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

Moon Miners' Manifesto

& The Moon Society Journal

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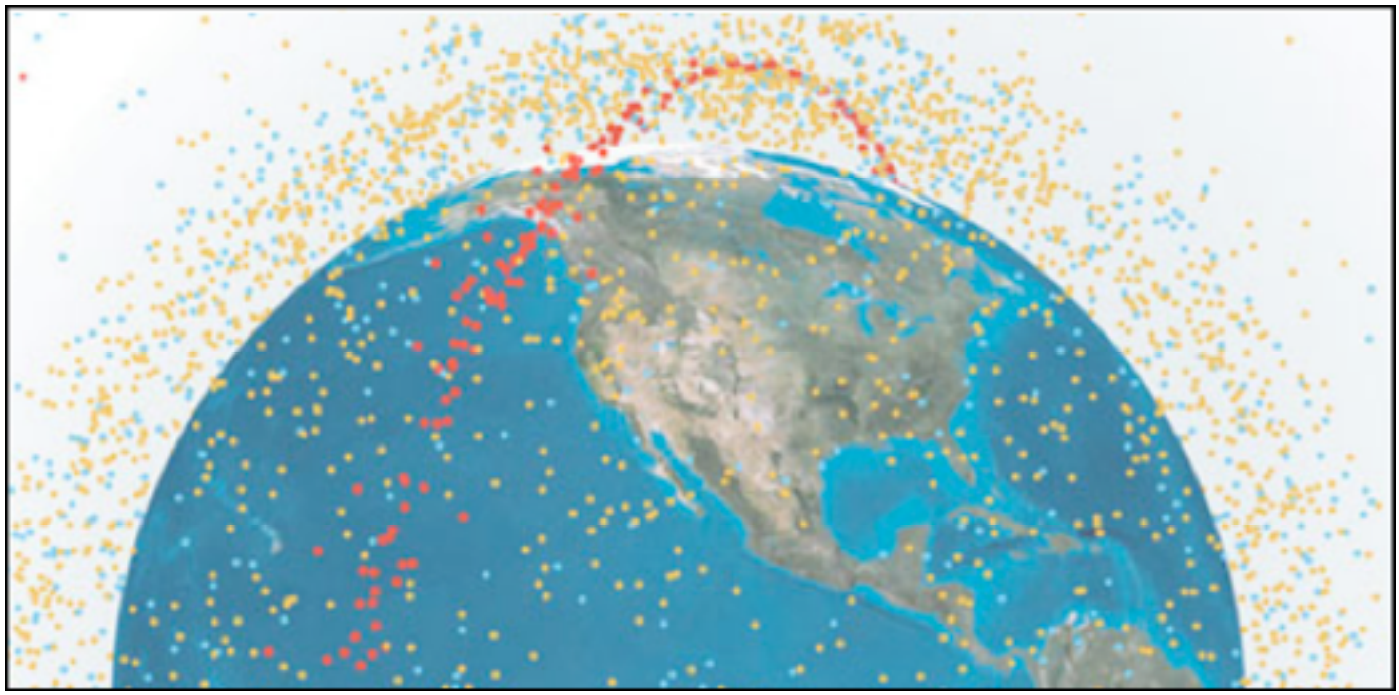


Above: A Cloud of Space Detritus

Feature Articles in This Issue

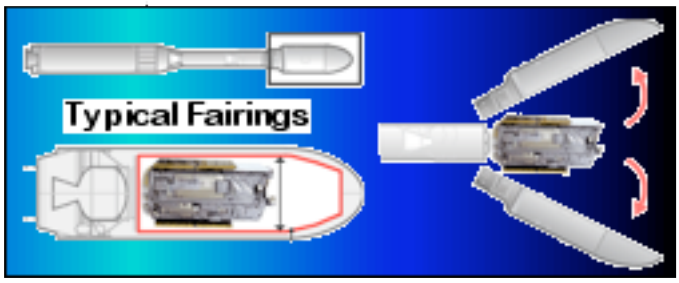
Fairings: one part of the Space Debris Problem

Left: Spacecraft designers have given no attention or consideration to the fate of spacecraft parts needed to put payloads into orbit, but not needed for mission operations. This negligence arises from failure to realize how many satellites would be needed to support Earth observation, weather, and telecommunications needs as well as from ingrained human habits. See pp. 1-2.

IN FOCUS ◎ Space Debris and "The Tragedy of the Commons"

Not quite twenty years ago, in MMM #31, Dec. 1989, we ran an editorial, "**Space Debris: Cleanup and Prevention**." Yes, twenty years ago, the problem we face today, while now much more urgent, was clearly recognized. Then, as now, most talk is about finding ways to cleanup the mess, none at all about ceasing to contribute to it. Changing our dirty habits would be too .... *er, "inconvenient."* Why? That's easy. No space agency or contractor wants to stop doing what is easiest, continue to regard space as a bottomless sink for discarding the no longer useful - It is the "Tragedy of the Commons."

[=> p. 2, col. 2]



Moon Miners' Manifesto

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• **Moon Miners' Manifesto CLASSICS:** The non-time-sensitive articles and editorials of MMM's first eighteen years have been re-edited, re-illustrated, and republished in 15 PDF format volumes, for free downloading from either of two locations:
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• **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 several 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, 1620 I Street NW, Suite 615, Washington, DC 2006; 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.
• **NSS chapter**s and **Other Societies** with a compatible focus are welcome to join the MMM family. For special chapter/group rates, write the Editor, or call (414)-342-0705.
• **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.***

• **Submissions by email** to KokhMMM@aol.com - Email message body text or MS Word, Appleworks, pdf attachments √ Mac compatible CD / or typed hard copy must be mailed to:
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⇒ In Focus Editorial continued from p. 1.

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

If if (i.e. Earth orbital space) belongs to no one, no one will take responsibility for keeping it clean, and, in fact, no one has. "Would've, could've, should've." So we've messed up in a typically adolescent brat kind of way (if the shoe fits ….) There is no point in saying "I/we told you so." What do we do now? There have been put a number of schemes for cleaning up. All of these seem to suffer from significant ignorance of the size and scope of the problem. And most schemes totally ignore the most significant challenge, the velocity at which most pieces of debris are orbiting, not in some synchronized swimming type of way, but helter skelter from all possible vectors.

Cleanup is going to be difficult. No one scheme will tackle more than a portion of the mess. The most practical thing we can do now, while sadly we are still in the talking stage, throwing out wild ideas, is to rank the various schemes in terms of: A) to what percent of the debris is the scheme applicable? B) how much would the scheme cost? And C) How soon could it be implemented?

Meanwhile we could be more productively busy trying to figure out a set of internationally acceptable protocols to prevent adding even more to the current problem. What are we doing wrong? That's easy. We are acting like typical spoiled consumers, wrapping up our packages then ripping the packaging off without taking measures to do anything more than shove the wrapping and packaging detritus to the side.

Many rockets shed their farings at an altitude where atmospheric friction will soon remove them as a problem. But some make it to orbit and are just shoved to the side. We do not know what are the "most common" other sources of debris. But these need to be addressed. From the MMM #31 editorial:

"***We propose that the Moon Society and the National Space Society refine, and strongly advocate the following international conventions to govern future objects bound for low Earth orbits.***

1 Farings and payload shrouds must be so designed to remain attached to the host booster and must incorporate sail-like devices that will automatically deploy to accelerate atmospheric drag on such boosters so that their orbits decay in six months to a year.

2 All payload satellites bound for drag-governed low Earth orbits (below 700 km) and not intended for intact recovery, must be equipped with a "dead-man's drag" folded sail device that will automatically deploy if power is lost, and which can be tele-deployed by ground controllers in other kinds of craft failure.

3 All orbit-bound payloads of a certain threshold size and weight must incorporate an internationally standardized grappling coupling.

4 Any orbiting payload or craft will be declared derelict by an International Board after failure by its launch agency to regain effective ground control within a two month period and if not retrieved or decay-accelerated by its owner or agent within a six month period, will be open to salvage of opportunity by any agent.

Space debris, already orders of magnitude more threatening than the natural micrometeorite, if shunted to the background of concern by apathy, has the potential to quarantine our species on our home planet. If we fail to rise to the challenge, we will deserve that fate.

Against any disease, and that's what space debris is, prevention is the first line of defense." **<PK>**

SELENERGY

Solving Earth's Energy Problems Using Energy and Material From the Moon

By David Caulkins d437@comcast.net

"Make no little plans; they have no magic to stir men's blood" Daniel Burnham, 1893

Abstract

Using lunar resources to solve Earth's energy needs is an attractive idea. This paper explores several ways of accomplishing it:

1) Build Space-Based Solar Power Stations using lunar materials and deploying them in geosynchronous orbits, beaming microwaves to rectennas on Earth.

2) Separating energy-containing metals from lunar regolith, and sending them to Earth via mass drivers; and/or

3) Two more technically challenging ideas:

3.1) Build Lunar Power Stations and beam microwaves to rectennas on or near Earth.

3.2) Use electron beams to transfer energy from lunar generators to Earth.

This paper examines these ideas. It also discusses costs and possible next steps.

Introduction

This paper is far from the first on these topics. A partial list of other sources can be found in Refs 1. to 5.

The basic idea is to set up automated manufacturing facilities on the Moon, and use solar energy and lunar regolith metals to export energy in various forms to Earth.

1) A system for pre-fabricating Solar Power Stations on the Moon, and using mass drivers to send pre-fabricated SPS parts into geosynchronous Earth orbits for assembly. A single kilometer-wide band of geosynchronous Earth orbit experiences enough solar flux in one year to nearly equal the amount of energy contained within all known recoverable conventional oil reserves on Earth today. See Ref 7.

2) Use solar energy and energy-containing materials on the Moon and send them to Earth. The effort and cost would not be small (see 5.0 below), but the long term pay-off could free humanity from dependence on Earth-based energy sources.

3) Two more technically challenging ideas:

3.1) Build Lunar Power Stations and beam microwaves to rectennas (Refs 3. and 7.) on or near Earth.

3.2) Use relativistic electron beams to transfer energy from lunar generators to Earth.

The Moon has several desirable properties:

2.1) The lunar surface has no atmosphere; ambient pressure on the Moon is in the range of 1 E-12 torr (night) to 1 E-10 torr (day).

2.2) The lunar regolith is generally about 4-5 meters thick in mare areas and 10-15 meters in older highland regions. It is typically powdery in nature, and could be easily 'strip mined.' There is a LOT of regolith; more than enough to supply all of Earth's energy needs for many centuries. It contains interesting elements:

Element percentage in lunar regolith blanket

Oxygen 41.7%	Silicon 21.2%	Iron 13.2%
Calcium 7.88%	Aluminum 5.97%*	Magnesium 5.75%
		Other 3.29%

* Aluminum has ~85% as much energy per unit weight as gasoline

Thus 32.8 % of the regolith consists of metals that easily combine with oxygen to release energy.

2.3) The Moon's escape velocity is low; 2.4 km/sec, compared to that from Earth, 11.2 kilometers per second. It takes 22 times less energy to launch material from the Moon to the Earth than it does from the Earth to the Moon.

2.4) A telerobot-operated (see Ref 8.) facility on the Moon could be largely self-replicating, creating more facilities and energy capacity at small cost in terms of moving stuff from the Earth to the Moon. This facility and its products could be used for all of the strategies discussed below.

3) And some undesirable ones:

3.1) It is 239,000 miles (1.25 light-seconds) distant. Current methods for sending stuff there are quite expensive; hundreds of dollars per kg. Something larger than the size and scale of NASA's Apollo missions in the late 60's and 70's would be needed. Hopefully the cost would be lower, since we've had almost 40 years to get farther up the learning curve. See 5) below.

3.2) Use of trajectories from points on the Moon to useful places close to Earth are not simple.

3.3) The Moon's magnetic field is weak; 10 x10^-9 Tesla or less on the near side. The Earth's field is much larger; 30x10^-6 to 60x10^-6 Tesla. Because of this and the absence of atmosphere the incidence of Galactic Cosmic Rays (GCR) is not attenuated as it is on Earth by our magnetic field and atmosphere. Humans would need shelter from GCR for stays of more than a week or so on the lunar surface.

4) Some strategies for generating energy on the Moon and exporting it to Earth:

4.1) 'Strip mine' the Moon regolith, use solar furnaces and electrochemistry (Refs 1., 2., and 9.) to recover the metals. Package these into suitable projectiles, and launch them to Earth using a mass driver (see Ref 10.). Some metal extraction designs have been developed by Peter Schubert and Dave Dietzler (Refs 1. and 2), but more work is needed to make sure these designs are feasible and functional on the Moon.

Use telerobots to build and set up on the lunar surface near a lunar pole the necessary equipment:

4.1.1) Solar electrical panels

4.1.2) Solar furnaces (see Ref 9.)

4.1.3) Projectile makers

4.1.4) Mass drivers

4.1.5) Infrastructure - systems for launching them to Earth.

The process would involve building necessary lunar facilities and then operating them. Moving regolith into the furnaces, forming the projectiles, loading them on the mass drivers, and launching them to Earth using correct launch windows that deal with the problems of 3.2). When the projectiles reach Earth they will possess considerable kinetic energy; ways should be investigated to capture this energy.

Extracting metals from the regolith on an Industrial scale needs a lot more study and development. When the projectiles reach the surface of the Earth the metals can be used as fuel to generate electricity. The combustion products are metallic oxides - no CO2.

What is needed is a 'Manhattan Project' type effort to do some or all of these things. My nominee to head it up would be Burt Rutan (see Ref 11.); he's already built a privately-funded space vehicle.

The next two are more technically challenging, and may not be feasible or cost-effective.

4.2) Build big microwave antennas on the Moon, and beam power to rectennas on Earth or in orbit around it. There are 3.2) type problems. See Ref 3.

4.3) Build big (!) electron guns, and send electricity in the form of beams of electrons from the Moon to collectors on Earth, or in orbits near Earth. [see lunar solar array image left.] The early days of electronics used vacuum tubes - evacuated glass bottles in which beams of electrons could be directed and controlled. The space between the Earth and the Moon is a better vacuum than that in vacuum tubes, so electron beams could be sent from the Moon to the Earth. Beams of negatively-charged electrons will tend to diverge, but this tendency can be opposed by other forces in ~ 5 MeV relativistic electron beams. It is possible that beam-steering stations in orbit between the Moon and the Earth may be needed to refocus and guide the beams. There are 3.2) type problems; it is likely the beams would only be turned on when every-thinglines up and the 'window' is open for successful transmission to Earth. [Ed. 3 relay sats 120° apart solve the problem]

This technology should scale, but the problems of doing so by ~12 orders of magnitude need to be carefully examined.

4.1 (and/or 4.2, 4.3) to be done by telerobots (see Ref 8.) No long term lunar stays by humans, and therefore no long term need for 'man rated' equipment or habitats. If it breaks, fix it, make another, or send up a new one.

5.0) Cost

The Apollo project lasted from 1968 to 1972; total cost was ~ $15x10^9. Increase this by a factor of five to allow for inflation and increased scale; the cost of a Selenergy project could be ~ $75x10^9. This is a modest percentage of various current stimulus packages - $787x10^9 passed by the Congress, the $700x10^9 TARP bank bailout program, and/or the $1x10^10 additional programs Secretary Geithner may need.

6.0) Next steps

All of the processes discussed here need to be built and tested on Earth.

The PISCES project (see Ref 12.) for simulating a Lunar environment is a good start. More work needs to be done on separating metals and other useful material from the lunar regolith.

It is probable that all parts of a lunar manufacturing facility would need to be built and tested on Earth before anything is sent to the Moon. Early work on this was done by Professor Gerard O'Neill in the 70's (Ref 13.)

I participated in a modest way; I did some early studies on the composition of the lunar regolith.

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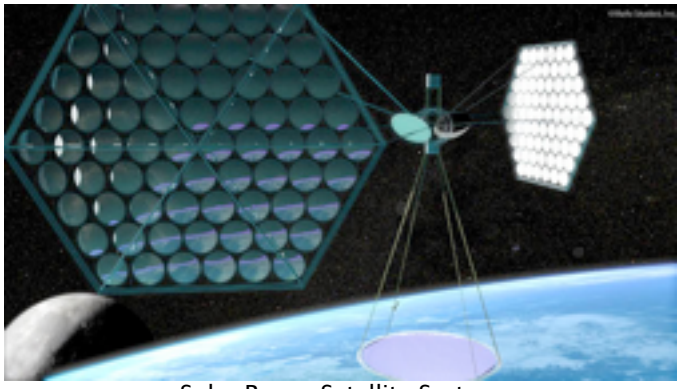
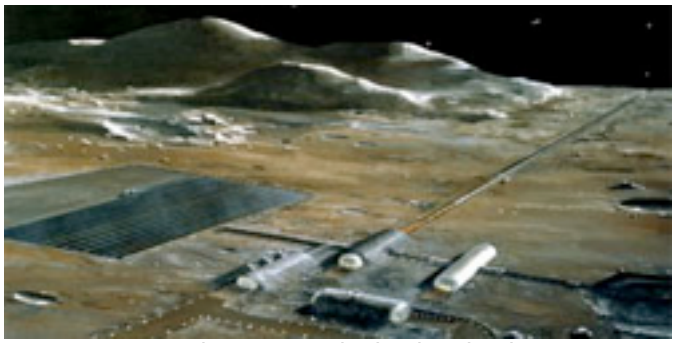
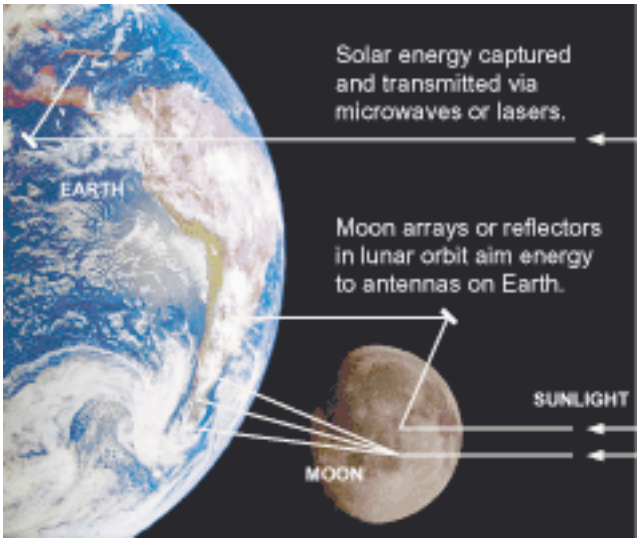
Dave Caulkins is a new Moon Society member, from Los Altos, CA



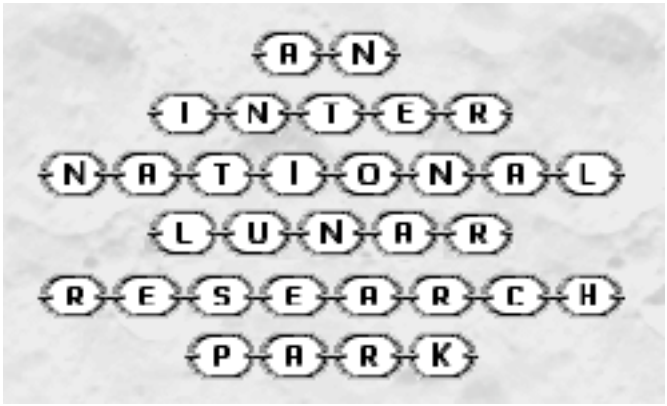
Solar Power Satellite System



Mass Driver above catapults bucket-loads to space



David Criswell's Lunar Solar Power Arrays & Relays



An Open-ended Lunar Initiative v. 2*

By Peter Kokh and David Dietzler

• V.1 published in MMM-India Quarterly (Feb. 2009)

Current Prospects

The United States, under former President George W. Bush, redirected its ISS and Planetary Exploraation-focused Space Program to a "return to the Moon" and "beyond to Mars." This direction will probably continue under President Barack Obama. Meanwhile, China, India, and Japan have launched lunar probes and spoken of putting crews on the Moon. Whether these will be one time "science picnics" å la Apollo or real efforts to establish permanent facilities to support manned exploration sorties and other activities remain to be seen.

The Question

If each nation picks a different location on the Moon for its surface activities, areas of cooperation are limited to data sharing, tracking, and other support activities.

If, however, some or all national lunar outpost efforts are concentrated at one and the same location, be it at the north or south lunar poles or somewhere else, then the opportunities for shared facilities is enormously increased, and with it could come major savings by reducing unnecessary duplications.

Shared Facilities: Corporate Partners

Of course, then the question becomes "who will build and provide the facilities to be shared? And right here we have the opportunity to introduce new parties: contractor companies. Possible contractors could include Boeing, Lockheed-Martin, EADS, Antrim, and other names associated with the Aerospace industry, but also other major contractors. To pick a few: Bechtel, Halliburton, Mitsubishi, and on and on.

Added Players: Enterprise, University Consortia

If we collectively choose to establish not a collection of national outposts, collocated or not, but an "**International Lunar Research Park**" the possibilities for future expansion, elaboration, and outgrowth – *even into the 1st human lunar settlement* – will increase greatly.

Facility Lists

The lists below are meant to show how great are he possibilities for diversification and outgrowth. The items in **bold** will come first. Plain type next, *italics* last. Note, that this subclassification is just one person's first attempt, and corrective input is most welcome. No one expects to "get it right" the first time! What we want to do is to put out the general concept of how enormously the choice of an International Lunar Research Park could bust the future wide open. After the itemized lists (we surely have forgotten or not thought of many items!) we will give our thoughts on just what must come first.

National Outpost "Core" Elements

- **base habitat**
- **base laboratories**
- **basic life support**
- **command center**
- **airlock**

Contractor Corporation Services

- **Site preparation**
- **Spaceport services**
- **Construction equipment**
- **Shielding services**
- **Solar wind gas scavenging**
- **Fuel storage**
- **Fuel production**
- **Power generation**
- **Power storage**
- **Warehousing systems**
- **Thermal management**
- **Waste treatment**
- ISRU Research
- ISRU Manufacturing
- Habitat expansion modules
- Agricultural modules, basic agricultural services
- Biosphere maintenance
- Road construction
- Connector modules

Enterprise Opportunities

- **Commons with meeting space**
- **Restaurant**(s)**, pub**(s)
- **Recreational facilities**: exercise, sports, dance, theater
- **TV/Radio Facilities, satellite communications telephone system, internet provider**
- Instruction, continuing education – keeping up to date with improved lunar systems
- **Financial services**
- **Hotel facilities** for visitors, tourists, overflow between crew changes
- **Cabbotage** (outfitting) services
- **Surface transportation (passenger, freight)**
- **Vehicle maintenance**
- **Space suit services**
- **Tools, equipment**
- Recycling services
- tour coaches & excursion services
- marketplace
- agricultural production, products
- green (horticultural) services
- reassignment services (new roles for scavenged parts of landers etc.)
- agricultural production
- customization services
- event management
- surface recreation vehicles
- archiving services

University Consortia

- **Medical Center**
- Continuing education
- Research facilities
- Astronomy installations

Joint Civic

- **Road planning local**
- **Road planning regional**
- **Environment protection**
- **Environment enhancement**
- **Inter-Sector coordination** (Contractors, Enterprise, National, University)
- Parks, parkways, gardens
- Outstation planning

Discussion – where you come in!

It would be miraculous if the list above did not have many holes, even if nothing was misclassified. Your input is most welcome!

The effort above is an attempt to start a discussion and to keep us, nationals of the various countries contemplating lunar surface activities, from being blindsighted to the enormous advantages to be gained not only by collaboration between the various national agencies, but *by restraining agency hubris and by taking the plunge to invite corporate, enterprise, and university consortia as equal partners in a joint "human" effort.*

The idea is for the national outpost agencies to buy or lease or tent equipment and services from the contractors and enterprises as their needs change and expand. This should provide not only substantial cost savings but a greater variety and supply of equipment and services.

Agencies need not provide quality and other specifications, because corpor-ate and enterprise personnel would be just as much as risk from improperly designed and manufactured equipment as would national agency crews. Toss out the mind-boggling bureaucratic paperwork, and down comes the costs.

Corporation employees would need housing, and all the other life support services as needed by the agency crews so it is natural, that as they begin to construct pressurized modules and other equipment from lunar building materials that they could provide for expansion of national outposts as well at considerable savings.

The national outposts would be "anchor tenants" so to speak, but as in shopping malls, in time their share of the economic value of total activities and facilities at the site might become, even though essential.

Some sort of Civic Council representing all of these Parties would be needed to make decisions that affect every-one, decisions about growth directions, environmental safe-guards, and so on. As this unfolds, the International Lunar Research Park will have become the first lunar settlement!

It is time for humanity to open the next continent, one across a different kind of sea. The "out of Africa" effort is ready for the next act. Only humans as a species, not horse-blindered agency managers, have the vision to grasp what is needed – and it is *not a collection of agency outposts!*

What Comes First?

Frankly, national agency planning puts the cart before the horse. Why? Two things come first, and no one is giving either of them more than trivial attention.

Part I: Developing *now* the Technologies needed for using lunar resources

We are not going to anything of lasting significance on the Moon unless we learn how to process useful building materials out of the elements in moondust. Known by the uppity Latin term *"In Situ"* Resource Utilization *("on location"* works just fine!) various processes have been proposed to isolate oxygen and other elements, but few have been tested either in laboratory scale or (more importantly) in mass production scale. How do we advance the "readiness" state" of these technologies? It is important to have them ready to go when we land on the Moon. Getting there, and then having to scratch our heads for additional time-wasting decades makes no sense. But that is the path we are on.

This topic is the subject of **"Improving the Moon Starts on Earth"** in MMM #s 132,133, Feb/Mar 2000.

Part 2 – Site Development

No site on the Moon, no matter what advantages are touted on its behalf, is anything but "unimproved" land, what in might be called "Florida swampland."

Before the first national agency manned lander sets down on a chosen site, it makes sense for a corporate contractor to have already "improved the site" – conferring on it various advantages that will make outpost deployment, construction, and operation so much easier. Indeed, Carnegie-Mellon University, a contestant for the Google Lunar X-Prize, has just proposed that establishment of the first spaceport be contracted to the university to be done by telerobotics.

www.post-gazette.com/pg/09063/952880-115.stm

This is the subject of the article, **"The Developer's Role"** from Moon Miners' Manifesto #131, December 1999.

Both articles are combined in one Online Paper:

"Improving the Moon & the Developers Role"

www.lunar-reclamation.org/papers/improving_moon_paper.htm

Also relevant, "The Outpost Trap" serialized in MMM #s, 198, 199, 200 September, October, November 2006

www.lunar-reclamation.org/papers/outpost_trap.html

<PK/DD>

Lunar Research & Development Priorities List: 1-5

By David Dietzler – pioneer137@yahoo.com

1a) Space Transportation: cheap access to space – CATS, from inexpensive expendable and/or reusable Earth to LEO launchers to ion drive or sail propelled craft for transport from LEO to LLO, L1, etc.

1b) Lunar derived fuels / propellants for lunar landers after some initial development on the Moon. Ion drives and sails are only good for cargos, not manned craft, given the great length of time they require for travel to LLO and therefore exposure to Van Allen Belt radiation, as well as life support. Thus we also need orbital fuel depot infrastructure. *The cost barrier must be broken.*

2A) Life Support Systems for prolonged (months, even years) human stays in space

2B) AI robotics for the majority of work done in space

3) Production of oxygen, other gases, metals and ceramics from lunar materials (some of this is included in category 1, for the production of rocket propellants on the Moon, given the assumption that lunar derived fuels will be cheaper than boosting them from Earth to LEO,

although this assumption might be challenged depending on how much infrastructure on the Moon and in space would be needed, when it would be needed, how low the cost of launching to LEO goes, and how many manned flights would be called for given that robot power not manpower will do most of the work

Lots of research has been done on Oxygen production and most of it has been done with simulants only on laboratory bench top scales for short periods of time. Much more research must be done with real regolith using equipment that is built to work in vacuum, low G, hard radiation and temperature extremes for extended periods of time-years, not just weeks or months. Understanding the chemistry of regolith refining is just square one. A vast amount of R&D is required to build the equipment that does the work from shovel to final product and to determine which processes will scale up from the lab bench to the industrial level, work reliably for years in the lunar environment, demonstrate the greatest economy in terms of labor, time and energy required; require the least amount of input from Earth (some processes will require chemicals from Earth that must be carefully recycled) and the most amount of "Moon-makability." We will need to replicate this equipment on the Moon from lunar materials to expand production rather than constantly import devices from Earth hench the need for "Moon-makability" otherwise the cost of ISRU will be too high.

Prerequisite to production of lunar materials is energy production. It's going to take a lot of energy to smelt or refine regolith so we will have to land substantial payloads of reflectors, concentrating lenses or mirrors, solar panels, batteries and/or fuel cells and fuel cell reactant storage equipment, cables, switches, invertors and possibly small nuclear reactors. We will need to expand energy production as materials production grows and this takes us to the next category:

4) Lunar manufacturing: what to make and how to make it as well as what to make it from. Once we get past the hurdle of producing gases, metals and ceramics on the Moon we have to figure out how to make more devices for producing them from the gases, metals and ceramics available on the Moon. It won't be much use if the regolith refining devices require large amounts of gold, copper, zinc, flourine or other elements from Earth. We cannot upport huge masses of equipment, even with what passes for "cheap access to space" in the future, because even CATS will still be expensive compared to transportation on Earth. We must upport a seed of regolith refining and manufacturing devices that can replicate itself in order to refine more regolith and produce more materials as well as make things from those materials like solar panels, power storage systems, habitat, farm modules, robots, vehicles, machine tools and mass drivers for launching millions of tons of lunar materials into space for SPS construction.

To grow the mighty tree of space industry on the grand scale envisioned ever since O'Neill wrote "The High Frontier" from a tiny seed amassing perhaps just hundreds of tons will require a lot of brainpower, real world experience, and some sophisticated AI robot software as well as hardware. At this time even the experts can only take shots in the dark as to what that seed will consist of. It's fun to speculate about the payloads this seed might consist of, but only after some extensive R&D on the ground and on the Moon during NASA's RTM program and some high paid teams of mission planners have had years to work on this will we know exactly what the lunar industrial seed will consist of. Because of the high price of even CATS in the future it will be essential to minimize the mass of the lunar Industrial seed machines, maximize the use of local materials, and maximize the lifetime, durability and efficiency of the seed. Also, the seed must be reasonably priced. What good will it be to use a one-ton machine that costs a billion dollars if a ten ton machine can do that job and be transported to the Moon for much less than a billion dollars? In other words, when does miniturization start costing more than rocket transport?

As for nanomachines, I have no doubt that nanotechnology will be involved in lunar industrialization but I don't go as far as suggesting that a few kilograms of nanobots will replicate like a growing algae bloom and lunar colonies will emerge from that. I do not have anything against that scenario, I just don't buy it. I would love to be wrong but I suspect that lunar industrial seed will amass several hundred to several thousand tons and even that will be tiny compared to the millions of tons of lunar industry and SPSs that emerge from that over time.

5) Space construction. We have never built anything as large as a solar power satellite in outer space. What will it take to do this? We can presume that lunar aluminum, silicon and titanium, possibly some steel and glass, will be used but how will billets of metal from the Moon be turned into SPSs? What machines will be needed? How do we get those machines in space? Launch them from Earth or make them on the Moon and launch them from the Moon or will a combination of Earth launched and Moon made/Moon launched machines be used? Will we need a space colony and 10,000 space workers or will we just station a small human crew in space and use thousands of robots teleoperated by humans on Earth and on the Moon?

MAGNESIUM & IRON

Lunar Workhorse Metals

By Dave Dietzler pioneer137@yahoo.com

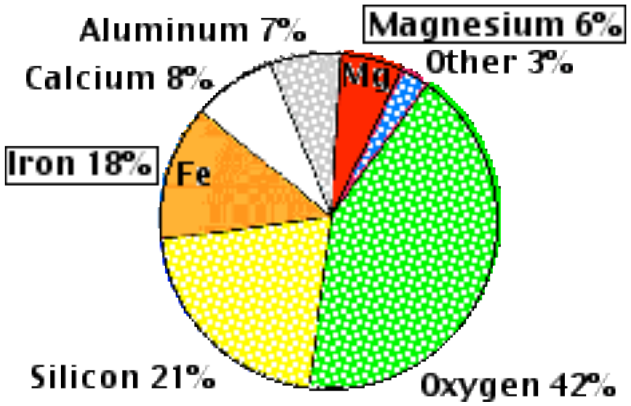
Outside of Convention

The literature contains many descriptions of processes for extracting aluminum and titanium from lunar regolith. Space colonies and solar power satellites have been designed that use these metals primarily. I will not elaborate on the processes for getting aluminum and titanium here. For the curious, see:
www.nss.org/settlement/ColoniesInSpace/colonies_chap07.html
and www.nss.org/settlement/nasa/spaceresvol3/plsoom1.htm

The difficulty with these processes is that they require substances not too common on the Moon like sulfur, hydrogen, sodium, carbon, chlorine, fluorine and/or lithium. There are lunar sources for some of these like troilite, FeS, of meteoric origin for sulfur that is sprinkled throughout the regolith. Hydrogen and carbon can be obtained by mining and roasting millions of tons of regolith. Sodium should be found as an impurity in oxygen from molten silicate electrolysis. Chlorine could be obtained by mining and roasting millions of tons of pyroclastic glass. Fluorine and lithium are especially rare on the Moon. Although aluminum and titanium production will not be impossible, this will be limited by the number of times upported reagents can be recycled and by leakage losses. It will also be limited by the quantity of

reagents that can be produced by mining and roasting huge amounts of regolith and volcanic glass.

Magnesium and iron are two metals that can be obtained on the Moon *with processes that use only substances common and easy to get.*



Relative abundance of Iron & Magnesium in Lunar Crust

Magnesium

This metal might be overlooked because it is somewhat soft and burns; however, in a vacuum it will not burn and in air it is only likely to ignite if powdered or fine parts are being machined. Machining could be done in inert gas filled work chambers. As to its softness, it can be used for applications that don't demand a high degree of hardness and it has a very high strength to weight ratio that makes magnesium at times more desirable than aluminum or steel. Magnesium could be used for jobs that we might conventionally choose to use aluminum like railroad cars, rockets and spacecraft, ground vehicle frames and pressure cabins, and solar reflectors and supports. It is a slightly better reflector than aluminum.

On Earth magnesium is used for many products like auto body parts, wheels, engine parts, gear boxes, and sports equipment, for which light weight is an advantage. Baseball catchers' masks, skis, racecars, and horseshoes are made with magnesium alloys. Consumer goods such as ladders, portable tools, electronic equipment, binoculars, cameras, furniture, and luggage also benefit from magnesium's lightweight, and other applications make use of its ability to absorb vibration. It could be used on the Moon for these as well.

Magnesium can be welded with electric arcs and a helium shield gas. In the vacuum a shield gas won't be needed. Lasers are also good for welding magnesium due to their low heat input. It can also be cast in plaster molds, extruded and hot rolled. Magnesium alloys usually contain zinc, zirconium and aluminum. Zirconium might be hard to produce on the Moon, but some zinc can get obtained from pyroclastic glass and some aluminum should also be available. Rare earth elements from KREEP can also be used to alloy magnesium.

Mg could be extracted by removing magnesium olivine, forsterite (Mg_2SiO_4), from regolith with electrostatic separaters. Magnesium oxide could also be gotten by roasting regolith at 1500 C°+[1]. The olivine or MgO could be reduced with silicon in a flux of lime or calcium aluminate. Silicon or ferrosilicon can be obtained by serial molten silicate electrolysis. Calcium aluminate can be gotten by roasting anorthite or highland regolith at 1500 C.+. This silicothermic reduction process is most popular today and has replaced electrolysis of magnesium chloride for the most part. It is done at a temperature of about 1500 C. in a vacuum. The magnesium boils off and is condensed in the form of masses of metallic crystals. Solar or electric furnaces for this process could be made of cast basalt or glass bricks. Ceramic from magma electrolysis might also be used. The furnaces could be lined with titanium dioxide bricks because of their high melting point. The bricks could fit together like lego blocks and they would be welded tight with microwaves or electron beams.

Iron

Pure iron can be obtained on the Moon bymagnetically harvesting meteoric fines that compose 0.15% to 0.5% of the regolith and are 5% nickel by mass [2]. Iron can also be gotten from serial magma electrolysis. Earthly cast iron is 3.5% carbon and is very brittle. Wrought iron is basically pure iron and these will have similar characteristics. Wrought iron has 40,000 psi tensile strength and 40,000 psi compressive strength. This may not be very high compared to steel and alloys of steel, but it is higher than that of unalloyed aluminum or magnesium. Before blast furnaces and Bessemer convertors wrought iron was the primary structual metal. So lunar pure iron should be respectable.

Rivets, nails, chains, railway couplings, water and steam pipes, nuts, bolts, handrails, roof trusses and ornamental ironwork were once all made of wrought iron. It was also used to make iron plates suitable for boilers. Blackplate consisted of sheets of iron thinner than plate iron [3]. To conserve carbon on the Moon, sheet iron instead of steel could be used to make studs for hanging cement board or drywall for walls inside lunar habitat.

Pure iron might be converted to limited amounts of steel on the Moon by using the old blister steel or cementation process, since blast furnaces and basic oxygen furnaces on the Moon are out of the question. Sheets of iron with carbon sandwiched in between or iron rods packed in carbon can be heated until they are cherry red in furnaces made of stone, cast basalt or ceramic. After several days the iron will absorb enough carbon to become steel. The steel is removed and melted down, perhaps with some calcium aluminate flux to absorb sulfur impurities, then cast and/or rolled. Carbon would come from scavenging of millions of tons of regolith. At the University of Wisconsin a Mark 3 mining robot has been designed. It could produce about 80 tons of carbon a year as well as substantial quantities of hydrogen, nitrogen and helium. Most lunar carbon will be used for biospheres, but if we devoted just 10 tons of carbon to steel production it would be possible to produce 1000 tons of 1% high carbon steel. This steel would be reserved for special applications like nuts and bolts, tools, cutting blades, drill bits, bearings and perhaps mining shovel buckets.

Works Cited

1) Rudolf Keller & David B. Stofesky of EMEC Consultants " Selective Evaporation of Lunar Oxide Components" reported in SPACE MANUFACTURING 10 PATHWAYS TO THE HIGH FRONTIER Proceedings of the Twelfth SSI-Princeton Conference May 4-7, 1995; pg. 130.
2) www.nss.org/settlement/nasa/spaceresvol3/lunarben1b.htm
3) http://en.wikipedia.org/wiki/Wrought_iron

[Editor: also see: MMM #118 SEP. '98 p 8. MAGNESIUM: Workhorse Metal for Europa, P. Kokh, republished in MMM Classic #12] **<D. Dietzler>**

The Moon Society www.moonsociety.org

An international nonprofit 501(c)3 educational and scientific organization formed to further the creation of communities on the Moon involving large scale industrialization and private enterprise

Objectives of the Moon Society

include, but are not limited to:

- Creation of a spacefaring civilization which will establish communities on the Moon
- Promotion of large-scale industrialization and private enterprise on the Moon
- 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 & 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, 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.

Our Full Moon Logo above:

The Moon in its natural beauty, empty and deceptively barren, waiting for human settlers to shelter and to mother as their adopted second human home world. We have work to do!

Masthead Design: Charles F. Radley, Society Vice-president\

Moon Society Elections 2009
Step 1: Call for Nominations
for Society Officers and Directors

from President Peter Kokh president@moonsociety.org

Our annual election ritual begins again. This year, these positions are open: ***respond by May 1st***

Moon Society Officers:

Vice-President: for a two year term, ending in 2011: currently held by Charles F. Radley

Secretary: for a one year term, ending in 2010: This position is currently vacant, and *you may volunteer at any time to serve the rest of the current term*, as well as to nominate yourself for the new term.

Moon Society Directors:

Three Director (Board member) slots: for two year terms, both ending in 2011: currently held by Scotty Gammenthaler, James Gholston, and David Dunlop.

Notes: All of the above, except David Dunlop, are expected to run for re-election. We are expecting new persons to nominate themselves. Thus, for the first time in a while, we will have contended seats and/or offices.

Remaining Office and Director posts will be up for election next year – 1010.

Eligibility for office or Board positions

Any current member, who has bee a member of the Moon Society for one full years as of August 1, 2009, is eligible for nomination and election. That includes all members with membership #s 1518 or below.

For officer positions, it is important that only those apply who believe that they can regularly attend our Management Council meetings held on the ASI-MOO (our advanced chat room environment) the first and third Wednesday evenings each month, 9-11 pm Eastern, 8-10 Central, 7-9 Mountain, and 6-8 Pacific Time (2-3 am Thursday morning UT).

We understand that now and then, something may come up that makes attendance impossible. But unless you are sure that such occasions will not be frequent, please do not nominate yourself or accept a nomination. To keep the Society on the move, it is vital that we meet on this frequent schedule to tend to business and opportunities as promptly as possible.

For Board positions, the above also holds but if a Board member misses a quarterly "Board" meeting without a prior excuse, that will be grounds for removal under the revised bylaws adopted last year.

To nominate yourself, write
elections@moonsociety.org
Please respond by May 1st

Town Meetings an Unexpected Success!

By Peter Kokh

After just two meetings, the Town Meetings have taken on a life of their own, launching member-originated projects, that could multiply the total Society output substantially. This is something wonderful, something that had not been foreseen or imagined.

Our second Town Hall Meeting was held March 11th on Skype group chat. The meeting began with a request for agenda items, and was chaired by Shaun Moss. Attendance was again close to two dozen, including several new participants.

Log of February 11th Town Meeting
http://www.moonsociety.org/reports/townmeetings/2009/townmeeting021109.html

Log of March 11th Town Meeting
http://www.moonsociety.org/reports/townmeetings/2009/townmeeting031109.html

Our 1st "Town Meeting Project"

Discussion was dominated by the idea to stage a world wide "**Apollo Moon Party**" on the 40th Anniversary of the Apollo 11 moon landing and first moonwalk, in the time frame July 16-24, 2009.

There will be **local Apollo Moon Parties**, most likely on Sat. July 18th and/or Sun. July 19th and **An International Party, possibly an Internet Telethon** with hosting to skip from time zone to time zone around. While logic would put this second event on Sunday, July 20th, "landing day," convenience dictates it also take place on Saturday, July 19th, so that we can go live from local party to local party.

Our Apollo Moon Party is already online
http://www.apollomoonparty.org

If you go to this site, you will find a number of buttons. Notable is PARTY IDEAS & PARTY REGISTRATION. We are also working on "AMP" logo products for sale, to increase recognigtion and identification of the Party.

Where Chapters & Other local groups come in

With currently three months to anniversary time, throwing a local Apollo Moon Party is something that can marshall the talents and energies of local groups, even of industrious individuals, with a potential payoff in local media attention, new members for the local group and for the society, and increased local morale, confidence.

A starter list of party ideas
http://www.moonsociety.org/events/amp/ideas.html

Is this a one-shot deal?

If we were to throw a 40th Anniversary Party for each of the Apollo missions, we would most likely get the same "ho-hum" reaction that the original series of landings did. But while it is hard to think of anything memorable about Apollo's 12, 14, and 16, **Apollo 13** was the mission that almost ended in tragedy and was one the greatest display of heroism and ingenuity under fire in modern history. **Apollo 15** not only landed beside Hadley Rille (a valley that formed with the collapse of the ceiling of a large lava tube) and Hadley Mountain, but featured the debut of the first Moon Rover. **Apollo 17** landed in scenic Taurus-Littrow Valley. Its departure marked humanity's long "retreat" from the Moon. So this writer's advice is to skip Apollo 12, 14, and 16 and concentrate on 13, 15, and 17 – with more time between!

Apollo Moon Party Memorabilia

By Peter Kokh

Party Patch designed by Shaun Moss
Based on the official NASA Apollo 11 Mission Patch

Apollo Moon Party Monolith design by Peter Kokh

A takeoff on the Science Fiction classic ***2001: Space Odyssey*** monolith, with the same power to bridge our proto-human past with our star-faring future. Lower half: etching of the recent photo of the earliest known human footprint, dated 1.5 mya; upper haff: etching of the famed first human bootprint on the Moon from the Apollo 11 mission.

Need a list of members, current and former near you?
Email president@moonsociety.org

Introducing the Society's 4th NSS Partner Chapter

San Diego Space Society

The San Diego Space Society is a brand new NSS Chapter formed by some members of the San Diego Mars Society, especially Gerry Williams and other NSS members is the area: http://sandiegospace.org/about/

Part of their founding vision has been to form an alliance of all pro-space individuals and organizations in the area: http://sandiegospace.org/alliance/

In addition to an impressive new website, the chapter has a quarterly newsletter, the *Bussard Scoop.*

From the outset, SDSS has made itself home to the several Moon Society members in the area, who have had an ongoing luncheon gathering every other month.

Gerry Williams, a filmmaker with 16 feature films to his credit, produced a powerpoint presentation of the Moon Society's crew (MDRS Crew #45) at the Mars Desert Research Station in Utah February 26-March 11, 2006. Crew commander Peter Kokh has since added additional material to this presentation.

www.moonsociety.org/moonbasesim/Artemis_Sim-1b.ppt

SDSS Treasurer, Dave Dressler, was born and raised in Milwaukee, WI, also the hometown of Society President, Peter Kokh, and had made contact with Peter on a recent visit to Milwaukee last year. Unfortunately, family members kept him too busy for us to find time to get together. Gerry and Dave have been strongly supportive of the successful effort to have the SDSS board accept Moon Society Partnership status.

The Moon Society and San Diego Space Society look forward to a fruitful and productive association in the years ahead.

Meanwhile in Chicago ….

The Moon Society has friends in Metro Chicago as well. Larry Ahearn, the pillar of the Chicago chapter, had organized the Minnesota and Chicago L5 Society chapters joint expedition to Milwaukee on August 15, 1986 which led to the formation of the Milwaukee Lunar Reclamation Society L5, now simply the Lunar Reclamation Society, and its newsletter *Moon Miners' Manifesto*. The Twin Cities - Chicago - Milwaukee (L5, now NSS) chapters have maintained close working arrangements and mutual support for over two decades.

There has been some discussion of the Chicago Space Frontier Society adopting Moon Society partner status as well. But there are two other NSS chapters in Metro Chicago, and some support exists there also. So it seems at this time that a new Moon Society Outpost or Chapter is the more likely outcome. There is no set timetable for this development, however.

And the rest of our NSS "MMM" Family

While they haven't adopted Moon Society Partner Status, the NSS chapters in Los Angeles, Philadelphia, Denver, and Sheboygan, whose members get MMM as a membership benefit, are exposed to the vision, mission, and projects of the Moon Society.

At ISDC '09 in Orlando, Moon Miners' Manifesto will receive unprecedented exposure and publicity. We will be making a pitch for other NSS chapters to come aboard. This growing collaboration flows from the 2005 Moon Society/NSS affiliation agreement.

Our Chapters & Outposts Map has many empty areas

www.moonsociety.org/chapters/chapter_outpost_map.html

33 US Metro areas of a million plus population lack a Moon Society Chapter, Outpost or NSS Partner Chapter

New York, Miami, Atlanta, Boston, Detroit, San Francisco, Riverside, Seattle, Tampa-St Pete, Pittsburgh, Cincinnati, Cleveland, Sacramento, Orlando, San Antonio, Kansas City, Las Vegas, Columbus, Indianapolis, Virginia Beach-Norfolk, Charlotte, Providence, Austin, Nashville, Jacksonville, Memphis, Louisville, Richmond, Oklahoma City, Hartford, Buffalo, Birmingham, Salt Lake City

If you live in one of these areas - or in smaller urban areas, and would like assistance in attempting to get something started,

Email us at

chapters-coordinator@moonsociety.org

or write us at

Moon Society Program Services
PO Box 080395
Milwaukee, WI 53208-0395

Or call us (Peter) toll free at

1-866-243-4357 7am-10pm CT

Chapters now have a powerful voice

There had been talk some years ago of having a Chapters Council, but for many years, St. Louis was our only full-fledged operating chapter. Now Houston and Phoenix both have dynamic growing chapters as well.

But what has happened is something unexpected - the launching of **the Town Meeting**, which most society leaders at expected to be an effort with little promise. But from the calling to order of the first Town Meeting on Wednesday February 11th, it became clear that something wonderful was happening. Many members we had not heard from previously attended, and ideas started flowing, dynamic "grass roots" ideas, ideas perfect for individuals and chapters to tackle, ideas which, had the Moon Society Management Council of Board come up with them, would have fizzled for lack of leadership.

We had suddenly empowered our members at large! From this point on, chapter leaders attending the Town Meetings have a direct voice and influence. Our new Apollo Moon Party project is but the first result.

While someday, a Chapter Council, or several of them (in the US, in India, in Australia, in Europe, etc.) may make sense. But through the Town Meetings, anyone can have a voice, give input, and help brainstorm efforts that will move the Society forward towards its goals and the realization of its mission.

If you have not yet taken in a Town Meeting, or, because of time conflicts, are prevented from doing so, you still have the ear of the President - use the contact information just above (president@moonsociety.org and chapters-coordinator@moonsociety.org both end up in the same mailbox: kokhmmm@aol.com

In the Moon Society, "member" status means something, or can, if you exercise the rights membership gives you. Unlike the Planetary Society which makes a show of member polls and then ignores them, the Moon Society *is its members*. You can put your talents, aptitudes and energies to work to help make our relatively small society, "The Little Engine that Could!"

<PK>

The Moon Society Chapters & Outposts Frontier Report

Moon Society Phoenix Chapter

http://www.msphx.org
http://www.moonsocphx.blogspot.com/
Contact: Don Jacquish djmitzlplick@yahoo.com

Meeting the 3rd Saturday of the month
Upcoming Dates: Apr 18th – May 16th – June 20th

March 21st Meeting Minutes: Meeting called to order at 3:30 pm. Present: Don Jacques, Patti Hultstrand, Mike Mackowksi, Art Felsinger, Mike Marron, Stewart Scott .

1. Website Update: a) Noted the addition of the Chapter & Outpost events on the National Moon Society Site. b) Re-iterated to all that they could place articles on the local website. c) Discussion touched on opportunities to network through Facebook, Linked-in, and MySpace sites for outreach. d) Art suggested that the calendar on the Phx Moonsociety site be moved out of the members only area, and made available to all visitors. Patti seconded.

2. Skype networking is blooming! Brief report on recent Moon Society Town Meeting held on Skype. It has some kinks, but seemed to be a very effective means to reach, and include many across the country, and the world. Skype will be an important part of the Apollo Moon Party.

3. It was suggested that an **easel** be placed at the site of each meeting to guide members & visitors to our tables.

4. Flyers were suggested as a means of publicizing our meetings at places like ASU. Mike Marron offered to place some for us if the group provided them.

5. Patti described **the Apollo remembrance book** in the works. Mike Mackowski was concerned about the pricing. Patti noted that new pricing (almost halvf the original) has been updated on the website (www.freethewod.info).

6. The Apollo Moon Party was conceived at the Moon Society Town Meeting. It represents a single world wide party that travels the timezones around the planet. Enthusiasm was high on the town meeting. Questions still remain as to how it will work, and details are still sketchy. It is scheduled for July 16-18, 2009. There hopefully will be more info at the next town meeting.

7. Discussion of outreach opportunities: local rocketry, R/C, and HAM radio were suggested. However no one has a current membership that is active. It was mentioned that Humanist group is involved with the United Federation of Phoenix. All of these groups represent oppportunites for collaborative projects and outreach.

8. Don mentioned he is preparing a proposal for a **display at the Challenger space center.** The display would highlight activities of New Space companies such as Excor, SpaceX, Bigelow, and others.

9. Mike Maron has a projector that the group could use at meetings and conferences. It is an older unit, and so the resolution may not be as high as newer models.

10. Upcoming conferences: Space Access conference in April; FiestaCon (July 2-5) Tempe, Az $75 individual registration $100 table in dealers room DiscWorld (Sep 4-6) Tempe, $80 indiv. registration (dealers room tba)

11. Mike Marron presented a proposal on Exploiting Space for power production, mining of asteroids, and materials available on the moon, near asteroids, and in our orbital area.

12. As the room was already reserved for next month, our April 18th meeting will be at our alternate location: Dennys Restaurant - US 60 at Rural road in Mesa.

Moon Society St. Louis Chapter

http://www.moonsociety.org/chapters/stlouis/
Contact: Keith Wetzel <kawetzel@swbell.net>
Meetings **2nd Wed** monthly at Buder Branch Library
4401 S. Hampton, in the basement conference room
Next meeting days April 8th – May 13th – June 10th

Moon Society Houston Chapter

http://www.moonsociety.org/chapters/houston/
Contact: Eric Bowen eric@streamlinerschedules.com

March 30 Meeting Report: At this meeting, Eric Bowen was reelected as chapter chair and Ken Sweeney II was elected to take over the treasurer position. The chapter voted to actively pursue incorporation as a 501(c)(3) non-profit organization; this will open additional doors to allow us to support the Moon Society's programs and goals. Ken Sweeney Sr. has volunteered to lead the effort. We plan to file our initial paperwork with the state in a few weeks and to have a rough draft of our forms to be submitted to the IRS by our next meeting. Members who may have missed this last meeting are encouraged to contact Ken or Eric with their suggestions for mission and goals proposals; eric@streamlinerschedules.

To provide support for a larger mission, we voted to establish dues for chapter membership. Membership in the Houston chapter for those who are also Moon Society members will now be $15 per year or $10 for students/seniors. For those who are not Moon Society members but who wish to participate as non-voting chapter members as permitted by the chapter rules of the Moon Society, dues will be $20 per year. $15 for students and seniors. The proposal was accepted and passed unanimously. However, there are no plans to "close our shop"; we intend to keep meetings and activities open for all who are interested, members and guests alike.

We also discussed what we as a chapter could do in support of the Apollo Moon Party proposal. As we are currently a small chapter in a very big space city, we decided that the most effective move we could make would be to find another organization(s) to partner with and co-sponsor a joint activity. We will be contacting other space enthusiasts as well as professional organizations to see what kinds of joint venture may be possible.

We concluded with a capsule discussion by Larry Friesen of the 40th Lunar and Planetary Science Conf., which he recently attended. **Next regular meeting May 18th at 7pm** in the Coffee Oasis meeting room at 4650 NASA Road 1 in ----Eric

College of the Menominee Nation-Green Bay* Student Chapter (*Formerly, Green Bay, WI Outpost)*

Contacts: Dan D. Hawk hawkd_0212@menominee.edu
David A. Dunlop dunlop712@yahoo.com

Meeting some Saturday afternoons at the College of the Menominee Nation, 2733 South Ridge Rd, Green Bay, WI

Activities: Rocket Launching, Mine tailings lunar simulant project, Experimenatal lunar agriculture.

ISDC 2009 Orlando – Dave and Dan will be attending.

Chapters & Outposts Map

www.moonsociety.org/chapters/chapter_outpost_map.html

< End Moon Society Journal Section >

GREAT BROWSING

Satellite Collision & Need for Space Traffic Control
http://www.space.com/news/090213-space-traffic-control.html

A bilateral approach from maritime law to prevent incidents in space
http://www.thespacereview.com/article/1309/1

Galileo and the Chinese: one thing after another
http://www.thespacereview.com/article/1307/1

Lincoln and the railroads, Obama and RLVs?
http://www.thespacereview.com/article/1303/1

Chasing the Soviet Zond Moon Capsule
http://www.thespacereview.com/article/1302/1

Space as a frontier
http://www.thespacereview.com/article/1301/1

Darwin and evolutionary progress to the stars
http://www.thespacereview.com/article/1300/1

Can Black Holes get Indigestion?
http://cosmiclog.msnbc.msn.com/archive/2009/01/29/1770113.aspx

Book: Venus Revealed: A New Look Below The Clouds Of Our Mysterious Twin Planet
http://www.amazon.com/dp/0201328399/ref=pe_5050_11202450_pe_snp_638

Book: Worlds on Fire: Volcanoes on the Earth, the Moon, Mars, Venus and Io
http://www.amazon.com/gp/product/0521008638/ref=pe_5050_11202450_pe_snp_638

Pete Conrad Spirit of Innovation Awards
http://www.conradawards.org/

Detailed Kaguya map shows Moon "dry to the core"
http://www.moondaily.com/reports/Detailed_map_shows_dry_Moon_999.html

Dogs in Space (1st Earthling in space: Laika, and more)
http://space.about.com/b/2009/02/22/dogs-in-space.htm

Billiards in Space: The Irridium collision
http://www.thespacereview.com/article/1314/1

First Steps for Point to Point Spaceflight
http://www.thespacereview.com/article/1311/1

Are UFO's really "sprites?" (high altitude lightning)
http://www.space.com/scienceastronomy/090223-ufos-sprites-explained.html
http://www.universetoday.com/2009/02/23/ufos-or-high-altitude-lightning/

Could this tiny Earth creature survive on Mars?
http://www.theepochtimes.com/n2/content/view/12670/

Heavy Construction on the Moon
http://www.universetoday.com/2007/12/17/heavy-construction-on-the-moon/

Robots could prepare Moonbase site
http://www.universetoday.com/2009/02/25/robots-could-prepare-moon-outpost-site/

Outward Migrating Jupiter, Saturn, Uranus, Neptune account for some Asteroid Belt "Kirkwood Gaps"
http://www.universetoday.com/2009/02/25/jupiter-saturn-plowed-through-asteroids-study-says/

Odyssey Moon to carry Dutch Instrument
www.nature.com/news/2009/090210/full/457770b.html

Economics of Lunar Development; Civilization impact
http://www.tdf.it/IC2/ACTA/COLLINS-IC2.pdf

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 VIDEOS

Space Station shaking during Jan. 14engine burn
http://www.space.com/common/media/video/player.php?videoRef=SP_090204_shaky_ISS&mode=

ISS astronaut Jeffrey Williams' orbital acrobatics
http://www.space.com/common/media/video/player.php?videoRef=ISS_acrobatics2&mode=

The Orbital Industrial Revolution:
Richard Gariott Report From Space:
Kibo, Jem, Dexter and more
http://www.space.com/common/media/show/player.php?show_id=21

Could Skylon Jets Open Up The Final Frontier?
Could the Britts leapfrog ahead of US, Russia, ßChina?
http://www.colonyworlds.com/2009/03/video-could-skylon-jets-open-up-final.html

Revisiting the Moon with Paul Spudis
http://www.thefutureschannel.com/dockets/space/revisiting_the_moon/

You can either visit the stars or watch them from afar.
But if you choose the former, you'll definitely get a better view. *~Darnell Clayton, 2007*

Help us put MMM in a Library near You!

Whether you are a member of an NSS Chapter or of a Moon Society Chapter or Outpost, or a Moon Society member at large, you all get Moon Miners' Manifesto as a membership benefit.

A library subscription to a library in your community will help spread the word, whether about local or national or international Moon-focused programs and projects.

For chapters and outposts such subscriptions will be good advertising for your local efforts.

For Moon Society members, as all copies of MMM include the Moon Society Journal centerfold section, community library or school library copies of MMM will help grow name recognition and invite readers to join. As membership services are not involved, the cheapest way we can do this is by submitting these subscriptions directly to the publisher at a cost-minus rate of $10 a year, available for libraries only.

How to participate in this program
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- Your check of money order for $10.00/per year
- With the complete name and address of the Library,
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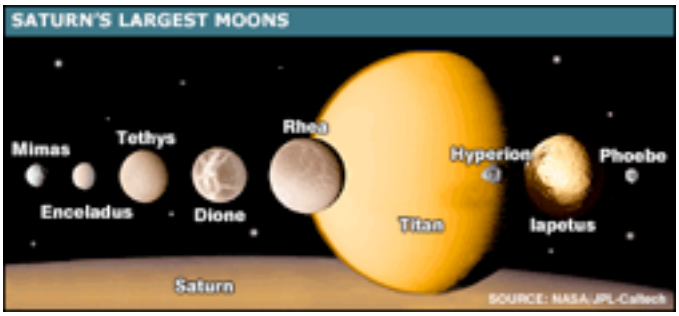
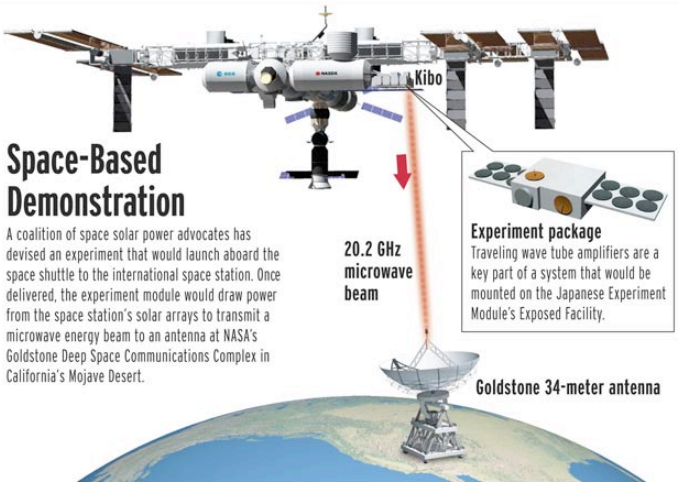
Attn: Library Subscriptions
PO Box 2102, Milwaukee, WI 53102

MMM PHOTO GALLERY

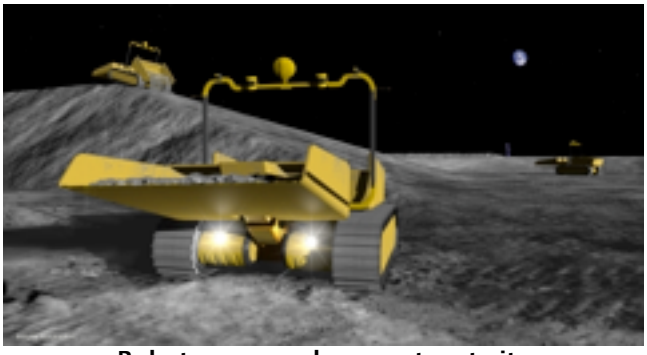
Dawn swings by Mars en route to Vesta – painting
See AFD News Service report page 8



Saturn's larger long known moons
See AFD News Service report on Enceledus, page 8

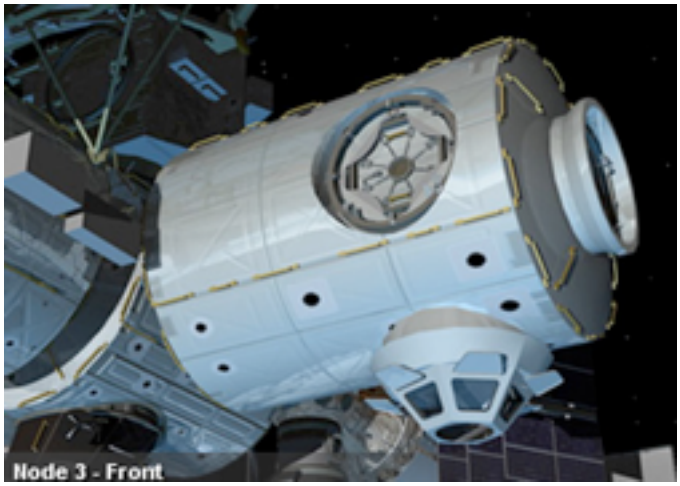


Above: proposed power beaming experiment from ISS Kibo module to Goldstone dish in California
http://www.space.com/businesstechnology/090225-tw-space-solar-power-obama.html



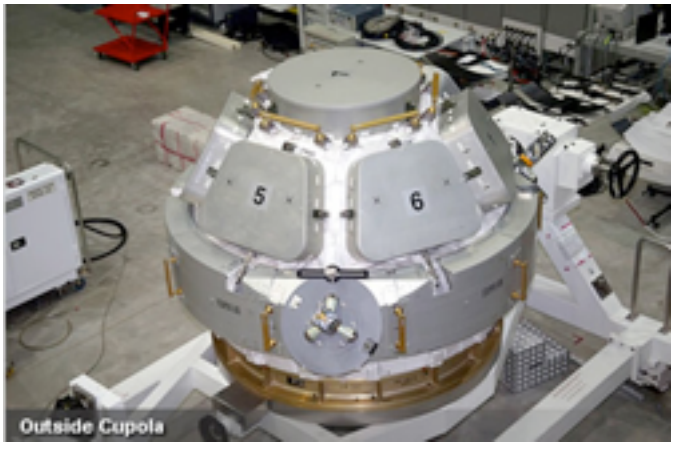
Robots prepare lunar outpost site
http://www.universetoday.com/2009/02/25/robots-could-prepare-moon-outpost-site/

The Moon's permanently shaded circumpolar craters have remained areas of mystery up to today, but new probes will eventually shed "light" on their hidden floors – See AFD News Service report, page 8



New ISS Module: Node 3's name up to popular vote
Note: Node 1 is "Unity", Node 2 is "Harmony"
(We wrote in "Cooperation")

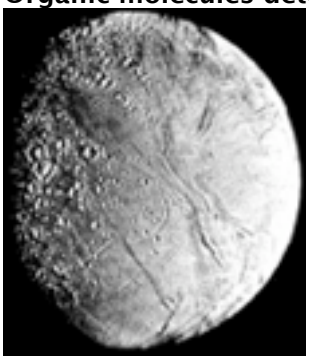
The view inside the Node

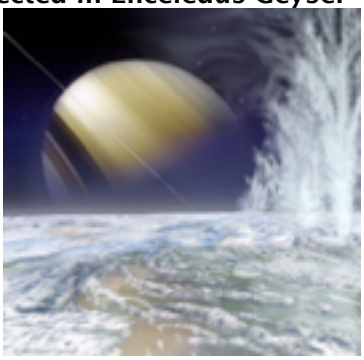


Outside view of ISS Node 3 cupola

WORLD WATCH
AFD News Service

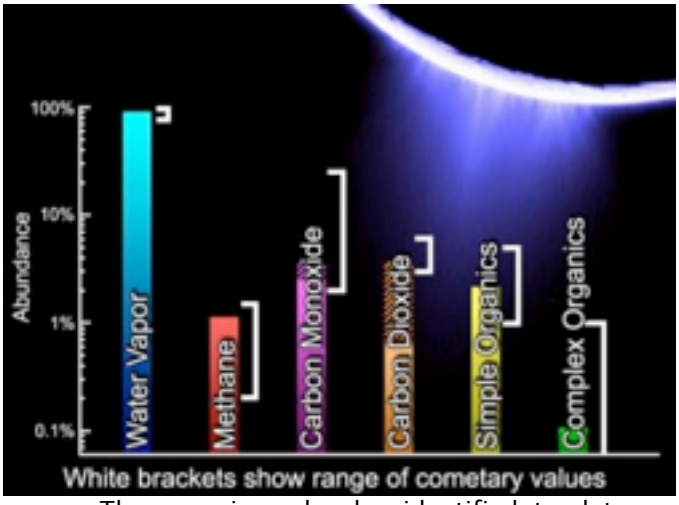
Organic molecules detected in Enceledus Geyser





04.01.2009 Pasadena, CA. Wishing not to be cited by name, a JPL scientist disclosed the 90% certain detection of four organic molecules in a plume venting near the south pole of Saturn's moon Enceladus at the time of the October 9, 2008 very close (272 km, 169 mi) flyby.

Earlier, water vapor, nitrogen, carbon dioxide, and methane had been detected.



The organic molecules identified to date are ethylene glycol C2H4(OH)2, acetic acid C2H4O2, glycine C2H5NO2, and aldehyde CnH2nO. The organic molecules are present in abundances per hundred inorganic molecules ranging from 0.01 to 1.3. **AFD News**

Dawn photographs small Martian moonlet

04.01.2008 Tucson, AZ. A PSI spokesman confirmed the rapidly spreading rumor that the Vesta- and Ceres-bound Dawn Probe caught a previously unknown moonlet of Mars in 3 frames snapped shortly after the probe skimmed about 549 kilometers (341 miles) above the planet at 4:28 p.m. PST on February 17, in a planned maneuver designed to redirect the probe towards Vesta.

The three frames did not supply enough data from which to determine this small body's orbit path and period, with any real precision.

The unnamed moonlet, for now designated as DM-3-021809 "Damn" (after the one word remark of the technician who discovered it on the first plate) is about 400 meters in maximum observed cross section and in an orbit which at best first approximation brings it to within 137,000 km (85,000 mi) of Mars at closest to out about 250,000 km (115,000 mi) at furthest, in an orbit inclined about 15° to Mars' equator (Damn was to the south at time of detection). This suggests that Damn revolves around Mars every 30 days or so.

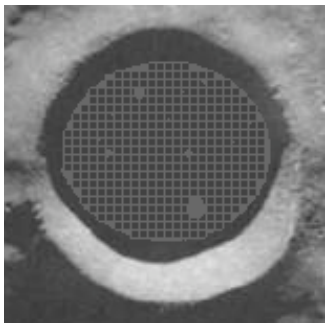
Whether "Damn" has a composition similar to Deimos and Phobos (the Soviet Phobos Grunt mission should help pin that down) is anyone's guess, and will probably be unknown for some time to come. **AFD News**

"Inverse waffle grid" feature found in permanently shadowed South Polar crater by NASA instrument on Chandrayaan-1 lunar orbiter

04.01.2009 Applied Physics Laboratory, Johns Hopkins U.

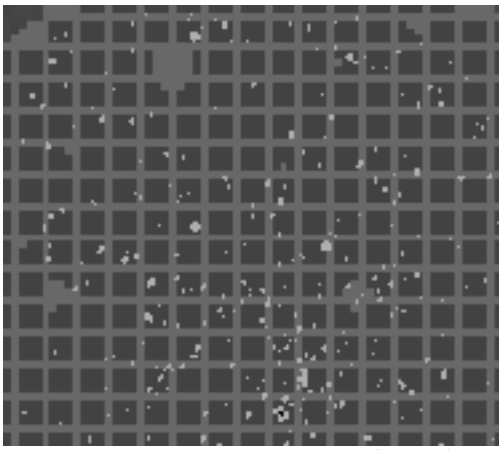
A series of Mini-RF synthetic aperture radar (SAR) strip overlain on an Earth-based, Arecibo Observatory radar image of the interior of Shackleton Crater on whose rim NASA is contemplating location of its lunar station, has revealed what seems to be an artificial pattern on the crater floor, an embossed inverse waffle like pattern of squares, each about 550 meters on a side with a grid of "alleys" about 100-some meters wide. The grid is 23 mounds wide E-W and 21 N-S.

Judging from the amount of pattern degradation by meteorite bombardment, this feature seems to be about 20-30 million years old.



So far no one has found a geological or geochemical process that might explain this degree of regularity.

No one at APL was been willing to speculate about the alternative, an intelligent origin. The reason for their reluctance is clear. The implication would be that the Earth-Moon system was paid an extended visit by an intelligent starfaring civilization 20-30 million years ago.



Shown with exaggerated albedo (light dark) differences, is one section of the grid with clear post-creation impacts that suggest that 20-30 m yrs have passed since grid formation.

But speculation outside APL is that what we see here is "some sort of provisions stockpile or warehouse." That poses the question: For us? For someone else who is still coming, and who never arrived? We may never know.

MM M's 22nd Happy April Fool's Day News

moonmars.com

www.moonmars.com is a new online social network dedicated to everyone interested in **exploring and colonizing the Moon & Mars**.

A place where enthusiasts, professionals, businesspeople and students can **connect**, **communicate** and **collaborate**, as we work together towards an exciting future in space.

Would you like to be kept informed?

Just enter your email address below to be added to our mailing list. First newsletter link below:

http://moonmars.com/newsletters/moonmars.com-Newsletter-1.pdf

Email address:_____

(don't worry - we will never share your information)

Launch Date: May 31, 2009

Email Shaun Moss: shaun@starmultimedia.biz

"Martian Sunrise: Year 20 after Crew 2 Refuses to Return to Earth" - by Simon Cook

Pathfinder Marsscape, framed in Inverse "Missing Colors" by Simon Cook

Get MMM in Color PDF file as a Moon Society Member!

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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TREAS./ Database - *Robert Bialecki
bobriverwest@yahoo.com 414-372-9613

LRS News

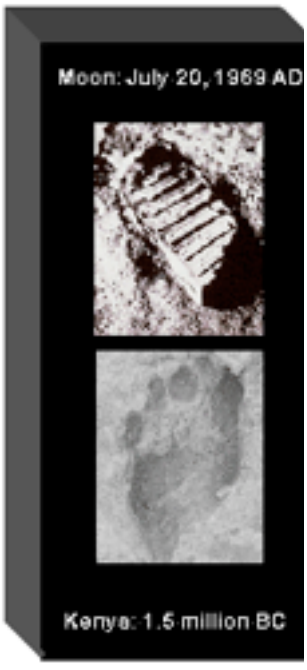
● **The Apollo Moon Party** is a new Moon Society "Town Meeting" project. To commemorate and celebrate the 40th anniversary of the 1st Apollo Moon Landing / Moonwalk by the Apollo 11 crew: Neil Armstrong and Buzz Aldrin. There will be local parties put on by chapters on Sat., July 19th, and a round-the-world Internet Telethon probably on Skype Video.

http://www.apollomoonparty.org/

The new Soref Planetarium at IMAX in Milwaukee is now showing Planetarium shows on the IMAX dome, and will be showing "Astronaut" at the time.

http://www.mpm.edu/planetarium/astronaut/

Peter will approach the Planetarium staff about setting up manned displays during the showings that weekend. The staff already is looking for ways to celebrate the anniversary. Peter came up with this idea for a 2001: Space Odyssey-reminiscent memento:



● **April 11th meeting** besides Peter, only two people came. We adjourned early.

Saturdays: 1-4 pm

May 9th - June 13th

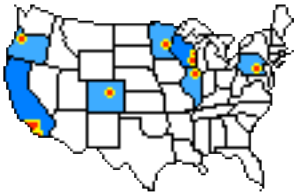
LRS Meeting, Mayfair Mall, Garden Suites Room G110

AGENDA: www. lunar-reclamation.org/page4.htm

May 9th meeting: We will show episode 5 of "Mars Rising" - "Six Minutes of Terror" (drama of the first human landing on Mars.):

Also: Apollo Moon Party planning; Space News update

And General Discussion



News & Events of NSS' Nine "MMM" Chapters

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

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
April 18th - May 16th - June 20th

WISCONSIN

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

c/o Will Foerster 920-894-2376 (h) astrowill@tcei.com
SSS Sec. Harald Schenk hschenk@charter.net

>>> **DUES:** "SSS" c/o B. P. Knier
22608 County Line Rd, Elkhart Lake WI 53020

http://www.tcei.com/sss/

- **We meet the 3rd Thurs even # months 7-9pm**
At The Stoelting House in Kiel, WI
- **Apr 17th - Jun 19th - Aug 21st - Oct 16th**

MINNESOTA

Minnesota Space Frontier Society
c/o Dave Buth 433 South 7th St. #1808
Minneapolis, MN 55415
Tom Greenwalt (w) 763-784-6244 (h) 763-442-6015
David Buth (w) (612) 333-1872, (h) (763) 536-1237
Email: tomg@mnsfs.org
www.mnsfs.org/

Calendar: MN SFS 2009 Past & upcoming chapter events
www.freemars.org/mnfan/MNSFS/2009-12-Review/

- May 1st-2nd MAS Astronomy Day
http://www.mnastro.org/
- May 2nd, 2009 CVAS Astronomy Day
http://www.cvastro.org/
- **May 12th, 2009 STS-125 Display**
www.nasa.gov/mission_pages/shuttle/shuttlemissions/hst_sm4/index.html
- **May 12th, 2009 MN SFS Meeting**
- **May 15th, 2009 STS-127 Display**
- **June 09th, 2009 MN SFS Meeting**

Chicago Space Frontier L5

610 West 47th Place, Chicago, IL 60609

Larry Ahearn: 773/373-0349 LDAhearn@aol.com

Larry Ahearn and Geri Haracz took in the MarsCon Science Fiction event in the Twin Cities, Feb 28 - Mar 1 Both manning exhibit tables in the Science Room.

COLORADO

Denver Space Society
(formerly 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, every 1st Monday, 7 PM
Englewood Public Library, Englewood, CO 80110
1000 Englewood Parkway
First Floor of the Englewood Civic Center - **Map:**
www.mapquest.com/maps/1000+Englewood+Parkway+Englewood+CO/

Meetings: Tues. April 6th, May 4th, June 2nd

- **April 6th:** Former Space Shuttle Astronaut Dale Gardner will speak on :Renewable fuels science and technology
- **May 4th:** Former Space shuttle and Space Station Astronaut James Voss will talk about his space missions.
- More information: Bill Nelson at 303 330 2888

PENNSYLVANIA

Philadelphia Area Space Alliance
PO Box 1715, Philadelphia, PA 19105

c/o Earl Bennett, EarlBennett@verizon.com
215/633-0878 (H), 610/640-2345(W)

http://pasa01.tripod.com/
http://phillypasa.blogspot.com

● **PASA regular business luncheon/formal meeting 1-3 pm**, the **3rd Saturday of every month** 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.

Next Meetings: April 18th - May 16th - June 20th

March Meeting Report: If Things work out we will be meeting at the Franklin (Institute) as part of the Moon Landing anniversary in July. Dennis Pearson came down from the Allentown area for the meeting and told us of this next major event: The 2009 ISDC, May 28 to 31, in Orlando, Florida. He also reported that George Whitesides has moved from NSS to a post in the Obama administration which should be good news for our efforts, and he mentioned the passing of Konrad Dananberg of the Rocket Team we had brought out of Germany for Our missile and then space program. For our July Franklin activities it was suggested that Dennis could shepherd a moon rock through its public appearance at the Institute. He is a trained custodian of moon rock exhibits and can request one for an event. He will do it if it doesn't conflict with other events he will be part of in July.

Mitch Gordon brought a copy of The Futurist Magazine that included a timeline for space development that was done by Futurist but seemed pretty restrained: by 2040 we would have a well populated moon base with the population of a small town (5,000 people ? ?) and our first Mars landing that same year! The summary included a timeline for this but it seems slow. He also brought scale models of several structure for our April exhibit. These included: a great pyramid, an ocean liner, and the Empire State Building. These where to compare against the Island One model I am trying to build. This will give the public at events the scale of our space construction ambitions. More later. Mitch has also volunteered as treasurer. Yeah! One less job for me! And finally: Mitch asked Larry our webmaster to consider putting a 40th anniversary commemorative banner on our website for the Moon Landing.

Hank Smith will be liaison for Space Sciences for Philcon this year and was appointed by the president of the group, Rock Robertson, who was reelected head of PSF, parent group of Philcon). Hank will miss the Super Science event in April due to a PSFS meeting that day. He will probably be attending the Balticon event in May and volunteer to help there.

Larry, our webmaster, will be getting pictures from the George Washington Carver Science Fair events taken by Pete Stevens of MENSA as a courtesy as well as from Dennis Pearson from the 2006 ISDC that he had. Larry will try to develop a banner suggested by Mitch noted above. This sounds like a great idea.

Dotty mentioned an exhibit on Exo-Planet hunting technology at The American Museum of Natural History as well as the film "Roving Mars" at its IMAX theater. She noted that a replica of Gemini 3 will arrive soon on the Intrepid. Why does that sound like history repeating itself hum? She also had a suggestion for the Lunacon management: they should talk to (or be talked to by) the New York NSS. group to improve there hard science presentations quantity and range. She was not as enthusiastic as she had been in the past about The Cons presentations. We'll see if the New York group will help (they have avid readers who will see this).

Earl limited his in meeting presentations (big cheer from members) to announcing the Carver Science Fair winners and progress on the Bernal Sphere model. On the first topic: two young ladies, Adrianna Hill and Amy Lam, where the winners of the James H. Chestek and Oscar H. Harris Awards respectively. They each received $50 cash, two small robots ("Crust Crawlers") a set of seeds and peat pots in a planting box, and a certificate acknowledging their receipt of their awards. I put them in recyclable grocery bags. They were surprised and delighted to explain their projects, Adrianna's on using plants to cover buildings for climate moderation, and Amy's on what I think was connecting to organic solar cells for electricity extraction, a not so easy task.

The Bernal Sphere agricultural rings are proving difficult to do and I was in the process of trying something different from my original material, carved polyfoam, for the part. Vinyl tubing is also difficult but closer to looking "real". I brought the central body component to the meeting and have since began coating in with a paper maché layer to build it up and give it the proper shape. It started life as two Dollar Store 12" colanders. I'm behind but will keep plugging.

On reading material: I received three publications with interesting material in them: Analog magazine, for June, actually had two interesting pieces, one optimistic and one less so: Michael Carroll, science writer and artist, gives us what NASA hopes to do in " Futuropolis: how NASA plans to Create a permanent Presence on the Moon". Readers of this publication have seen many of the ideas and it should be no surprise that there talking of surface dwellings initially around and in Shakleton Crater. There is lots of neat technology in the form of assistive rovers (the manned Chariot and the r.c.ed (or crewed) Athlete multi-legged vehicle. There is some talk of inflatable and Tuna Can (!) habitats, covered in regolith for safety, with lots of cautionary talk. There are a number of people working on studies, again, with lots of chat but missing important things, like time lines. The author quotes NASA scientists talking of this as leading to Mars but it is kind Of nebulous as to when anything will happen. The author has a companion book on the subject: " The Seventh Landing: How We'll Return to the Moon and Stay". I suspect it will give a detailed report on this Latest version of NASA's studies about getting there.

On a more pessimistic note, Jeffery D. Kooistra in Odds & Ends #4 Alternate view section of the magazine. Jeffery thinks that the recent economic battering we are going through will Further stall even the most mundane plans for space habitation. He thinks we are in a shift as described in "The Fourth Turning" wherein a situation like we are going through, and its antecedents, is described (in general terms, the book is 15 years old). Space, as a place to live, may simply be ignored.

The amateur satellite magazine, AMSAT Journal, had a report on launch opportunities and the changing conditions in the world of getting a ride. It included a description of the various locations on a mounting platform used to launch large satellites that could hold some of the smaller craft they (and other "ride share" candidates) could obtain. Jan./Feb issue.

The last is *Ad Astra;* and in particular the piece by Lt. Col. Paul E. Damphousse on "Energy for the Future". This write-up is on space solar power and the efforts of several groups to demonstrate it. This is *important.* Included is background information on the Space Solar Alliance for the Future and its inauguration in 2007 and the subsequent displays of elementary systems on the Discovery Channel and a space to ground demo. That would light an LED at a demonstration site. This equipment is to be built by students at The Air Force Academy for Space Studies (the Eisenhower Academy). The previously mentioned Discovery Channel demo was an inter island transmission in Hawaii. The distance was chosen to simulate LEO-to-ground. Very nice. The rest of the article was about plans and partnerships and conferences. These could be good to. This is from the Winter issue of the publication.

All of the last report was interesting but I am leery of such efforts. I have been reading these enthusiastic runnings toward a space based power system for Earth for a long time. I will make several points here: to me, the obvious demonstration is beaming power to space since we have an excellent emitter: Arecibo. It can put hundreds of kilowatts on any LEO target within its window. This could result in hundreds of watts of collected energy with a modest rectenna (a few tens of meters on a side). And it could be done in 2010 also. We *need* demonstrations. I am not just blowing steam: I have talked to a number of "civilians" (non space connected middle of the road tax payers) who haven't heard of this concept. The most recent was at a "Green" event in Philadelphia. I started out commenting on a display about nuclear power saying "it shouldn't be on Earth, We should put it in orbit and beam the power down". This got me a "What?" from the women who was next to me. I then explained that I was kidding about the nuclear part (must not scare your audience) and told her about the SPS concept and how we could use sun power to create electricity for use on Earth. She turned out to be a school teacher who was trying to educate the children about ways out of the current mess. She had never heard of what we are trying to sell. We need demonstrations where the public will see them often. The unit that Peter Kokh was showing is a start but I think that large, general newscast presentations are necessary also. I may be invited to speak at that school to talk on this, and other, subjects. At this point I am thinking of putting together a simple, enclosed system for our July Franklin event. Without the *Ad Astra* nudge, I would not be thinking this.

Report by Earl Bennett, President, PASA.

CALIFORNIA

SDSPACE.org

San Diego Space Society

http://sandiegospace.org/

info@sandiegospace.org

Quarterly Newsletter: ***The Bussard Scoop***

Meeting the 2nd Sunday monthly

- **Next Meeting: May 10th** 2:30 to 4:30 pm
  Serra Mesa Branch Library 9005 Aero Dr, San Diego
  Greg Meholic will talk on advanced space propulsion concepts for interstellar travel, including nuclear rockets, faster-than-lightspeed travel, quantum drives, wormholes, and some really exciting physics.
- **April 11th Yuri's Night San Diego (4:00 pm)**
  http://sandiegospace.org/2009/01/30/yuris-night-san-diego/
- SDSS member **Maria Catalina** is at the **Mars Desert Research Station** in Utah to serve as **MDRS Crew #80 commander** March 28th-April 10th
  http://desert.marssociety.org/mdrs/fs08/crew80/

CALIFORNIA

OASIS

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
http://www.oasis-nss.org/articles.html

Regular Meeting 3 pm 3rd Sat. each month
Next Meetings April 18th - May 16th - June 20th
Information: OASIS Hotline, 310/364-2290; website.

OASIS BOARD MEETINGS

Saturday, April 18, 3:00 PM
Home of Steve Bartlett & Tina Beychok, 7108 East Peabody Street, Long Beach, CA 90808

Saturday, May 16, 3:00
Home of Bob Gounley & Paula Delfosse, 1738 La Paz Road, Altadena, CA 91001-3317

Saturday, June 20, 3:00
Home of Craig & Karin Ward, 1914 Condon Avenue Redondo Beach, CA 90278-3403

OTHER EVENTS

Thurs/Fri April 16th/17th - 7 pm - Jet Propulsion Lab.
"Rainbows, Red Sunsets, and Rocket Science Revisited"
David J. Diner, P.I., Multi-angle Imaging Spectrometer,
Thursday Venue: The von Karman Auditorium at JPL 4800 Oak Grove Drive, Pasadena
Friday Venue: Vosloh Forum, Pasadena City College, 1570 East Colorado Blvd, Pasadena

Moon Miners' MANIFESTO

Lunar Reclamation Society Inc.
PO Box 2102, Milwaukee WI 53201-2102

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- $25 for all members

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SHEBOYGAN SPACE SOCIETY (WI)

- $15 regular, • $10 student,
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"SSS" c/o B. P. Knier, 22608 County Line Rd, Elkhart Lake WI 53020