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1.

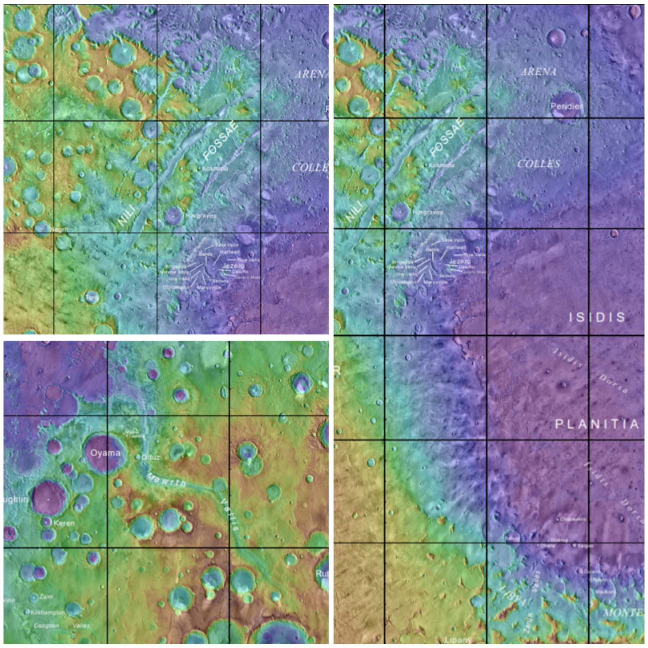

Figure 1. Maps of the *Mars Orbiter Laser Altimeter* (MOLA) instrument of different Mars structures. At the top, the Nili Fossae region. At the bottom, the Mawrth Vallis area outflow channel. Isidis Planitia bordering Nili Fossae at the left. Each grid represents 300 km.

a. This article [1] deals with phyllosilicates, i.e. Fe/Mg and Al phyllosilicates, a class of hydrous minerals.

b. These minerals were identified from high-spatial-resolution, precision-pointing, and nested observations collected using a range of instruments on board of the *Mars Reconnaissance Orbiter* (MRO). These are the *Compact Reconnaissance Imaging Spectrometer for Mars* (CRISM), with mineralogical mapping at 18 m per pixel, the *Context Imager* (CTX) and *High Resolution Imaging Science Experiment* (HiRISE), for martian metre-scale geomorphology. Images of the *Observatoire pour la minéralogie, l'eau, les glaces et l'activité* (OMEGA), *Mars Orbiting Camera* (MOC) and *High Resolution Stereo Camera* (HRSC) instrument, from other Mars orbiters missions, were also analysed. To study these minerals, reflectance spectra from 1.0 to 2.6 μm were used.

c. Al and Fe phyllosilicates have been observed over vast areas in the Mawrth Vallis area, and are commonly found along the flanks of the outflow channel and within the surrounding plateau. Expansive outcrops of phyllosilicates and olivine are also found across a distance of 2 000 km from the Nili Fossae region to the southern edge of the Isidis Basin. The researchers also made hundreds of detections of Fe/Mg phyllosilicate in rims, ejecta, and central peaks of craters in the southern highland Noachian-aged cratered terrain.

d. These geological structures are a part of the earliest geological era of Mars - the Noachian.

e. The researchers found evidence of alteration of extensive sections of Noachian crust, based on the striking association of phyllosilicates with impact craters. They argue that these impacts excavated pre-existing deposits or kickstarted phyllosilicate formation processes.

Olivine deposits, a mineral susceptible to aqueous alteration, overlain the phyllosilicates, whose formation requires high water activity. The fact that olivine was deposited prior to Isidris Basin formation during the late Noachian, and no alteration is observed indicates that the phyllosilicates were formed earlier than the olivine deposition, i.e during the Noachian.

f. Large Valles features are named after Mars/star in various languages. *Mawrth* is a welsh word for *Mars.* Fossae and Planitiae, albedo features, have names from classical mythology assigned by Schiaparelli and Antoniadi, e.g. *Isidis* after the Egyptian goddess of heaven and fertility - *Isis.*

g. (Figure 1)

2. A plethora of celestial bodies can be found just in the Solar System. Of them, the terrestrial planets and natural satellites provide the most astounding sights of rich geological features. The most obvious difference between them is their size, Earth and Venus being the standouts with almost double the radius of the next largest body - Mars. Their relatively large size translates to a large volume to surface area i.e. a slow release of their internal heat, an already large amount of energy in relation to its smaller cousins.

However, the Earth and Venus *twins* share little more features than their size and composition. A Venusian day is longer than its year, rotating with an unusual axis rotation of 177.3°. This could explain its weak magnetic field in relation to Earth, due to a weak dynamo effect in the core, but few signs of volcanism are also present in the planet [2]. Earth has its share of unique features as well, being the only planet with constant liquid water on the surface, a multi-plaque tectonic system, and a moon size comparable with those of the giants. The state-of-the-art science explains the evolution of these unique planets with primordial major collisions. A large collision with early Venus could have literally turned him upside down and released large amounts of its internal heat. On Earth, a collision with a Mars-sized planet - Theia

- reaped its crust creating an accretion disk that would eventually form the Moon. Very recent research indicates that Theia was a water world, inputting a large quantity of water to the early Earth [3]. This new water-rich composition of Earth's geological layers meant less friction between them, starting massive convection currents carrying heat from the interior to the planet's surface [4]. This unique feature of Earth is essential for recycling its crust and this is why it is so young. Such a system isn't found on Venus, however, its lightly cratered surface indicates a young crust as well. The answer might be in its very dry geological composition. Since no tectonic features are present due to high friction, i.e. larger amounts of energy to start convention within the mantle, the inner heat escapes through generalized volcanism episodes where the low lands of Venus melt in unison, spanning all the planet's surface. The theory finds ground in the fact that the high lands, where the lavas don't reach, are heavily cratered in opposition to the low regions.

The next largest body - Mars' - interior quickly cooled in relation to the latter planets, leaving an early formed crust to the elements. With no crust recycling, much of Mars' crust is very ancient and cratered, and interesting consequences arise. With a stationary crust, a hot spot built the largest shield volcano on the Solar System over millions of years - *Olympus Mons*! [5]. The lowlands of the southern hemisphere lack the crater features of the northern highlands. Theory suggests that an ancient surface ocean protected the seafloor from collisions [6]. Ancient (and not so ancient [7]) martian water carved the landscape into beautiful deltas, salt deposits, and gullies. Aeolian features are abundant like wind tails, drift deposits, dune forms [8].

The last of the telluric planets brothers, and the least researched, Mercury has many mysteries to solve. It has an ancient cratered crust and an abnormally large core. Surface cracks (or fault scarps), potentially caused by the shrinking of the planet, may indicate a one-plate tectonic system [9]. Hopefully, *BepiColombo*'s recent arrival to Mercury can shed light on the Sun's closest neighbor.

The formation and consequent evolution of the giants' moons are very different from the rocky planets since they are formed almost independently, in their own secondary *planetary* systems. There is only one rocky moon of the gaseous planets e.g. Io the planet of volcanism (Earth's moon is the only other rocky moon, however, its formation is associated with a cataclysmic event as explained before). This volcanism is fueled by the high tidal forces experienced by the satellite interior due to a distorted orbit. This tidal heating makes Io the most geologically active object in the Solar System! [10].

All other moons are icy. This means that their surfaces are composed mostly of water ice. If these satellites are heated by tidal forces, similar to Io, they could harbor an extensive subsurface ocean, or several, underneath the ice resulting in surface features, e.g. Enceladus *tiger stripes*, or even cryovolcanism. This type of volcanism is similar to Earth and Io's 'lava volcanism' but erupts volatiles at very low temperatures. Direct observations of cryovolcanism have been made like Titan's *Doom Mons* or Enceladus, and potentially Triton, geysers. Some dwarf-planets, mainly Pluto and Ceres, also appear to exhibit cryovolcanism features [11].

Titan is an oddball among the giants' natural satellites. Being the largest moon of Saturn and the second-largest natural satellite in the Solar System, Titan is also the only moon with an atmosphere in hydrostatic equilibrium and the only known moon (or planet!) other than Earth on which clear evidence of stable bodies of surface liquid has been found. This means a complex climate system, composing an earthlike cycle of liquids raining from clouds, flowing across its surface, filling lakes and seas, and evaporating back into the sky, akin to Earth's water cycle however with hydrocarbons, mainly methane and ethane. The surface is then described as *complex, fluid-processed, [and] geologically young* [12], shaped by fluvial and eolian erosion.

Very little is known about these and other celestial bodies yet humanity has already laid eyes to so many astounding sights. Each year new space missions are assigned to these alien worlds. *Psyche* orbiter mission will explore the origin of planetary cores and, with this, try to increase the understanding of planetary formation and interiors [13]. *Europa Clipper* will investigate Europa's habitability by studying deeply what's beneath the surface ice [14]. *Dragonfly* is an astrobiology mission to Titan to assess its microbial habitability and study its prebiotic chemistry at various locations [15]. These are just a few examples of humanity's latest effort to better understand our celestial cousins.

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