If life ever existed on Mars, longest lasting habitats were underground http://www.nasa.gov/mission_pages/MRO/news/mro20111102.html

Mars' moon Phobos formed from massive blast http://www.bbc.co.uk/news/science-environment-11378762

NASA working on Nuclear Mars Rocket http://www.theregister.co.uk/2011/11/15/nasa_nuclear_rocket_report/

JSC To Outline Concepts and Challenges for Future Human Exploration Missions to Mars http://www.bizjournals.com/austin/prnewswire/press_releases/Texas/2011/11/17/DC09174

OTHER PLANETS & MOONS

New information on distant Eris' size and mass www.spaceref.com/news/viewpr.html?pid=35052

Saturn Storm Chronicles http://www.ciclops.org/?js=1

ASTRONOMY

http://blogs.scientificamerican.com/observations/2011/11/17/funds-restored-to-build-the-james-webb-space-telescope/?WT.mc_id=SA_Twitter_mdichristina

ASTROBIOLOGY

http://www.newscientist.com/article/mg21228374.400-**most-common-stars-are-more-lifefriendly-than-thought**.htm

http://www.universetoday.com/90945/**is-there-a-methane-habitable-zone/**

Can bacteria survive long journeys in space? www.spaceref.com/news/viewsr.html?pid=38624

Astrobiology: a brief introduction http://www.thespacereview.com/article/1967/1

EDUCATION - OUTREACH - MEDIA

Kennedy Space Center Vehicle Assembly Building opens for tours http://www.cfnews13.com/article/news/2011/november/336987/**Tours-give-firsthand-look-where-space-history-was-made**

GREAT VIDEOS

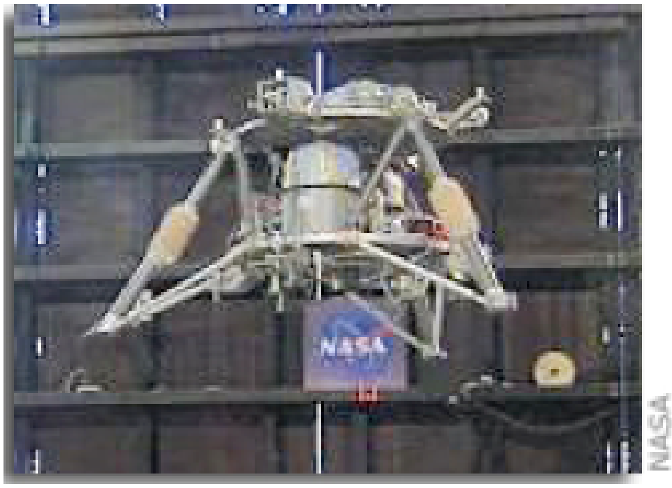
http://science.discovery.com/videos/100-greatest-**discoveries-shorts-the-core-of-the-earth**.html

http://news.discovery.com/videos/**space-top-5-moon-moments**.html

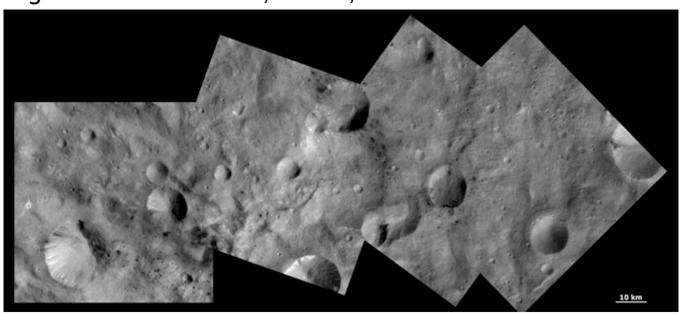
http://www.ndtv.com/video/player/news/**lightning-from-space-amazing-videos-taken-by-astronauts**/216442

Earth from ISS - Expeditions 28 & 29 http://vimeo.com/32001208

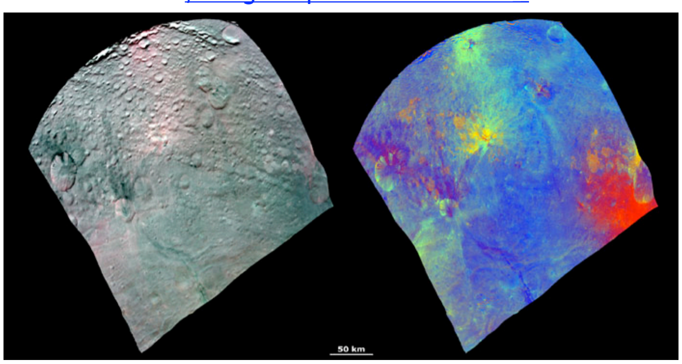
MMM PHOTO GALLERY



NASA conducted a 100-ft robotic lander altitude test flight Nov. 4, to mature technology needed for a new generation of small, smart, versatile robotic landers

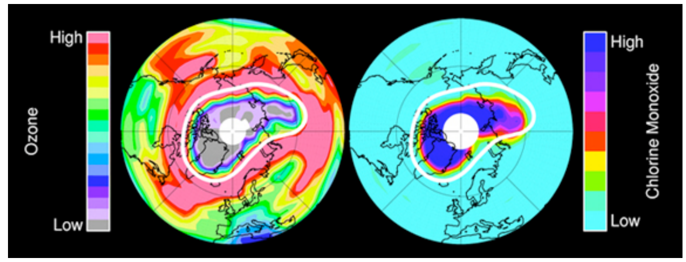


Unusual Craters on Vesta
http://dawn.jpl.nasa.gov/multimedia/imageoftheday/image.asp?date=20111023

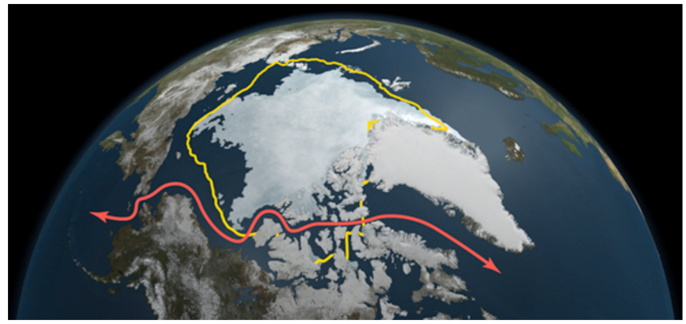


Color composite Views of Vesta
http://dawn.jpl.nasa.gov/multimedia/imageoftheday/image.asp?date=20111025

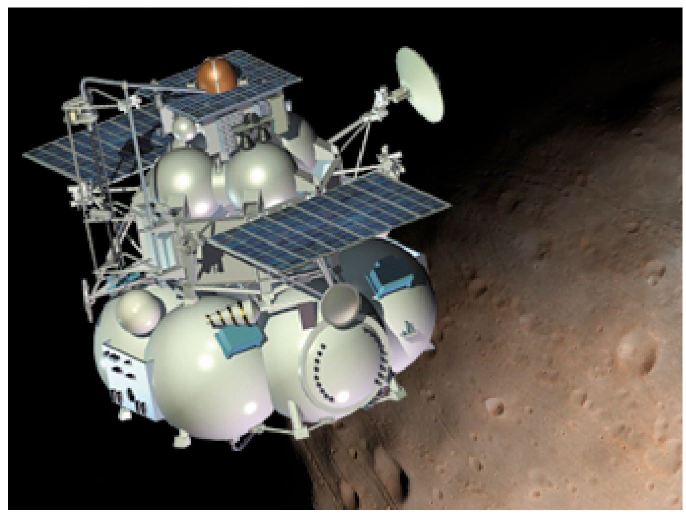
Preview of flight on Mars? Airship sets altitude record
http://www.spaceref.com/news/viewpr.html?pid=3505



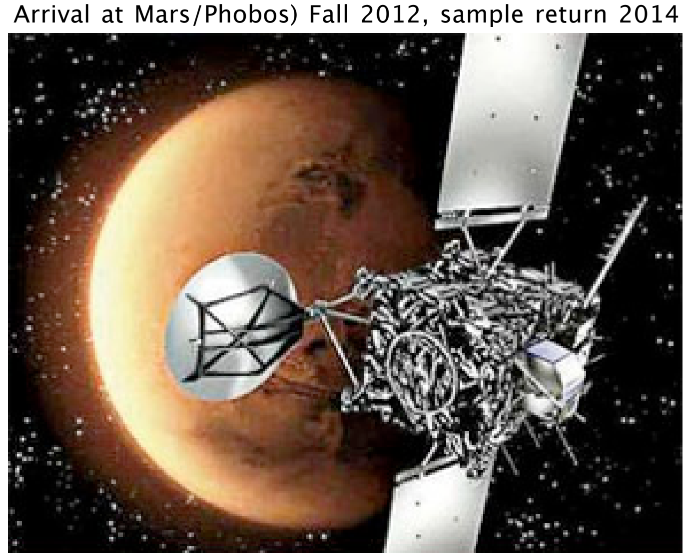
NASA studies unprecedented Arctic Ozone loss
www.spaceref.com/news/viewpr.html?pid=34839

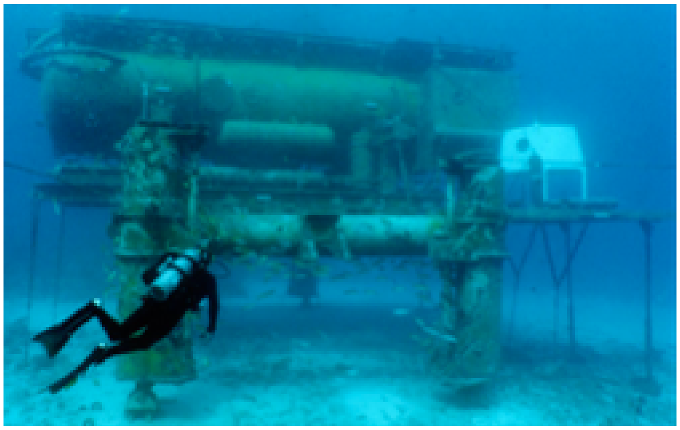


The long sought Northwest Passage between the North Atlantic and the North Pacific is now open (red line)
www.spaceref.com/news/viewpr.html?pid=34853



Russia launched **Phobos-Grunt** to Mars' larger inner moonlet, Phobos, November 9th, with China's Mars atmosphere probe **Yinghuo-1** (below) hitching a ride. Arrival at Mars/Phobos) Fall 2012, sample return 2014





NASA's Asteroid Analog Exercises Conducted on the Sea Bottom

www.nasa.gov/mission_pages/NEEMO/index.html

www.cornellsun.com/section/news/content/2011/10/28/squyres-helps-nasa-prepare-asteroid-exploration

www.ibtimes.com/articles/238725/20111027/nasa-neemo-under-the-sea-aquarius-asteroid-research-space-a

www.spaceref.com/news/viewnews.rss.html?id=1588

Underwater habitats make great analog facilities as models of isolation surrounded in an environment that requires humans to wear functional space-type suits that make it possible to breath. In this respect, they are better analogs than surface desert structures. NASA's asteroid analog mission are held aboard the Aquarius undersea laboratory off Key Largo, FL. NEEMO = NASA Extreme Environment Mission Operations.

The four-member international crew, included astronauts Shannon Walker, of NASA, David Saint-Jacques, of Canada, and Takuya Onishi, of Japan, as well as Steve Squyres, the Cornell University planetary geologist who serves as principal investigator for the Mars Exploration Rovers *Spirit* and *Opportunity.*

They entered the lab October 20th for a 13-day exercise to address a range of issues facing a human mission to an asteroid. During the 5 days prior to their forced evacuation by a threatening hurricane, they carried out 6 undersea "spacewalks," a day of internal science research and four days of work with deep water submersibles in the role of Space Exploration Vehicles hovering hover over the surface of an asteroid. This year's interrupted activities won't be rescheduled. The next NEEMO exercise is set for summer 2012. **MMM**

ONWARD UPWARD
ISDC 2012
WASHINGTON D.C. MAY 24 - 28, 2012

International Space Development Conf. (ISDC) 2012

May 24-28, 2012 Washington, DC

Th-M, Memorial Day Weekend

Grand Hyatt Washington

1000 H Street NW,

Washington, D.C., USA 20001

Tel: +1 202 582 1234 Fax: +1 202 637 4781

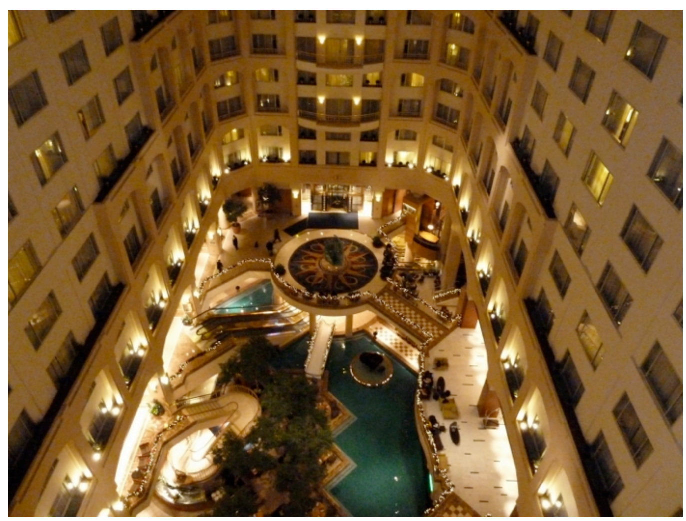
http://grandwashington.hyatt.com/hyatt/hotels/index.jsp?null

Registration form and rates:

https://www.nss.org/cgi-bin/register/tdregister?$Origin=ISDC12

Note: we could find no information on special ISDC hotel rates, nor information on tracks, programs, or presenters. Stay tuned.

Meanwhile ***circle the dates and keep them open.***



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ISDC 2013 will be in San Diego, CA

Previous ISDCs on the West Coast:

- **2006 Los Angeles (with the Planetary Society)**
- **2003 San Jose**
- **1990 Anaheim**
- **1986 Seattle**
- **1984 San Francisco**
- **1982 Los Angeles**

Apollo Metric Camera Maps Completed

From Dr. Terry Fong
Director, Intelligent Robotics Group
NASA Ames Research Center http://irg.arc.nasa.gov

"It gives me great pleasure to announce the release of the "Apollo Zone" Digital Image Mosaic (DIM) and Digital Elevation Model (DEM). These maps cover c. 18% of the Lunar surface at a resolution of 1024 pixels per degree (c. 30 m/pixel). The maps are the result of 3 years of work by the NASA Ames Intelligent Robotics Group (IRG) to align and process more than 4,000 images from the Apollo Metric Camera (AMC), aboard Apollo 15, 16, and 17. The images are from the Apollo Image Archive at Arizona State U. To preview the "Apollo Zone" maps, download the following "KML" file for viewing in Google Earth (http://earth.google.com):

http://byss.ndc.nasa.gov/stereopipeline/dataviz/apollo_metric.kml

Once you open that file in Google Earth you have options to view these "Apollo Zone" maps overlaid on Google Earth's "Moon mode". The full maps (in GeoTIFF format with complete metadata) have also been uploaded to the Lunar Mapping and Modeling Project (LMMP) portal (http://lmmp.nasa.gov) and will soon be available for visualization and download via that site.

The maps cover the following sites of interest: Apollo 15, Apollo 16, Alphonsus Crater, Rima Prinz, Aristarchus Plateau-2, Ina D Caldera, Sulpicius Gallus, Mare Crisium, Mare Smythii, King Crater, Tsiolkovskiy Crater, Aitken Crater, and half of Van de Graaf Crater.

The maps (image, elevation, hillside, color-shade, confidence and precision) were automatically generated with new computer vision algorithms by IRG:

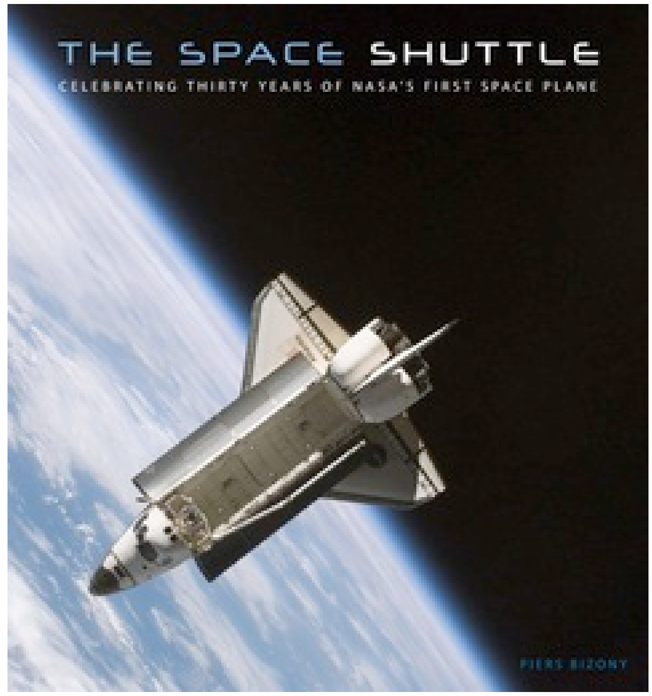
- robust statistical sub-pixel stereo correspondence
- robust bundle adjustment and radiometric corrections for large-scale image mosaics
- orbital camera position/orientation estimation using interest point extraction
- photometric correction of exposure time, shadow removal and generation of seamless large-scale image mosaics.
- photometric method for reconstructing lunar albedo
- photoclinometric terrain reconstruction method that improves lunar DTM precision
- statistical method for multiple stereo digital terrain model mosaicking
- multi-view 3D terrain reconstruction
- DTM / LOLA alignment and lidar / image matching

These algorithms have been released as NASA open-source (Ames Stereo Pipeline, Neo-Geography Toolkit, and NASA Vision Workbench). Map processing was performed with the NASA Pleiades supercomputer. In addition to the Apollo Metric Camera images, the fully automatic map processing pipeline was also used with data from the Lunar Reconnaissance Orbiter Camera (LROC) and several planetary science groups.

This work was funded by the Lunar Mapping and Modeling Project (LMMP). We acknowledge the support of our collaborators at NASA MSFC, NASA GSFC, JPL and USGS. We sincerely thank Mark Robinson and the Apollo Image Archive at ASU for restoring and bringing the AMC data to "digital life".

The above report has been abridged for MMM

THE BOOK WORM



THE SPACE SHUTTLE

Celebrating Thirty Years of NASA's First Space Plane

http://www.qbookshop.com/products/149788/9780760339411/The-Space-Shuttle.htm

http://blog.seattlepi.com/travelforaircraft/2011/11/20/the-space-shuttle-celebrating-thirty-years-of-nasa's-first-space-plane-—-book-review/

[From above review:]

"at first glance would be classified by most as a coffee table book. Full sized and hand sized photos abound, they number in the low hundreds I believe, and span the entire Shuttle program history — but there is so much more, making this so much more than an ooh-aah publication."

"Flying into, as well as out of space, for three decades with only a handful of ships is a technological and logistical accomplishment well beyond what other nations have accomplished."

"There are great scale panoramas for the introductory audience and there are environmental portraits, ones that show a moment in the life with the use of an intuitive angle, for the more sophisticated of readers or aerospace students. The Shuttles are explained in concise text and plentiful images from launch to recovery and readying for the next flight. An appendix is provided which is a roster of all the missions flown and their pertinent facts, including mission highlights — whether they are good ones or bad ones."

"A 3-D cross-section, rendered by Simon Atkinson and Lawrence Seward, is a special bonus. This book is one to get for many libraries (research, school or personal) as well as coffee tables." **MMM**

Lunar Reclamation Society, Inc.

P.O. Box 2102
Milwaukee
WI 53201

www.lunar-reclamation.org

Ad Astra per Ardua Nostra
To the Stars through our own hard work!

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VICE-PRES. Doug Armstrong **NSS** 414-273-1126
SECRETARY – *James Schroeter **NSS**
James_Schroeter@excite.com ...414-333-3679
TREAS./ Database – *Robert Bialecki
bobriverwest@yahoo.com ... 414-372-9613

LRS News

- **We cancelled our planned field trip to the Milwaukee Metropolitan Sewerage District facilities on Jones Island, scheduled for Saturday, September 24th,** because most of us had conflicts for the one Saturday this year that this facility was open for tours.
- **Peter has proposed that we dedicate an upcoming meeting, possibly the January 14th meeting if we have enough attending, to planning an "Event & Outreach Calendar for 2012.** We used to do much more outreach than we have in recent years. Yes, the opportunities arise much less often these days, but maybe we should create them, not wait for them.

LRS Upcoming Events

Next Meetings Saturdays: 1-4 pm

Jan 14th – Feb 11th – Mar 10th

LRS Meeting, Mayfair Mall, Garden Suites Room G110

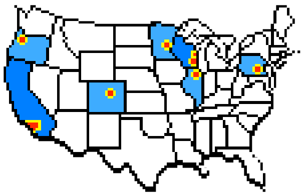
Our annual December Anniversary/Holiday Party – this year #25! - will be on Saturday December 10th :

√ **A PIZZA POTLUCK:** this year everyone is requested to bring **a 12" pizza (non-rising crust, please!)** of whatever variety they wish – we will have at least 2 pizza ovens on hand, along with paper plates, etc. You may bring beverages also, as you like.

√ **New Exhibits:** Peter's wish list includes a lunar settlement interior wall section made of steel studs clad with fiberglass-faced cementboard – painting experiments using simulated moondust of various natural and steam-rusted shades in a sodium silicate medium – a 3-D model of a lava tube; We will be fortunate if even one of these is ready!

√ Take-home materials as usual

√ The Science-Fiction film "**Paul**" if DVD is out. If not, we will show the comedy "**Spaced Out**"



News & Events of NSS "MMM" Chapters

Space Chapter HUB Website:
http://nsschapters.org/hub/

Feature Page: Project Menus Unlimited
http://nsschapters.org/projects.htm

OREGON

Oregon L5 Society
P.O. Box 86, Oregon City, OR 97045
voice mail / (503) 655-6189 – FAX (503)-251-9901
[http://www.OregonL5.org/]

Allen G. Taylor allen.taylor@ieee.org
Bryce Walden moonbase@comcast.net
(LBRT – Oregon Moonbase) moonbase@comcast.net

* **Meetings 3rd Sat. each month at 2 p.m.**
Bourne Plaza, 1441 SE 122nd, Portland, downstairs
NEXT: Jan 14th – Feb 11th – Mar 10th

MINNESOTA

Minnesota Space Frontier Society
c/o Dave Buth 433 South 7th St. #1808
Minneapolis, MN 55415
David Buth (w) (612) 333-1872, (h) (763) 536-1237
Email: info@mnsfs.org – **www.mnsfs.org/**

Congratulations on re-election to these MN SFS board members.

- Ben Huset: Executive Director
- Rich Brown: Asst. Dir. / Web Admin
- David Buth: Secretary
- Becky Huset: Treasurer
- Drew Haggquist: State Councilor

➜ *Not re-elected this year due to continuing terms in office*

- **Craig** Rostal: State Councilor
- Scott Shjefte: State Councilor

ILLINOIS

Chicago Space Frontier L5
610 West 47th Place, Chicago, IL 60609
Larry Ahearn: 773/373-0349 LDAhearn@aol.com

WISCONSIN

Sheboygan Space Society
728 Center St., Kiel WI 54042-1034

c/o Will Foerster 920-894-2376 (h)
Note new email address astrowill@charter.net
SSS Sec. Harald Schenk hschenk@charter.net
>>> DUES: "SSS" c/o B. P. Knier
22608 County Line Rd, Elkhart Lake WI 53020
www.sheboyganspacesociety.org
Note new web address above
This site will be getting a makeover soon
• We meet the 3rd Thurs even # months 7-9pm
At The Stoelting House in Kiel, WI ● February 16th
Our December meeting will a joint holiday event with the Lunar Reclamation Society in Milwaukee 12/10

COLORADO

Denver Space Society
(FKA The Front Range L5 Society)
1 Cherry Hills Farm Drive
Englewood, CO 80113
http://www.angelfire.com/space/frl5/

Eric Boethin 303-781-0800 eric@boethin.com
Monthly Meetings 6:00 PM on 1at Thursdays
Jan 5th , Feb 2nd , Mar 8th
Englewood Public Library, Englewood, CO 80110
1000 Englewood Parkway, First Floor Civic Center

CALIFORNIA

OASIS: Organization for the **A**dvancement of **S**pace **I**ndustrialization and **S**ettlement
Greater Los Angeles Chapter of NSS
P.O. Box 1231, Redondo Beach, CA 90278

Events Hotline/Answering Machine: 310-364-2290
Odyssey Ed: Kat Tanaka odyssey_editor@yahoo.com

http://www.oasis-nss.org/wordpress/
oasis@oasis-nss.org

Odyssey Newsletter Online www.oasis-nss.org/articles.html
Regular Meeting 3 pm 3rd Sat. each month
Next Meetings: Jan 21st - Feb 18th - Mar 17th

Sat Jan 21st 3 pm - OASIS Board Meeting at home of Craig & Karen Ward, 1914 Condon Ave. Redondo Beach

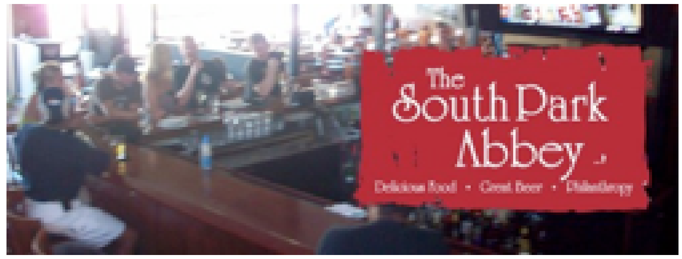
CALIFORNIA

SDSPACE.org

San Diego Space Society
http://sandiegospace.org/
info@sandiegospace.org

Meeting & Events

Tues Dec. 6th **Space Night Out**, 6:30-9 pm South Park Abbey, 1946 Fern St., San Diego
Repeats: Every 1st Tuesday (Jan 3, Feb 7 etc.)
http://sandiegospace.org/?m=20111206&cat=3



Mon Dec. 12th **Officers Meeting** at Space Travelers Emporium 1947 30th St. San Diego
http://sandiegospace.org/?m=20111212&cat=3

Sat Dec 17th **Board Meeting** 1-3 pm
http://sandiegospace.org/?m=20111217&cat=3

Tues Dec 20th **Space Night In**, Space Travelers Emporium, 6:30-9pm
http://sandiegospace.org/?m=20111220&cat=3

"**Always Bite off more than you** (think you) **can chew!** (You may be surprised!!)"

PENNSYLVANIA

NSS Philadelphia Area Space Alliance
928 Clinton Street, Philadelphia, PA 19107

c/o Earl Bennett, Earlisat@verizon.net
856/261-8032 (h), 215/698-2600 (w)
[http://pasa01.tripod.com/]
http://phillypasa.blogspot.com

• **NSS PASA** regular business luncheon/formal meeting 1-3 pm at the Liberty One food court on the second level, 16th and S. Market. Go toward the windows on the 17th street side and go *left*. Look for table sign. Parking at Liberty One on 17th St. Call Earl/Mitch 215-625-0670 to verify all meetings.

The NSS-PASA Report, November 2011

Meeting information: Our next meeting will be at The Liberty Food Court, our usual location, on **December third.** It is time to elect officers again and has become basically a return by acclamation of the present group. We have not set dates in January and February, but we will begin planning for our George Washington Carver Science Fair participation in the next two months.

November activity notes: we attended, and participated in, the 75th Philcon Science Fiction Convention from November 18th to 20th. Two of us, Earl Bennett and Mitch Gordon, were panel members during. Mitch was on" The Future Is Not Going to Slow Down", on the topic of writing about technologic and social change while the rate of both are increasing (and writing stories that are not obsolete before publication!), on Friday night, and "Thinking Like a Futurian", with Mitch moderating, on thinking not like a person writing in the society they live in, but as if the character is a part of the culture being described. This is often a problem: we tend to write about "what we know." Creating a culture that is not based on our standards and outlooks is hard. Sunday event.

Earl was on the panel "The Sky is the Limit: Amateurs and Astronomy". H. Paul Shuch was moderator, and Eric Kotani (who writes fiction as Yogi Kondo) discussed the contributions and joys of doing the avocation. Eric also brought copies of his new book on Interstellar Migration via multi generation star ships. Google him for more. Friday night event. The other panel was" Out of Space: The End of NASA's Manned Space Program". This Saturday panel included several writers on past space achievements, including Mark Wolverton and Frank O'Brien (Space probes and Apollo, respectively) and a psychologist, Tobias Cabral (working on a novel at present). We discussed the possible replacements for the NASA shuttle, and whether NASA will actually be getting out of the direct launch of humans into space. We had a number of really well informed audience members, and particularly George Bunk (a former NASA contractor in Florida, and, founder of a Challenger Center in Northern New Jersey). The road not taken came up here: "what if we had continued on the X Craft path rather than just pouring everything into one path, the Moon, almost exclusively". The short answer is; "Mars".

There were a number of other great panels on a wide range of topics: John Ashmead, a former PASA member, did his talk on Gravity ("Not Your Grand-father's Gravity") on past and recent thoughts on gravitational theory. A major part, for me, was the flurry of activity (probably hundreds of papers by now!) on the first two detections of particles traveling faster than light. Very heady talks at this time! Many other great presentations on alien life, and, space exploration in particular (like Laura Burns presentation on the James Webb Space Telescope).

Thanks to an outstanding effort by Dorothy and Larry we had a "fan table" for public. This was because we had a snafu happen in our responsibility structure, which we will avoid in the future, and Dorothy and Larry fixed the problem. They have volunteered to be our event contact coordinators. Since this is a change from the past, we will talk about how to bring our disparate outreach activities into coordination. Also: Dorothy brought a listing of a number of space related presentations scheduled at the Smithsonian in the next few months: On December! 7th there will be a lecture on "Antarctic Meteorites: Collection, Classification: Curation and Investigation". This requires stand-by tickets, which are free, and starts at 4:30 p.m. This is part of the Stars lecture series that continues during the winter. See the Smithsonian website for more.

I would like to extend our thanks to Philcon, and Margaret Trebing in particular, for inviting us to participate. And Hank Smith for encouraging us to be part of the events. I will limit the other reporting on science and technology to a story in Analog for January and February 2012: "Faster Than A Speeding Photon" by Edward M. Lerner. This is on the possibility of F.T.L. and non-F.T.L. star flight. This reviews some of the earlier science fiction speculation that included creative ways to explain our lack of visitors. The fundamental problem with star flight is that it is *hard.* Dr. Lerner explains the energies involved in the science, as we know it at present (see neutrino talk by Dr Asmead above on his website for new possibilities) and some of the (still energy intensive) recent ideas that may improve the chance of faster travel to distant places (and times?). And much more interesting stuff from the torrential deluge of science and innovation we are living in. Submitted by Earl Bennett.

PhilCon Photo From Miki

Moon Miners' MANIFESTO
Lunar Reclamation Society Inc.
PO Box 2102, Milwaukee WI 53201-2102

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National Space Society
1155 15th Street NW, Suite 500
Washington, DC 20005

Moon Society dues include *Moon Miners' Manifesto*
Electronic MMM (pdf) **$35** Students/Seniors: **$20**
Hardcopy MMM: U.S. & Canada **$35** - Elsewhere: **$60**
The Moon Society
P.O. Box 940825,
Plano, TX 75094-0825, USA

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Send proper dues to address in chapter section

> *For those outside participating chapter areas* <

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• US **$55** Surface Mail Outside North America
Payable to "LRS", PO Box 2102, Milwaukee WI 53201

CHICAGO SPACE FRONTIER L5
• $15 annual dues

LUNAR RECLAMATION SOC. (NSS-Milwaukee)
• $15 low "one rate" > PO Box above

MINNESOTA SPACE FRONTIER SOCIETY
• $25 Regular Dues

OREGON L5 SOCIETY
• $25 for all members

O.A.S.I.S. L5 (Los Angeles)
• $28 regular dues with MMM

PHILADELPHIA AREA SPACE ALLIANCE
• Annual dues for all with MMM $25, due in March or $6 times each quarter before the next March

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SHEBOYGAN SPACE SOCIETY (WI)
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• $1/extra family member
"SSS" c/o B. P. Knier, 22608 County Line Rd,
Elkhart Lake WI 53020