

[A publication of the Milwaukee Lunar Reclamation Society,  
a chapter of the National Space Society and of the Moon Society]

**OUTBOUND #16 MAY, 2019**

**What is the closest planet to Earth?**

<https://www.space.com/closest-planet-earth.html>

The answer most people would give is Venus. But ... **it might actually be Mercury.** Although Venus is the planet that “comes” closest to Earth as it sweeps by on its orbit, Mercury “stays the closest to Earth the longest,” according to a commentary published Tuesday (March 12, 2019) in the magazine **Physics Today**.

"By some phenomenon of carelessness, ambiguity, or groupthink, science popularizers have disseminated information based on a flawed assumption about the *average distance* between planets," Tom Stockman, a Ph.D. student at the University of Alabama; Gabriel Monroe, a mechanical engineer at the U.S. Army's Engineer Research and Development Center; and Samuel Corder, a mechanical engineer at NASA wrote in the commentary.

This comes as no surprise to us. *For some years now, I have spoken of Mercury as “The Grand Central Station of the Solar System.”* Want to go to Jupiter or Saturn or Neptune? Aim for Mercury, make a close pass by it, and you will find yourself *in a gravitational slingshot into the outer solar system, getting to your destination faster, and with far less fuel.*

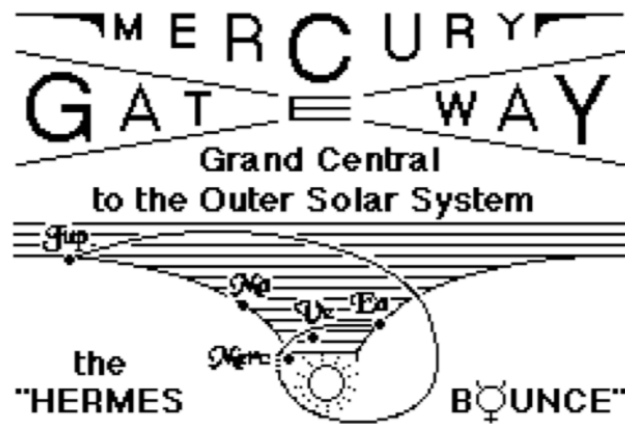
*√Energy and √Raw Materials are two of the four pillars upon which a planet's economy are supported. The other two are √Human Creativity and √Time.* The careful reader will note that ‘location’ -- which we hear about often -- is not on the list. *In space travel, location is entirely a function of energy.* Expend a certain amount of energy, and you will completely change your location. The implication here is that *the cost of generating energy is what will largely determine the cost of transporting from one planet to another.*

[Ed. We have another take on this issue. “Location” can matter, and far from being a handicap, its all in favor of Mercury’s economic potential. *It is Mercury’s proximity to the Sun* that endows it with an energy rich environment, as well as with *a very short orbital period. That, in turn, is the reason Mercury has such short intervals between arrival and launch windows*

*with all the other bodies in the solar system. Thus its location will one day make it the Grand Central station/transport hub of the Solar System.*

See MMM #78, Sept. '94, p. "Mercury: Gateway Grand Central" republished in MMM Classics #8 p 36, 38-9. [www.moonsociety.org/publications/mmm\\_classics/](http://www.moonsociety.org/publications/mmm_classics/)

Note also that all this solar energy can be used by lasers to  $\sqrt{\text{decelerate inbound, and}}$   $\sqrt{\text{accelerate outbound spacecraft.}}$



[image above by the author, Peter Kokh]

For Science Fiction, there has never been a problem with opening up the outer Solar System. It's "simply" a matter of inventing faster rockets, atomic ones probably. *In fact, Mars represents the limit of "doability" of the venerable chemical rocket for crewed expeditions.* No plausible improvements will extend this margin in any practical sense. Chemical rockets cannot carry enough fuel to take *manned* expedition-sized payloads much further. More, maximum efficiency travel times in Hohmann transfer orbits (without which chemical rockets could not even take crews to Mars) mean many months in space and unwelcome total exposure to solar flares and cosmic radiation.

Nuclear rockets are still largely on the drawing boards, but promise faster trips to Mars, doable trips to the Main Asteroid Belt. But even for them, trips to outer planets may be unacceptably long, ... and infrequent. For any vehicle must await proper planetary orbital alignments - the "windows." Some Trip Window Frequencies (bidirectional) and average Hohmann travel times (both in 30 day months.)

Anyone who studies this list should quickly get the idea, that, Delta V and fuel cost aside, *The quickest way to get from anywhere to anywhere else in the Solar System might be to "detour" via a "swing" by Mercury.* What about alignments? So what if you get to Mercury and have just missed a window to Jupiter. Another *window will open up every 3 months*, an insignificant delay parked in Mercury orbit.

Ah, but Delta V and fuel cost do matter, you say! My point is that *much of the extra Delta V needed to do the detour by way of Mercury can be managed by free deceleration into orbit around Mercury, and free acceleration into a trans destination trajectory — free courtesy of giant solar lasers parked in orbit about Mercury.*

In the chart below, the "travel time" is in 30 day months. The important thing is that these windows open much more often ("window frequency").

<i>between</i>		<i>window</i>	<i>travel</i>
		<i>frequency</i>	<i>time</i>
<b>Earth/Moon</b>	<b>Mercury</b>	<b>3.45</b>	<b>3.51</b>
Earth/Moon	Mars	25.87	8.63
<b>Mercury</b>	<b>Mars</b>	<b>3.36</b>	<b>5.68</b>
Earth/Moon	Ceres	15.55	15.75
Mars	Ceres	38.67	19.13
<b>Mercury</b>	<b>Ceres</b>	<b>3.09</b>	<b>12.01</b>
Earth/Moon	Jupiter	13.30	33.27
Mars	Jupiter	27.21	37.56
Ceres	Jupiter	91.81	48.43
<b>Mercury</b>	<b>Jupiter</b>	<b>2.99</b>	<b>28.36</b>
Earth/Moon	Saturn	12.60	73.65
Mars	Saturn	24.46	79.20
Ceres	Saturn	66.56	92.96
Jupiter	Saturn	241.9	121.8
<b>Mercury</b>	<b>Saturn</b>	<b>2.96</b>	<b>67.33</b>
Earth/Moon	Uranus	12.33	195.2
Mars	Uranus	23.42	202.8
Ceres	Uranus	59.47	221.4
Jupiter	Uranus	168.1	259.2
Saturn	Uranus	550.5	331.6
<b>Mercury</b>	<b>Uranus</b>	<b>2.94</b>	<b>186.3</b>

In going to Mars or Ceres this presents a problem. The Mercury-boosted ship will arrive with a great deal of excess momentum. This will require a lot of fuel to shed. But *ships going out to any of the moons around any of the Outer System gas giants, can shed that excess momentum free in an aero-brake maneuver through the upper atmosphere of the gas giant (Jupiter, Saturn, Uranus, Neptune)*. In fact, *the only Delta V that need be provided for by fuel carried on board is that for the boost in toward Mercury, and the landing fuel at the destination moon* (about Jupiter, Saturn, etc.) that would be the same in either case. The benefits would be astounding

### **LEAVE ANYTIME and GET THERE MUCH MUCH SOONER.**

Building such a **giant laser facility near Mercury** would be something for a “United Planets” government. It would establish singlehandedly a transportation infrastructure that will open the gates of human expansion into the Outer System, in search of energy (e.g. Helium-3 from Uranus), the ultimate in tourist experiences (Saturn’s rings), raw materials for terraforming (water, hydrogen, nitrogen, carbon), and exploratory knowledge.

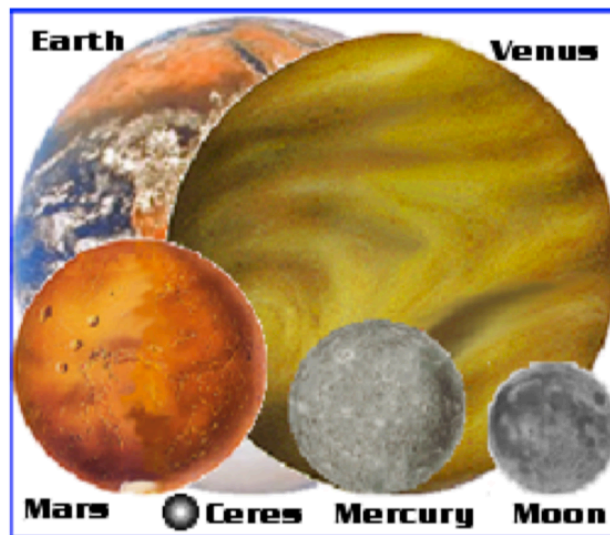
### **A Service Station orbiting Mercury at a distance that it will always be in its shadow.**

Because ships arriving at Mercury may have to wait up to 3 plus months for a reboost to their destination, there will be a major service market in orbit about the planet. This will include *ship repairs (engines, environmental systems, bio-sphere systems), warehousing, trading, transshipments, health care, entertainment and diversion, surface excursions and stays, even*

*continuing education courses.* And all the more interesting things that are usually found in wide open international marketplaces. **Mercury Gateway** could over time grow to become *the nerve center, financial center, trading center, even the political center of the Solar System.*

*Yes it's hot!, Yes it's dry! Yes it's barren! But so what!* Mercury's location deep down the throat of the Sun's gravity well and its location in very bright space (averaging seven times as much light and heat from the Sun as what reaches Earth/Moon) — these are the real estate pluses that will make this unsuspected oasis in the solar desert bloom and boom.

First, of course, *√ nuclear rockets will have to come on line, and mature.* *√ Next, economic motives must surface that would drive the expansion of the human economy into the Outer Solar System.* *√ Finally, some taxing authority has to build the necessary facilities in Mercury orbit.* Then this “god of speed” will be not only speedy himself, but impart some of that swiftness to us mortals and our “**Quicksilver Fleet**”.



### **Mercury, it's a detour that is also a shortcut! PK**

Larger than the Moon, smaller than Mars, Mercury is very dense and its surface gravity is equal to that of Mars. But it takes far less area to receive as much solar power as any other planets, because of its proximity to the Sun.

#### **Mercury Trivia**

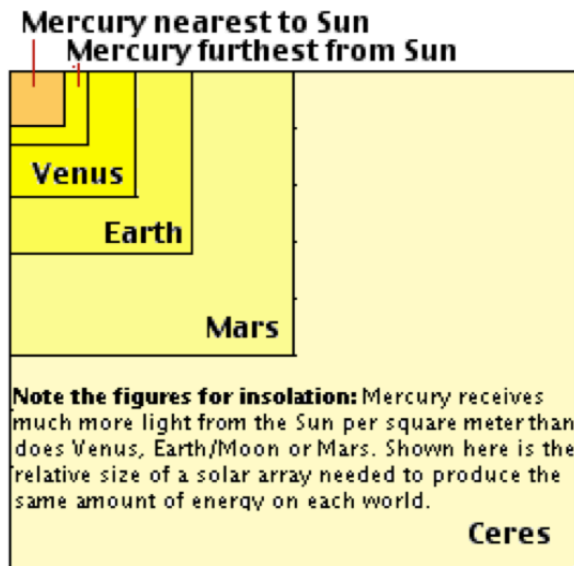
- The surface area of Mercury is about one seventh that of Earth: ~28,000,000 sq. mi, ~73,000,000 sq km, or put in more familiar terms, *about as large as North and South America and Africa together, and twice as extensive as the surface area of the Moon.*

### **More about Mercury in past issues of Moon Miners' Manifesto**

MMM #204 April 2007

([http://strabo.moonsociety.org/mmm/mmm\\_t\\_solarsystem.pdf](http://strabo.moonsociety.org/mmm/mmm_t_solarsystem.pdf))

**The closer a world is to its Sun, the less area is needed to capture the same amount of solar power - see diagram below.**



**3 Missions to Mercury to date**  
 ✓ **Messenger:** (NASA) 3 flybys in 1974-75.  
[https://www.nasa.gov/mission\\_pages/messenger/main/index.html](https://www.nasa.gov/mission_pages/messenger/main/index.html)  
 ✓ **Mariner 10** (NASA via a flyby of Venus)  
<https://nssdc.gsfc.nasa.gov/nmc/spacecraft/display.action?>

[id=1973-085A](#) and ✓ **BepiColombo** (ESA & Japan) <http://sci.esa.int/bepicolombo/>

While Mercury is smaller than Mars, it is much denser than Mars, and the surface gravities of both worlds are equal. Extensive lava floods (suggesting lava tubes) have been mapped conveniently near Mercury's North Pole, *along with confirmed water ice.*

**Around and around – Keeping up with the terminator**

That Mercury's dayspan-nightspace cycle is so long, 176 days or 6 months long, provides an advantage. On Earth, the terminator advances at over a thousand miles an hour at the equator and about 750 miles an hour at mid latitudes (mid 40's, north or south). *On Mercury, at the equator, the sunrise and sunset terminators advance some 87 km = 54 mi per day, or just 3.6 kph = 2.2 mph. One can almost walk that fast, though probably not in a space suit.*

As you go further away from the equator towards either pole, that slow walk becomes a crawl. Put it another way, the Sun crosses Mercury's sky at just 2° a day, compared to 360° here on Earth.

Ten days after sunrise, the Sun will be only 10° above the horizon at best, **less away from the equator.** *One could linger in an area for a week or more before moving on. Imagine, if you will, a circumpolar railroad, that hugs the pole on the side of the planet facing the Sun at perihelion, and dropping to lower latitudes on the side facing the Sun at aphelion.*

*Now imagine 6 settlements along the track. One could move to the next settlement every 29.3 days, or if there were just five settlements, every 5 weeks.* ✓ The permanent part of each settlement would be living space, with ✓ the highly functional spaces aboard railway cars, along with the expensive mining and processing equipment.

This would be a different way of life, but one more settled than that of terrestrial nomads. *Consider how many persons, here on Earth, now have two homes, one for winter months, another for summer months.*

Each trackside settlement would have to be dug in, of course, just to be safe from radiation hazards. If actual time spent traveling from one location to the next was relatively trivial, say a day or two at most, *the railroad track could be simply covered with a shielded shed all along its route. OR, each railroad car could carry its own shielding shed.*

Sound like too much of an adjustment? Consider the adjustment northern peoples have made since leaving Africa. *Humans are amazingly adaptable, and quickly adjust to new*

*surroundings and conditions, learning to be at home there, learning to love their new life style.* In time, humans will spread wherever they can find *a way to support themselves long term.*

*On the Moon, Mars, and Mercury, there is no real need to stick with narrow gauge tracks. Right of way is not a problem. We just need to make wider bridges, cuts, and tunnels. An average rail car could be two floors and double the width we are accustomed to having.*

*On Mercury, solar power at nearly seven times the intensity at which sunlight is available on Earth, could power rail systems. Overhead monorails would fit in nicely with overhead shielded shed structures.*

### **Brainstorming for fun and profit?**

Well, I don't know about profit, but the fun of this exercise is in looking for ways to extend an initial human presence on Mercury beyond the poles. We learned that not all of Mercury is uniformly hot, that there may be natural shelters in convenient places, in the form of near polar lava tubes.

We realized that the slow march of the Sun across the Mercurial sky opens up plausible semi-nomadic lifestyle options. By the time we get to go, we'll probably have found many more choices than these.

### **Rocketing in towards Mercury: Turning the increasing heat into an asset.**

A manned rocket *need not get overheated as it coasts inwards towards Mercury. A side-mounted shield* could keep the rocket and any personnel aboard, cool, while at the same time  $\sqrt$  capturing the energy needed to speed up the ship, and later,  $\sqrt$  the energy needed to slow the ship down for a landing on Mercury. ##

(A proverb: "Whenever you are looking at something and seeing a lot of negatives, *this just may be a sign that you are looking at it from the wrong perspective.*") #

### **More on Mercury in Moon Miners' Manifesto**

MMM #78 Mercury: The Other Terrestrial Planet;

Mercury Gateway: Grand Central to the Outer Solar System

MMM #111 Drumroll for Mercury: snail-pace rover;

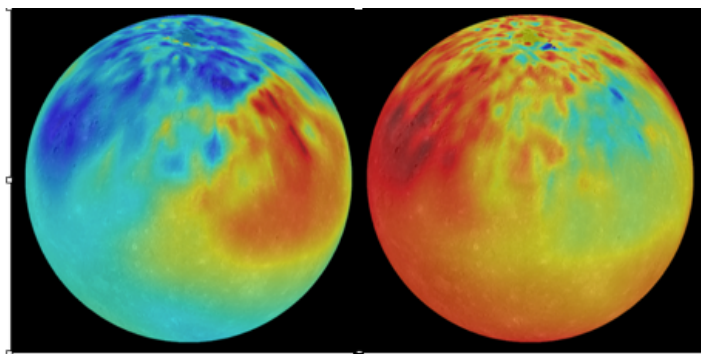
MMM #204 Three Myths of Planet Mercury; More on Mercury as a Human Frontier

MMM #205 Mercury Frontier Speculations for the fun of it

MMM #244 Mercury - A Coming Attraction

Most of the above are accessible at: <http://strabo.moonsociety.org/mmm/>

Map of  
Mercury's  
chemical  
composition  
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## Capital "M" for (the) Moon

by Peter Kokh

In a letter in the October 1989 issue of Ad Astra [the Publication of the National Space Society] the writer took exception to this author's insistence that "Moon" be capitalized. His argument rested on several all too common misconceptions. Perhaps it would be helpful to discuss the salient facts.

*Like Julius Caesar, the Moon is an original.*

*From time immemorial up until 1610 when Galileo first trained a telescope upon Jupiter and discovered it had four "moons," only one moon was known to mankind: The Moon, or Luna in Latin, and Selene in Greek.*

Similarly, until even more recent times when it became apparent that the Sun and the stars were members of the same class of celestial objects, we knew of only one "Sun". Until these discoveries, Moon and Sun had probably never been used in the plural. In one language version or another, since the dawn of language, these were **their names**. When we suddenly needed "class" names we borrowed these names from the sole objects we had ever known of each class. Ganymede, Titan, Phobos and company are thus "moons" *but only and simply by analogy or by extension*. The Moon remains the original, the satellite of Earth.

*Nor, as some are tempted to think, does the presence of the definite article "the" mean that "Moon" must be a common noun. If so, we had best start using "the bahamas," "the philippines," "the hague," and "the united states." Got you!*

## Mars Society Announces New "Mars Talk" Community Podcast

The Mars Society has released the first episode in a new podcast series titled "Mars Talk" which will be available in both video and audio formats on the organization's **YouTube channel**, via iTunes and the podcast's website [www.MarsTalk.org](http://www.MarsTalk.org). Billed as "a community discussion about humanity's future in space," the bi-weekly podcast will feature Mars Society chapter leaders and other guests to discuss the organization's activities as well as those of individual chapters. The online program will also provide commentary on recent space news, such as commercial space activities and those of the worldwide space agencies.

**The first episode of Mars Talk** was recorded on Friday, April 12th and was hosted by Christopher Tarantola from the Mars Society's Chapter & Outreach team. Christopher was joined by two co-hosts: James Burk, the Society's IT Director and organizer of the Seattle chapter, and Lucinda Offer, the Society's Executive Director and organizer of the UK chapter. In the inaugural broadcast, the three hosts provided commentary on the NASA return to the Moon announcement, SpaceX & Boeing's commercial crew activity, the recent Falcon Heavy launch of ArabSat-6A, Israel's SpaceIL mission to land on the Moon, India's anti-satellite test and its aftermath, recent discoveries of active groundwater on Mars, and several other current space-related news items. In addition, Lucinda provided an introduction to the Mars Society and the recent projects and activities carried out by our worldwide network of chapters.

Mars Talk will be a bi-weekly podcast and eventually cover most/all of the current Mars Society chapters, interviewing their organizers and members.

For more information, please visit: [www.MarsTalk.org](http://www.MarsTalk.org)

## Star Trek's "Prime Directive"

[https://en.wikipedia.org/wiki/Prime\\_Directive](https://en.wikipedia.org/wiki/Prime_Directive)

In the fictional universe of **Star Trek**, the **Prime Directive** (also known as "**Starfleet General Order 1**," and the "**non-interference directive**") is a guiding principle of Starfleet, *prohibiting its members from interfering with the internal and natural development of alien less mature civilizations.* ##

**Comment:** If endeavoring to contact extra-solar civilizations could cause upheavals in civilizations around other stars (hence the "Prime Directive") what about just a "Hello" with no other message content except the wavelength etc.?

A simple "Hello" that every civilization would recognize is the value of **pi** ( the circumference of a circle divided by its radius). Because it is irrational, it can't be written as a fraction. Instead, it is an infinitely long, nonrepeating number.

**3.14159265359..... etc.**

Now how do we do that? By putting out 3 beats of any set length, then the short fraction === === =.

Anyone would recognize it, even if it was shorter, say 3.1416.

Or by an image of a circle with a bar from anywhere on the circle to the center of the circle. This says "**Hello, we're in this direction**" **peace and prosperity! Goodbye!!**"

*Nothing in the signal gives the distance and/or the date sent.* Now maybe the signal will corrode with distance and thus narrow down the time sent and distance covered, but will still be too vague to identify the source.

As to the direction, there is no direction in which there is not a star somewhere, in this galaxy or beyond. Further, our civilization might not still exist, when our signal reached another civilization. *The purpose? Simple, just to say "Hello! Hope you are doing well too!"*

If we can do this, other races may have done (or are doing) likewise. Are we on the alert for such a signal, probably weak? After all, the signal must be sent in all directions, although there will be more stars in the direction the "Milky Way," and that will require some significant power. Any civilization capable of sending such a signal, *may* be on the alert for such signal from other civilizations. *More civilizations may be listening than sending, simply because it takes less power to listen than to send.*

So *hearing nothing is not necessarily a "No."* Just a thought. ##

## Should "The Sun" have a Name? What class does our Earth fall into?

**It does**, but we've made it a common name as we have "the Moon" (extending the use of the term "moon" (lower case), to satellites of other planets. If we were to do the same about planets discovered around other Stars by calling them "earths" small e, dropping "the.")

Capitalizing "the" takes care of the problem, as it does for "The Moon" pronounced "thee." (In this case, "earths" would mean "**earthlike worlds**" - vaguely similar in one or more of the following:  $\sqrt{\text{size}}$ ,  $\sqrt{\text{relative distance from its sun}}$ , *and the best definition is:*

$\sqrt{\text{A world of oceans \& continents, or more simply, a world of shores, "shore worlds"}}$ ?

In the past, I thought of giving Earth a name that does not mean "soil." For example - "**Magellena**" - after the first person to lead an expedition to circle our planet through its seamless Ocean (singular). (**or, we could call our seamless ocean, "Magellena,"** and refer to similar worlds around other "Suns" "**magellenoids.**") Just a thought. #



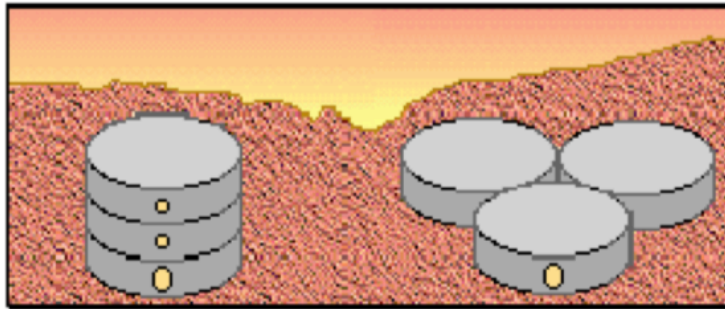
## Designing with the Future in Mind

The concept of Designing ships bound for Mars, so that once on Mars, they can be disassembled, then reassembled to become a “neighborhood” of a Mars Settlement had a precursor in my article in Moon Miners Manifesto #163, March 2003.

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“It would seem that “the tuna can stack” (of the Mars Desert Research Station in Utah, and its older sister station on Devon Island in Northern Canada) has disadvantages. Not only does the high profile complicate shielding emplacement, but it sacrifices volume to the stairs between them. *Further, if a fire were to start in the lower floor, crew members in the floor above might be trapped.* (In the Mars Desert Research Station in southern Utah, there is ladder access to an “attic” with a removable 30” wide circular “door” to the roof - (I went up there) - to escape, one would have to jump 20 some feet and hope there would be no broken bones!)”

“In Utah or elsewhere, **an “unstacked” version, in which all three (not two) separable floors are hoisted off the landing feet and onto a prepared flat soil bed, might have advantages.** (The 3<sup>rd</sup> and lowest floor being a garage/workshop with rovers inside.) “



“√ Access between units would be direct through doorways 120° apart.

“√ With the lower profile, covering the complex with shielding soil will be much easier.

“√ This makes expansion with additional modules easier in the future.

“Meanwhile, a faux-inflatable stacked M.A.R.S. Hab with a TransHab-like interior architecture could serve to test the ergonomics and operations performance of such a design.

“**Our Point: *The Vehicle, upon arrival on Mars, is disassembled from its stack alignment, and it’s floors placed side by side, to become the first Mars research station.***”

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[This “**One Way to Mars Strategy**” forecasts our concept of designing future advanced larger Earth to Mars spaceships so that on arrival, the various parts √ can be disassembled, √ then rearranged in a flat pattern, to become a “**neighborhood**” of a Mars settlement.]

***In both these arrangements, the entire Ship is “Cargo,” not just “what it carries.”***

(The only exception will be those spaceships bringing tourists to Mars, then taking them back home to the Earth/Moon system.) **This concept, if followed, will lead to a total revolution in settlement designs, as well as considerable speeding up of the spread of settlements around this new world. ##**

## **Will there be Greyhound Busses on Mars so settlers in one settlement can visit friends who may be in a different settlement hundreds of miles away?**

I'm sure that there will be. But they may be longer and wider, say with two floors, probably made from a long, wide rocket fuel tank, with the rocket crew cockpit now the bus drivers "cockpit." It would be heavily insulated to get through the very cold Martian nights.

*On Mars, we'll need roads with gentler curves and easier hills.*

Or, on the other hand, our bus might consist of two shorter vestibulated sections, for roads with sharper turns and shifting elevations, the vestibule connection being closed to passengers except when the bus is parked.

Upstairs for first class (better views of the countryside) plus cockpit, downstairs for us penny pinchers, plus kitchen and rest rooms.) On long trips, seats will recline for comfortable sleeping. (Yes, this writer has traveled far and wide on Greyhound busses, once 3 nights and 2 days, 60 hours, after climbing a mountain solo for the second time [age 17 and age 34, Mount St. Piran, Canadian Rockies], from Banff, Alberta to Milwaukee, Wisconsin.)

But why call these busses "Greyhounds?" Not far behind Greyhound dogs in speed, in 3<sup>rd</sup> place, is the **Vizsla**, a Hungarian speedster that happens to have a rusty color.



[https://  
www.akc.org/  
dog-breeds/  
vizsla/](https://www.akc.org/dog-breeds/vizsla/)

Interested in pulling up roots and getting "*a fresh new start on a wide open new world*"?



Roads may be built before railroads. And there is a lot to see on Mars, spread over the whole planet. You may have to fly (via rocket in a suborbital hop) to some places. Railroads may follow eventually.

*In the meantime, "if it's on Mars, Vizsla will get you there!"*

*Look at those long legs!*

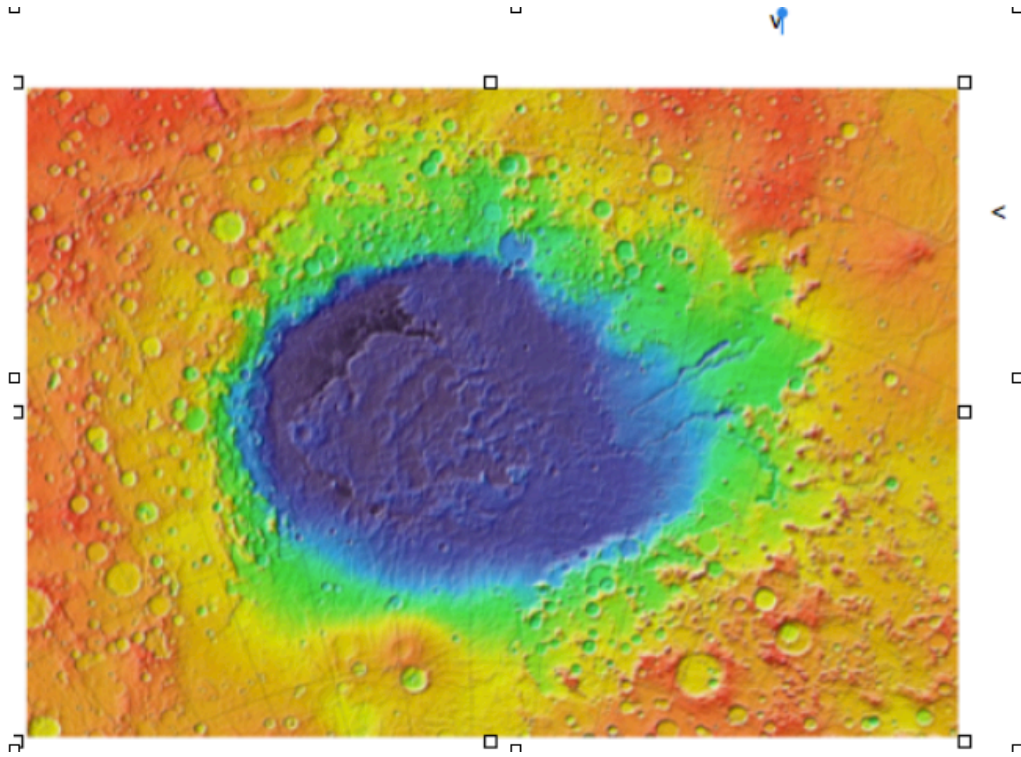
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## The top two best places on Mars to begin settlement

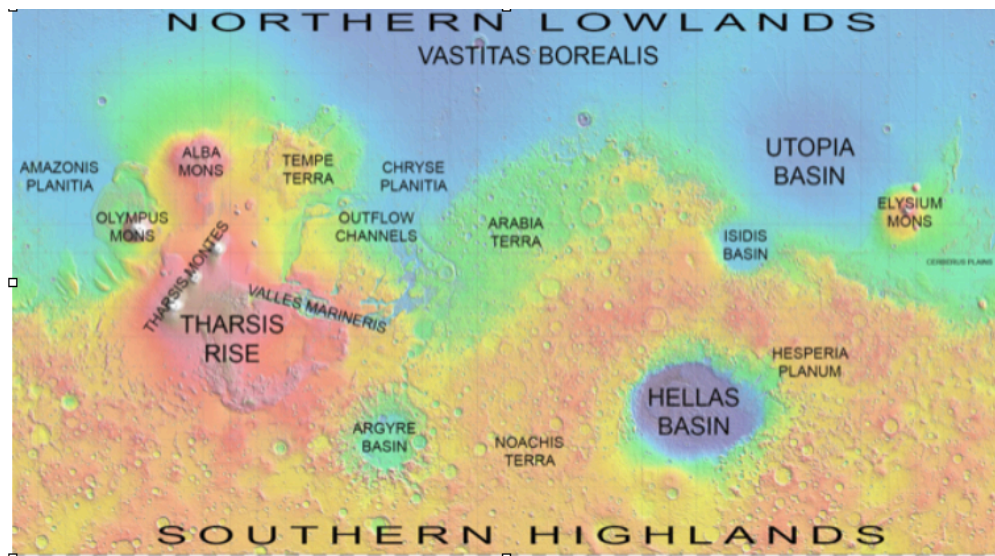
### Water & Basalt: where on Mars they are “close enough” to one another

1. **Hellas Basin** (water ice glaciers) and **Tyrrhena Mons** (basalt) to the NE at 2 o'clock position

[https://en.wikipedia.org/wiki/Tyrrhenus\\_Mons](https://en.wikipedia.org/wiki/Tyrrhenus_Mons)



2. **Utopia Basin** (water) and **Elysium Mons** (basalt) to the SE



While both of these sites are in the same hemisphere, the top tourist attraction, the stupendous canyon complex of **Valles Marineris** is quite a distance to the west.

## From Mars back to the Moon

### Meteor showers dig up water on the Moon

Water molecules released from the surface suggest water is buried in the Moon's soil  
By Lia Grossman, April 15, 2019

Meteor showers bring Moon geysers. A lunar orbiter spotted extra water around the moon when the moon passed through streams of cosmic dust that can cause meteor showers on Earth. The water was probably released from lunar soil by tiny meteorite impacts, planetary scientist Mehdi Benna of NASA Goddard Space Flight Center in Greenbelt, Md., and colleagues report April 15 in *Nature Geoscience*. Those random impacts suggest **water is buried all over the Moon**, rather than isolated in freezing dark craters — and that the Moon has been wet for billions of years.

Samples of lunar soil from the Apollo missions suggested that the Moon is bone dry. But since then, **several remote missions have found water** deposits on the Moon, including signs of frozen surface water in regions of permanent shadow near the poles (*SN: 10/24/09, p. 10*).

“We knew there was water in the soil,” Benna says. *What scientists didn't know was how widespread that water was, or how long it had been there.*

Benna and colleagues used observations from NASA's **LADEE spacecraft**, which orbited the Moon from November 2013 to April 2014 (*SN Online: 4/18/14*). LADEE's spectrometers detected dozens of sharp increases in the abundance of water molecules in the Moon's exosphere, the tenuous atmosphere of gas molecules that clings to the Moon. Twenty-nine of those measurements coincided with known streams of space dust.

When Earth passes through those streams, the dust burns up in the atmosphere, producing annual meteor showers like the Leonids and the Geminids. But because the Moon has no true atmosphere, bits of dust from the same showers strike the Moon's surface directly, stirring up what lies beneath.

Benna and colleagues calculated that only meteorites heavier than about 0.15 grams could have released the water. *That means the top eight centimeters (= 3.5 inches) or so of lunar soil are indeed dry — smaller impacts would have released water if any was there.*

*Beneath that dry coating is a global layer of hydrated soil, with water ice clinging to dust grains.* But the Moon is by no means soggy. *Squeezing half a ton of lunar soil would yield barely a small bottle of water*, Benna says. “It's not a lot of water by any measure, but it's still water.” And *it's too much water to have arrived at the Moon recently*, he says. The Moon may have held on to at least some of this water since the time of its formation (*SN: 4/15/17, p. 18*). *Future studies could help figure out whether and how that water could be useful for human explorers. ##*

## Capital "M" for (the) Moon

by Peter Kokh

In a letter in the October 1989 issue of Ad Astra [the Publication of the National Space Society] the writer took exception to this author's insistence that "Moon" be capitalized. His argument rested on several all too common misconceptions. Perhaps it would be helpful to discuss the salient facts. **Like Julius Caesar, the Moon is an original.**

*From time immemorial up until 1610 when Galileo first trained a telescope upon Jupiter and discovered it had four "moons," only one moon was known to mankind: The Moon, or Luna in Latin, the language of ancient Rome, or Selene in Greek.*

Similarly, until even more recent times when it became apparent that the Sun and the stars were members of the same class of celestial objects, we knew of only one "Sun." Until these discoveries, Moon and Sun had probably never been used in the plural. In one language version or another, since the dawn of language, **these were their names**. When we suddenly needed "class" names we borrowed these names from the sole objects we had ever known of each class. Ganymede, Titan, Phobos and company are thus "moons" *only and simply by analogy or by extension*. **The Moon** remains the original, the satellite of Earth.

*Nor, as some are tempted to think, does the presence of the definite article "the" mean that "Moon" must be a common noun. If so, we had best use "the bahamas," "the philippines," "the hague,"*

*AND, oh..... "the united states." Got you! ##*

### P.S. "Stars" and "Suns":

Let's call all stars that have planets, "suns" and those that do not, just "stars."

*In practice them, every star we see, is by default just a star, until or unless we find at least one "planet" revolving around it, as is the case with Proxima Centauri.*

We had thought that one of the two stars revolving around a common center of gravity, Alpha Centauri A and B, the latter might have a planet, but that has been disproved. Planets in a "close" binary might have wild orbits, and any ocean on either would have wild tides, if the two binary stars came close to one another. ##

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I hope to see some of you at the upcoming International Space Development Conference, ISDC, in Washington DC, June 5-9, 2018. PK