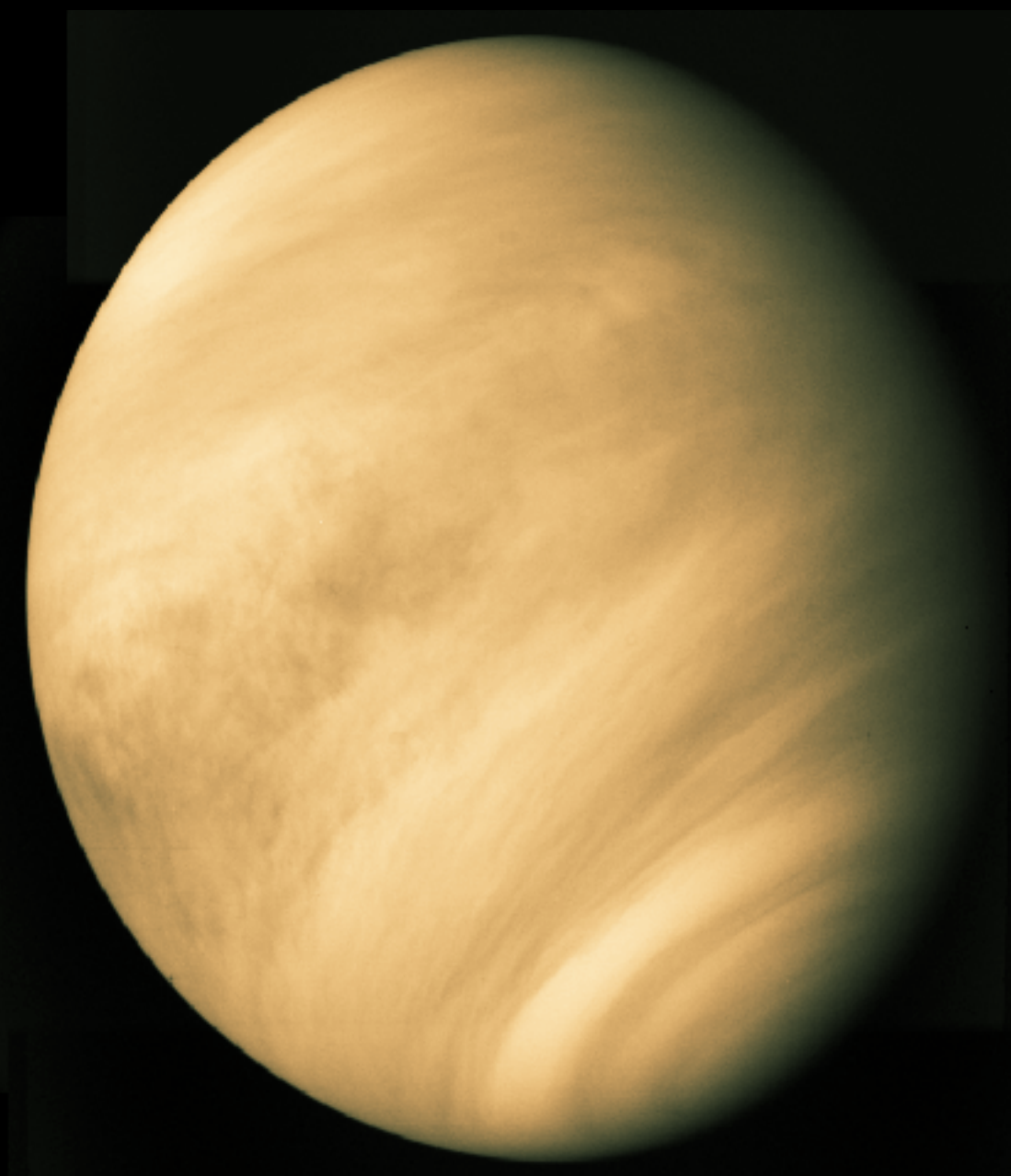
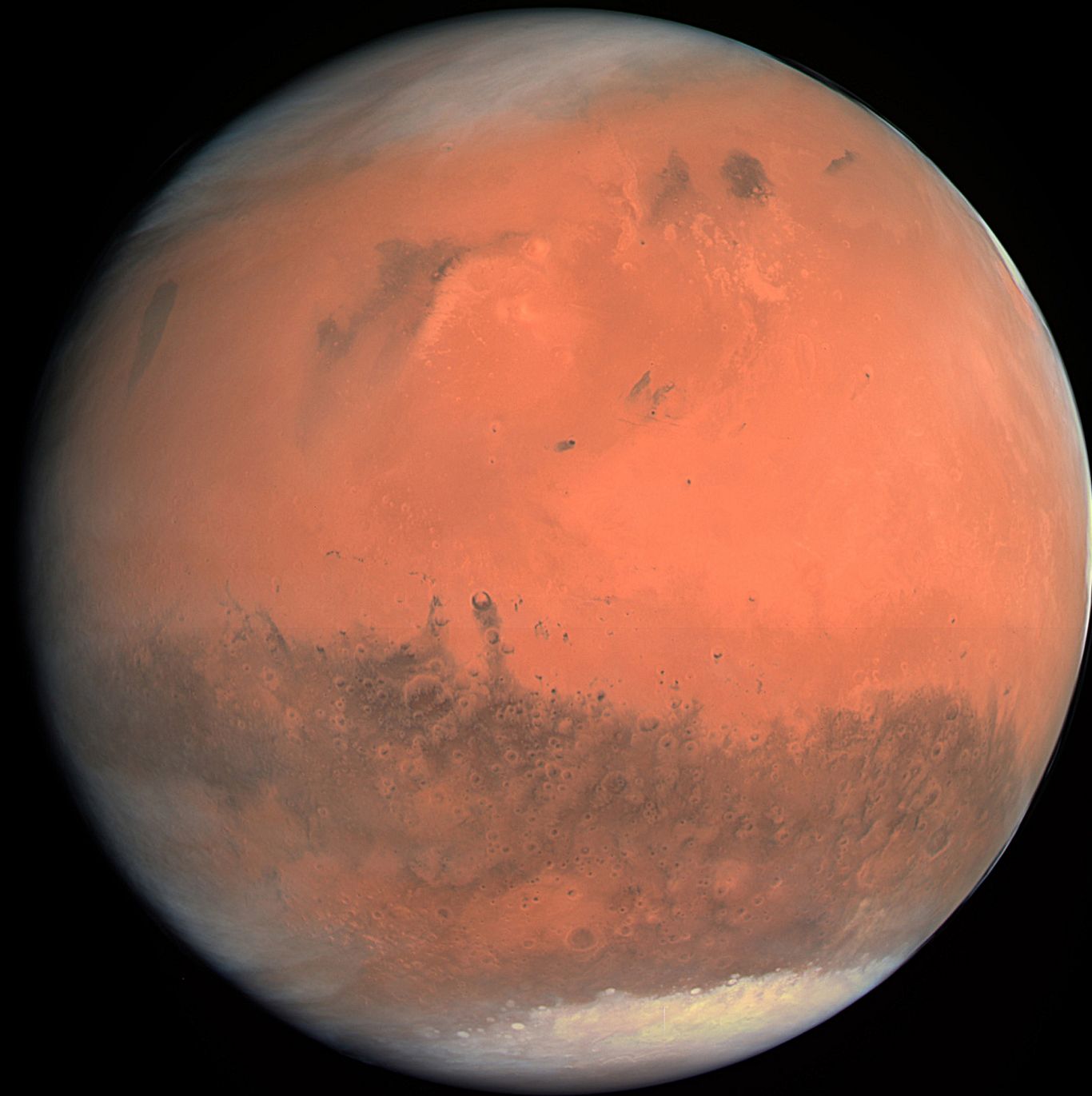






The above image is a mosaic of the Valles Marineris hemisphere of Mars. The center of the scene shows the entire Valles Marineris canyon system, more than 3,000 kilometers long and up to 8 kilometers deep. Although it appears to be a canyon formed by water, in fact, Valles Marineris is a deep crust fracture.



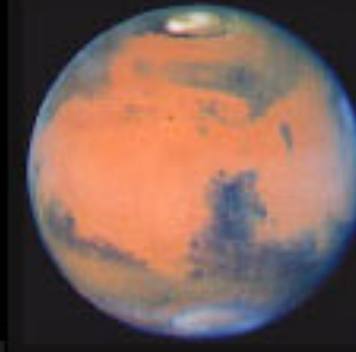
Christiaan Huygens,
1659



Giovanni
Schiaparelli,
1888



Telescopic view,
early 1960s



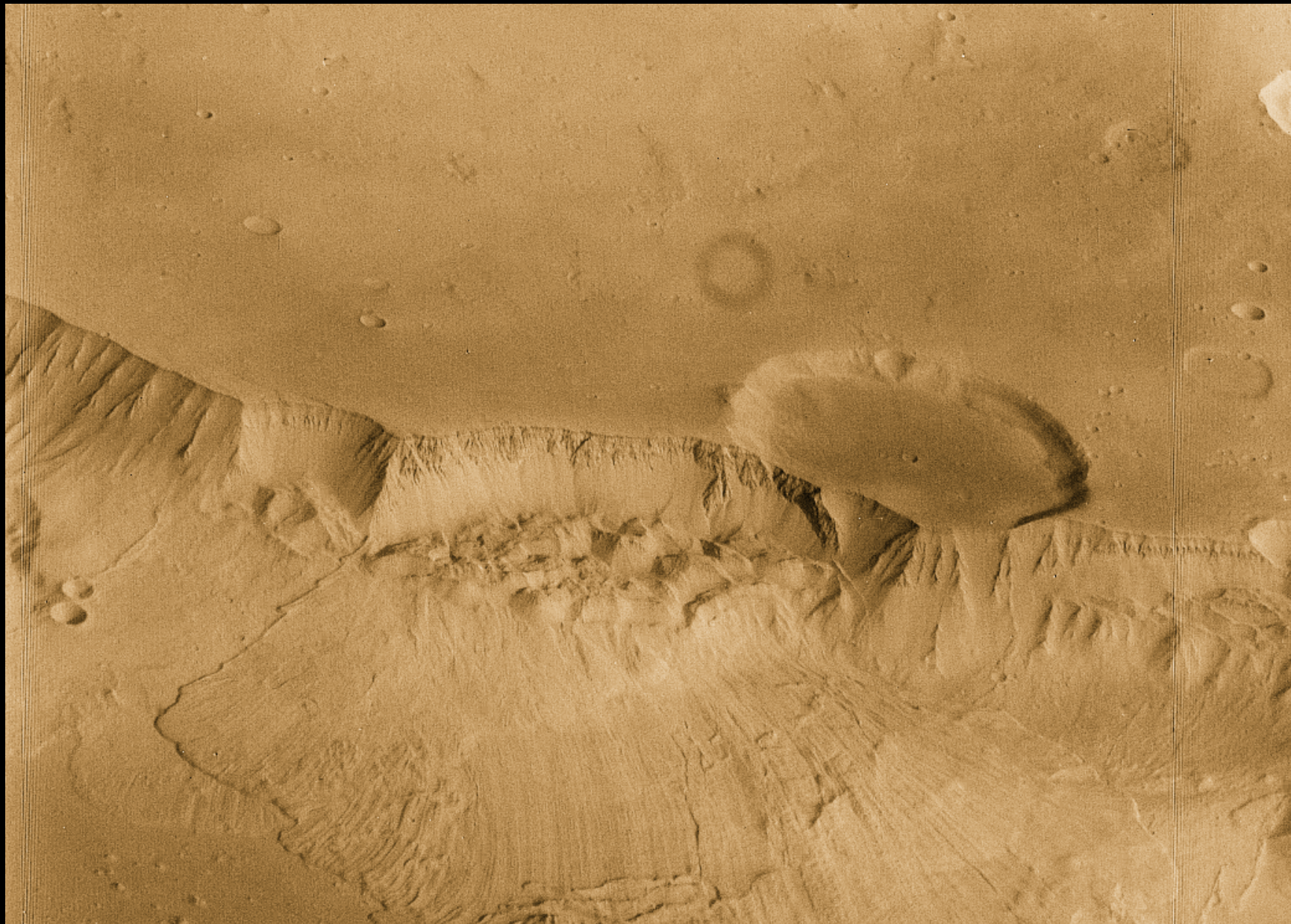
Hubble Space
Telescope,
1997



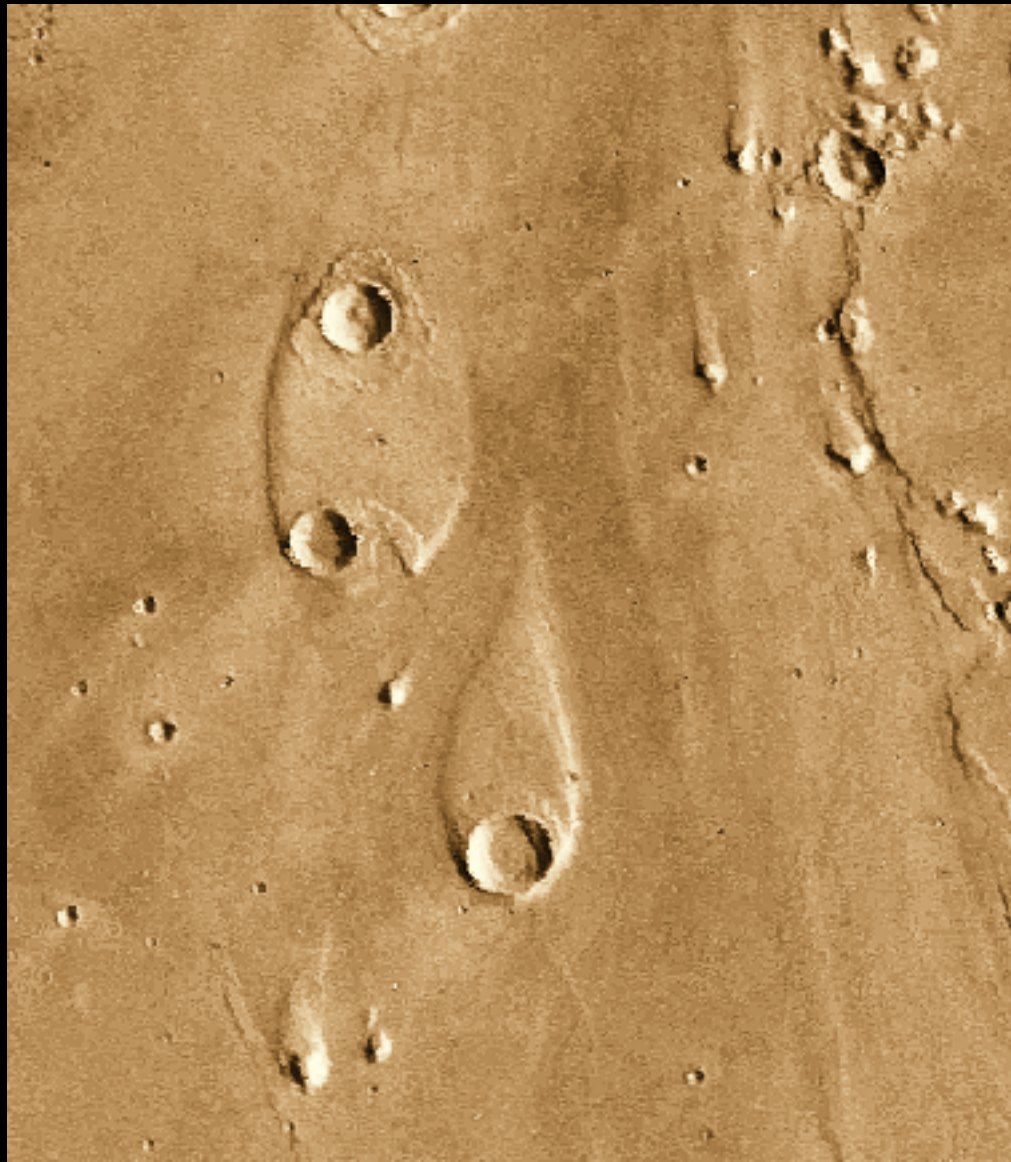
Mars Global
Surveyor,
2002

Courtesy of WORKMAN PUBLISHING, INC.; NASA/JPL/MALIN SPACE SCIENCE SYSTEMS (*Mars Global Surveyor*)

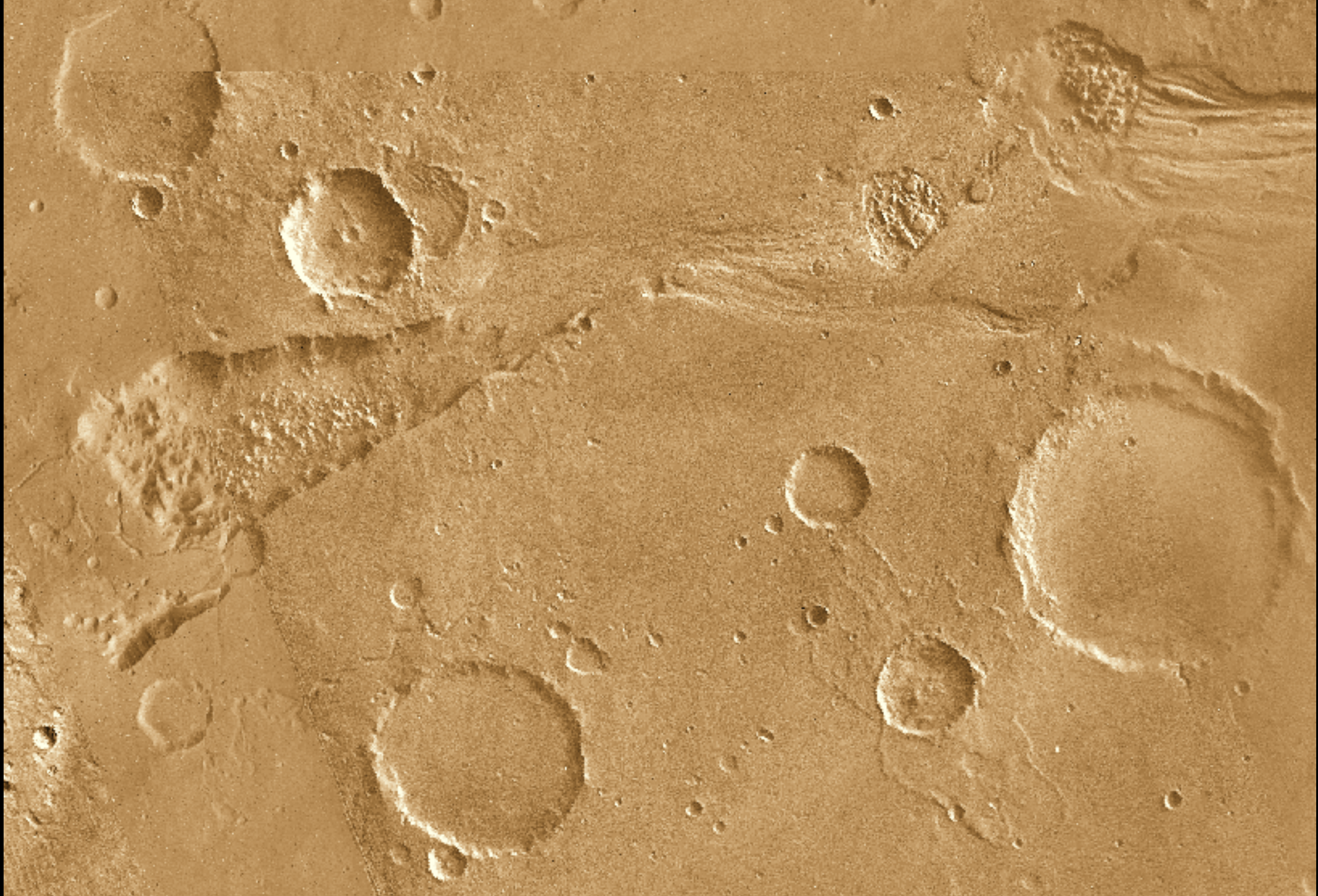
Mars is the fourth planet from the Sun and the second-smallest planet in the Solar System, after Mercury. Named after the Roman god of war, it is often referred to as the "Red Planet" because the iron oxide prevalent on its surface gives it a reddish appearance. Mars is a terrestrial planet with a thin atmosphere, having surface features reminiscent both of the impact craters of the Moon and the valleys, deserts, and polar ice caps of Earth.



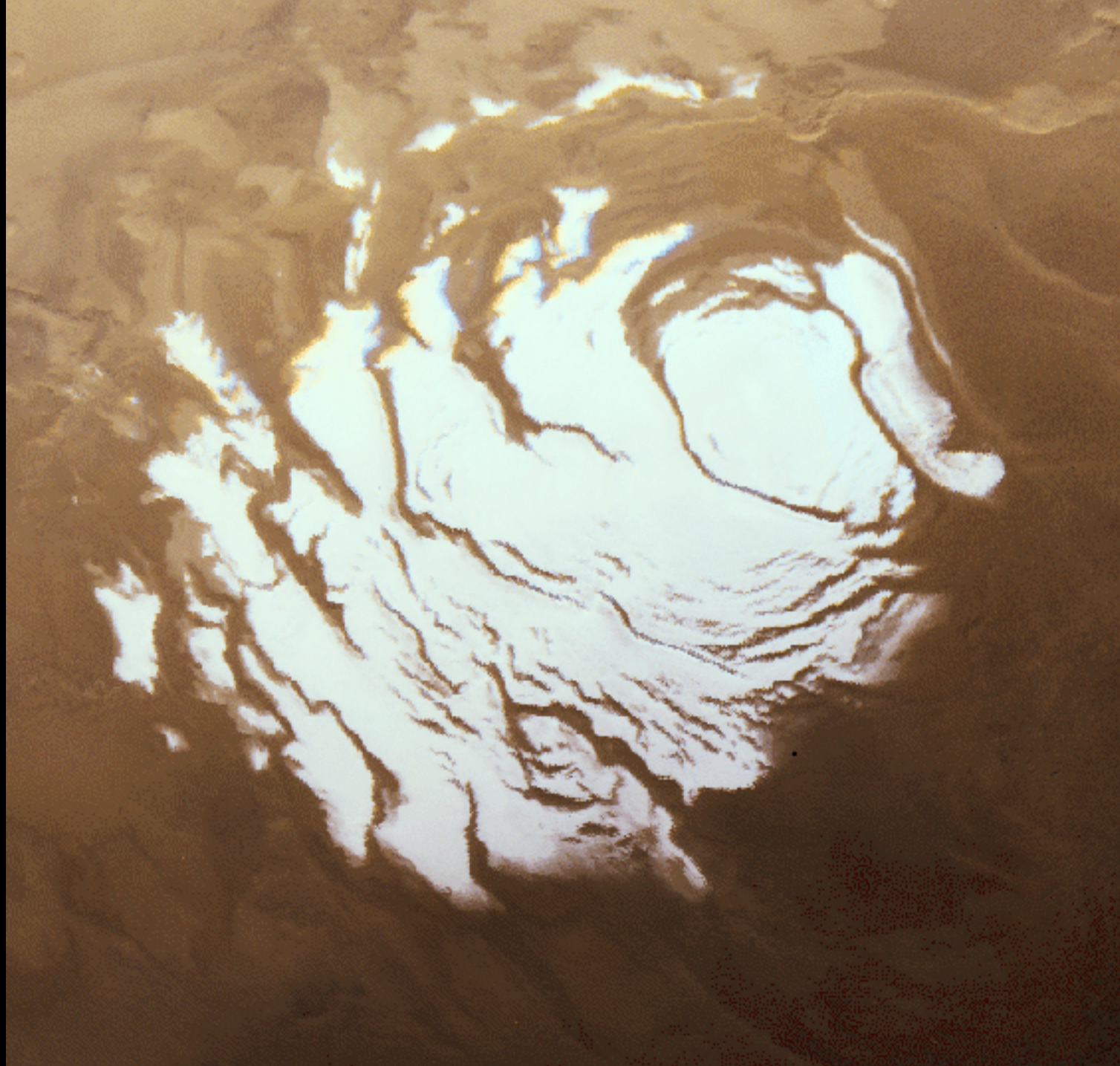
Although Valles Marineris originated as a tectonic structure, it has been modified by other processes. This image shows a close-up view of a landslide on the south wall of Valles Marineris. This landslide partially removed the rim of the crater that is on the plateau adjacent to Valles Marineris. Note the texture of the landslide deposit where it flowed across the floor of Valles Marineris. Several distinct layers can be seen in the walls of the trough.



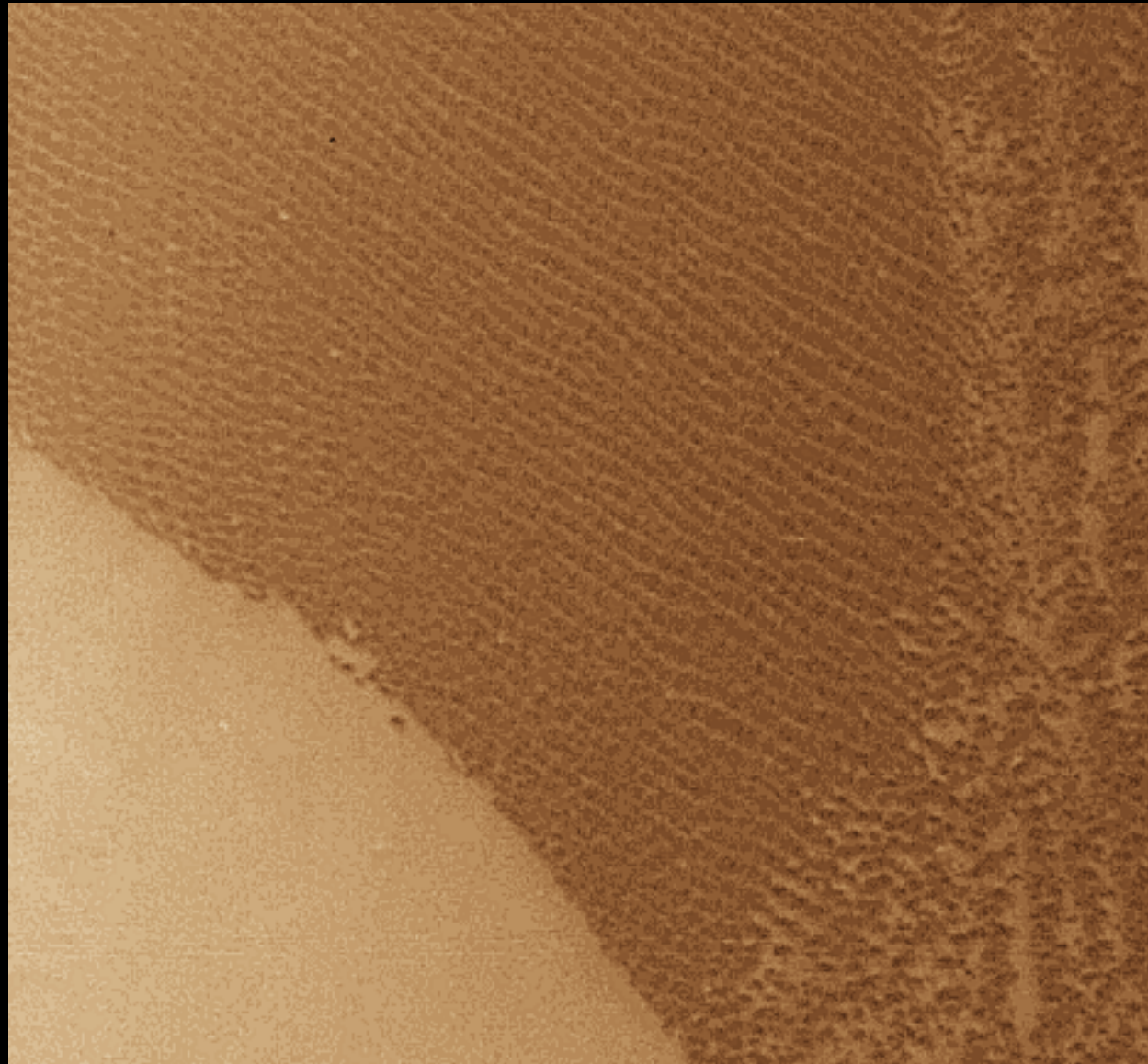
The water that carved the channels to the north and east of the Valles Marineris canyon system had tremendous erosive power. One consequence of this erosion was the formation of streamlined islands where the water encountered obstacles along its path.



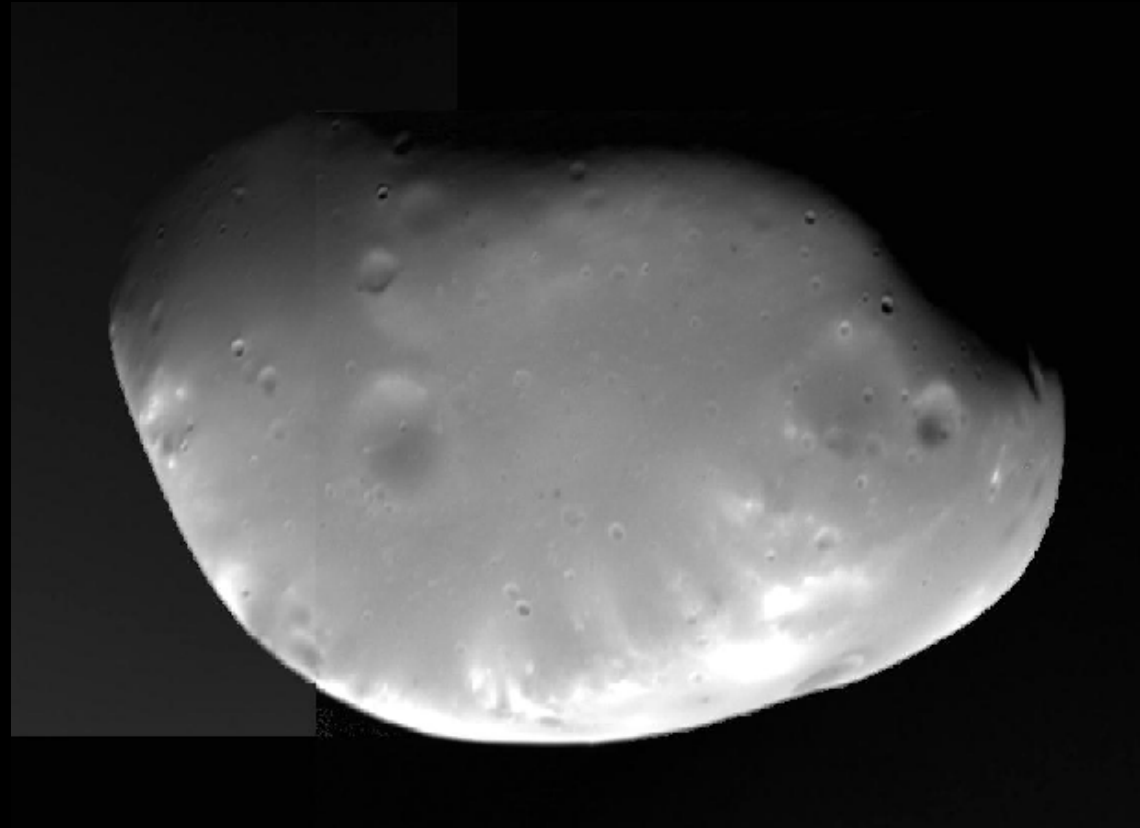
This image of the head of Ravi Vallis shows a 300-kilometer (186-mile) long portion of a channel. Like many other channels that empty into the northern plains of Mars, Ravi Vallis originates in a region of collapsed and disrupted ("chaotic") terrain within the planet's older, cratered highlands.



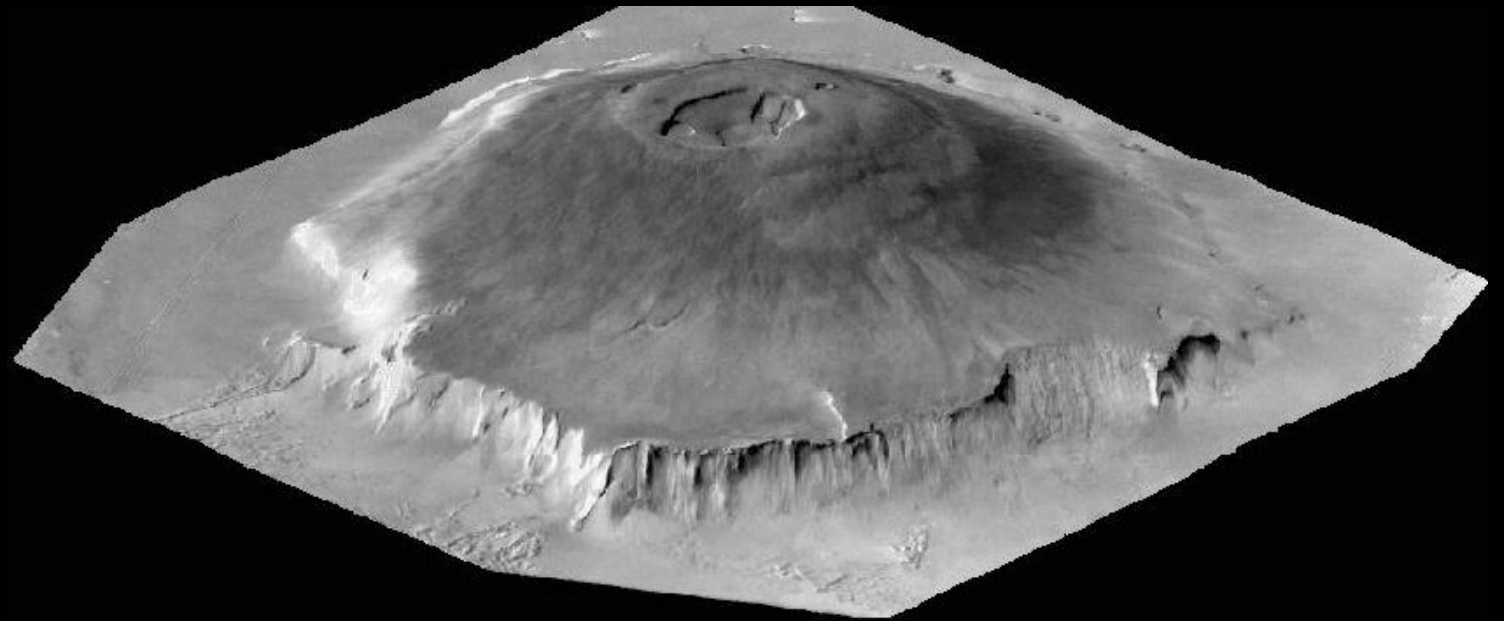
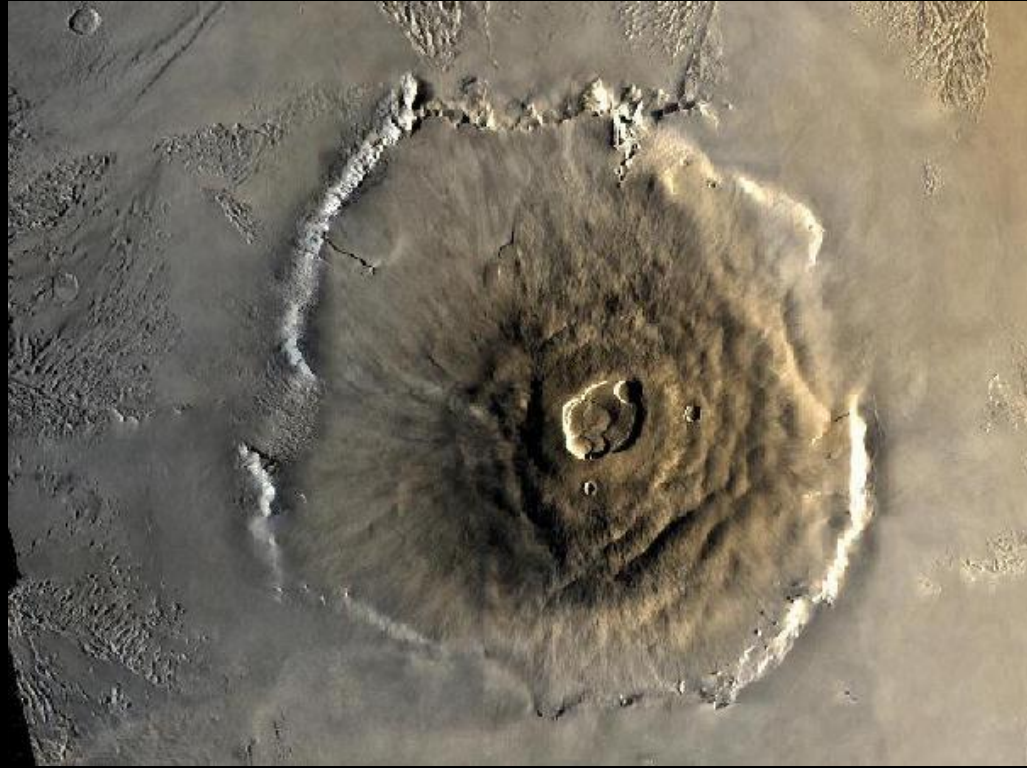
Mars has two permanent polar ice caps. During a pole's winter, it lies in continuous darkness, chilling the surface and causing the deposition of 25-30% of the atmosphere into slabs of CO₂ ice (dry ice). When the poles are again exposed to sunlight, the frozen CO₂ sublimates, creating enormous winds that sweep off the poles as fast as 400 km/h (250 mph).



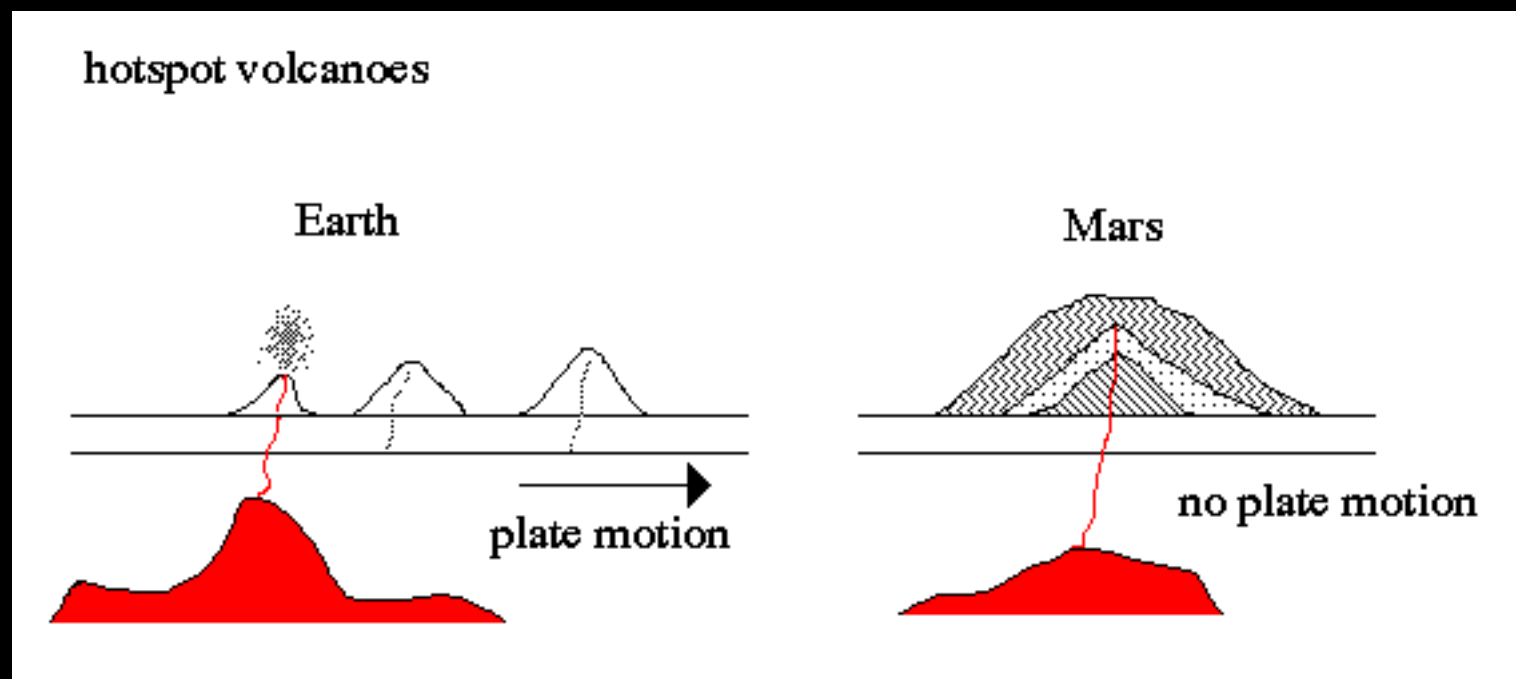
large regions devoid of faults or craters (not maria since no young craters are found). Observations by Viking Orbiter showed them to be deserts with dunes.

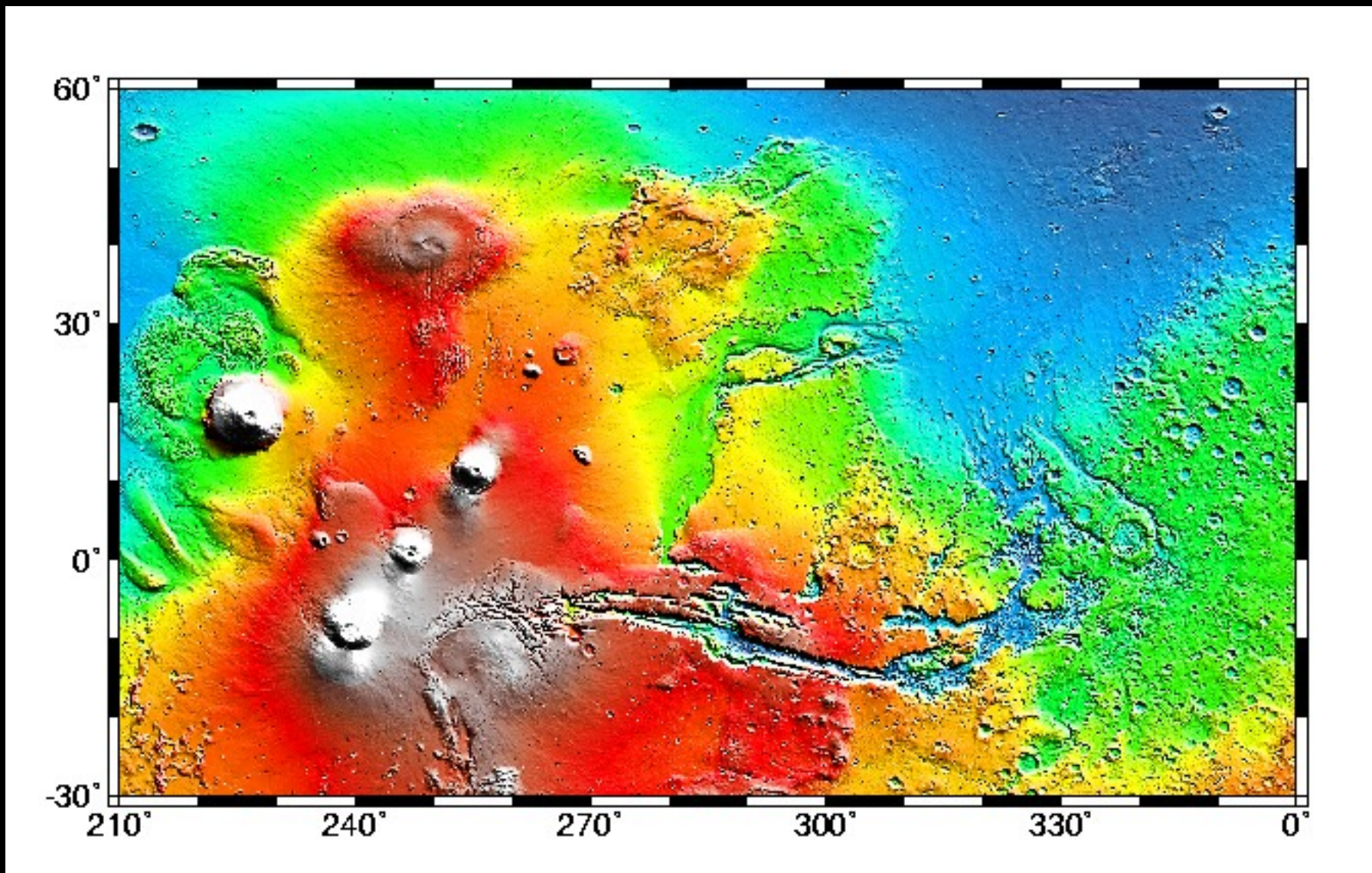


Mars has two relatively small natural moons, Phobos (about 22 km in diameter) and Deimos (about 12 km in diameter), which orbit close to the planet. Asteroid capture is a long-favored theory, but their origin remains uncertain.



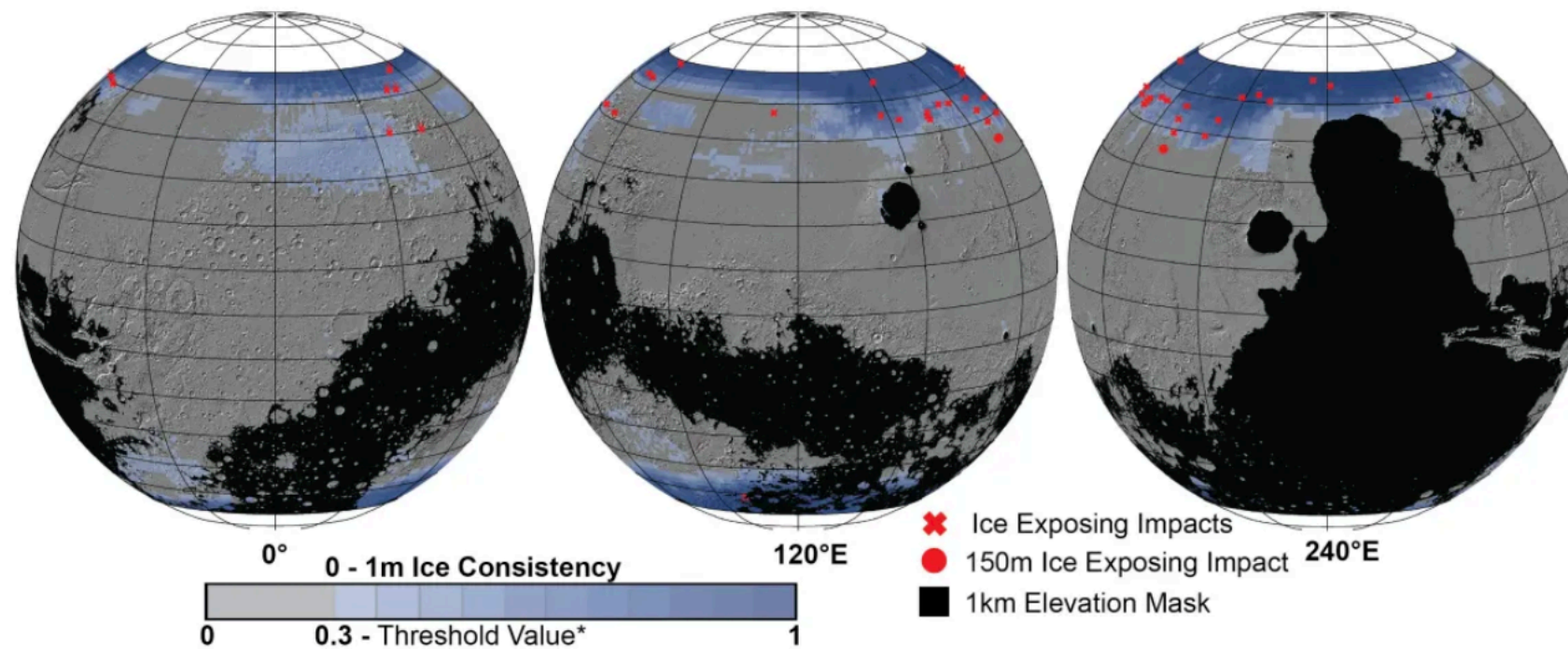
The Tharsis and Elysium regions are rich in old cone volcanoes, averaging over 500 km across and 25 km high. The largest is Olympus Mons, shown above. These are ``hotspot'' volcanoes like the Hawaii Islands.





There is a great deal of evidence of the existence of liquid water on Mars, at least in the far past.

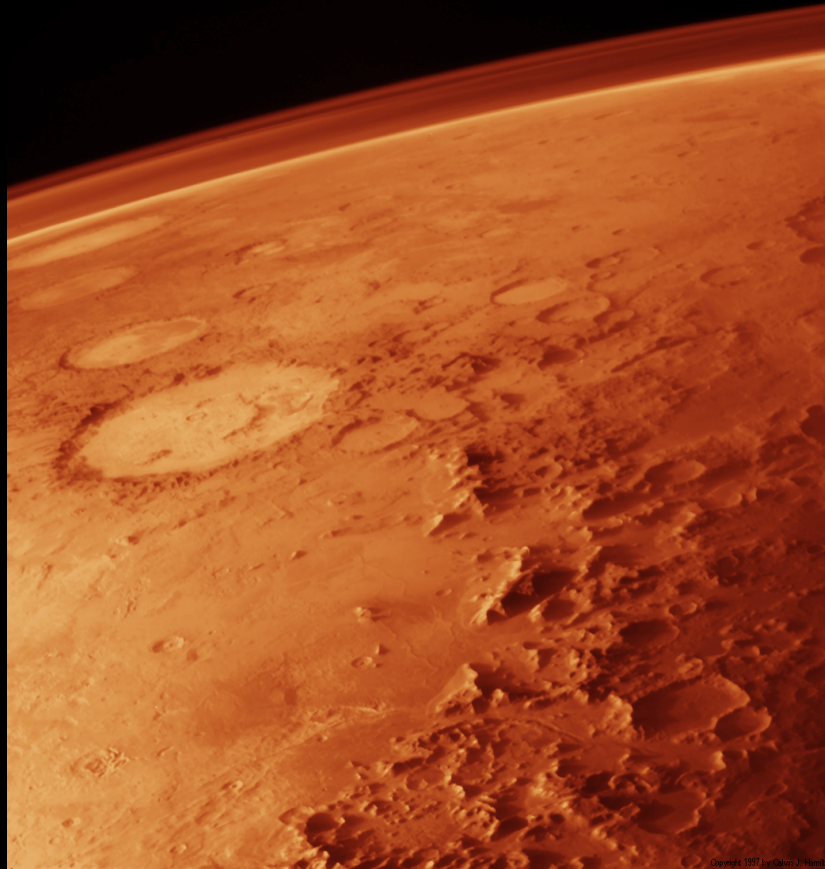
The secondary atmosphere for all terrestrial worlds is rich in CO₂, H₂O and SO₂. On Earth, the temperature is just right for H₂O to rain out and form oceans. On Venus, the temperature is too hot and H₂O stays as a vapor to be destroyed by photodisintegration. On Mars, it is too cold for large amounts of liquid water (i.e. oceans and lakes). Currently, all the H₂O is locked up in permafrost and subsurface ice reservoirs.



These Mars global maps show the likely distribution of water ice buried within the upper 3 feet (1 meter) of the planet's surface and represent the latest data from the SWIM project. Buried ice will be a vital resource for astronauts on Mars, serving as drinking water and a key ingredient for rocket fuel.

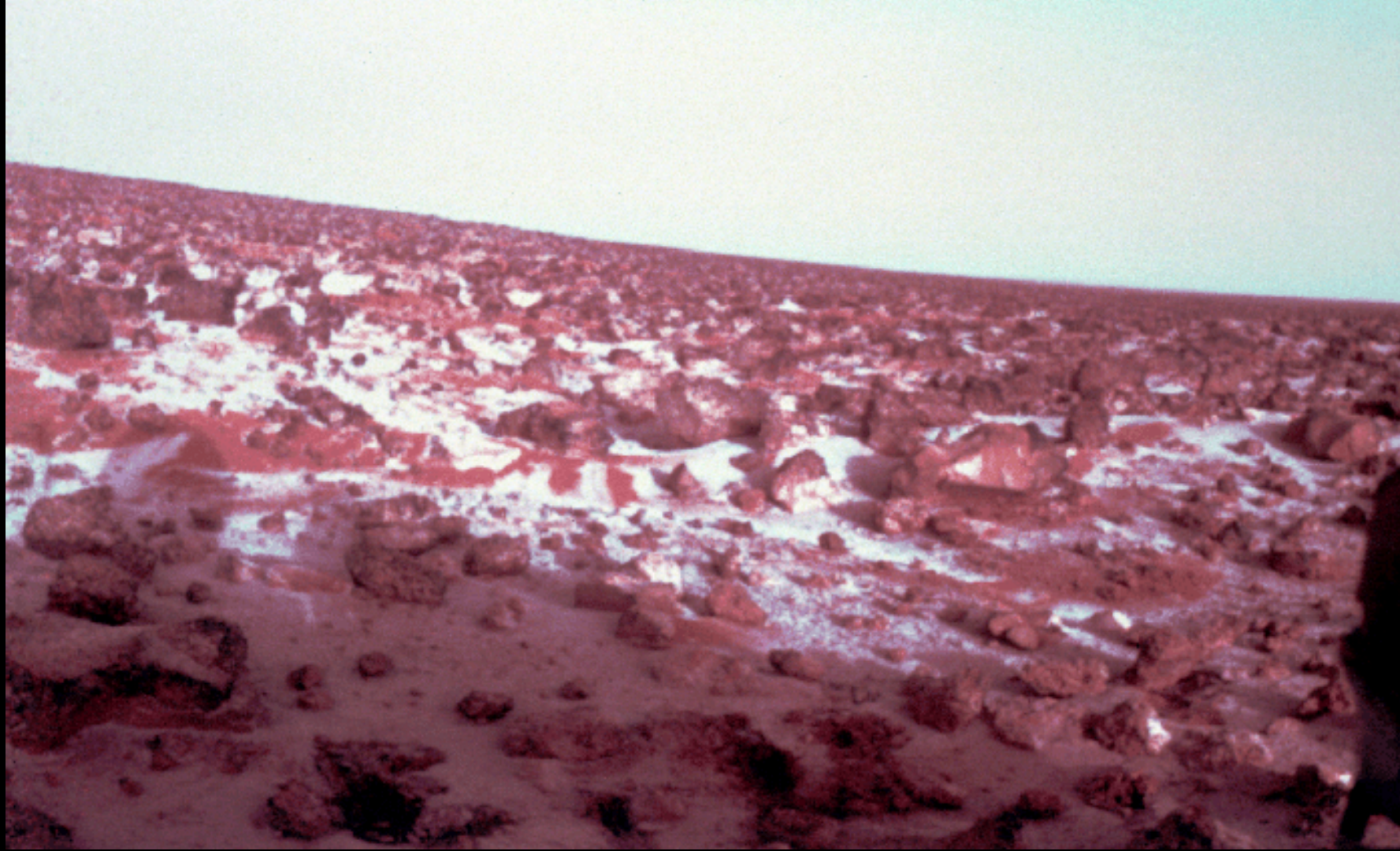
NASA/JPL-Caltech/PSI

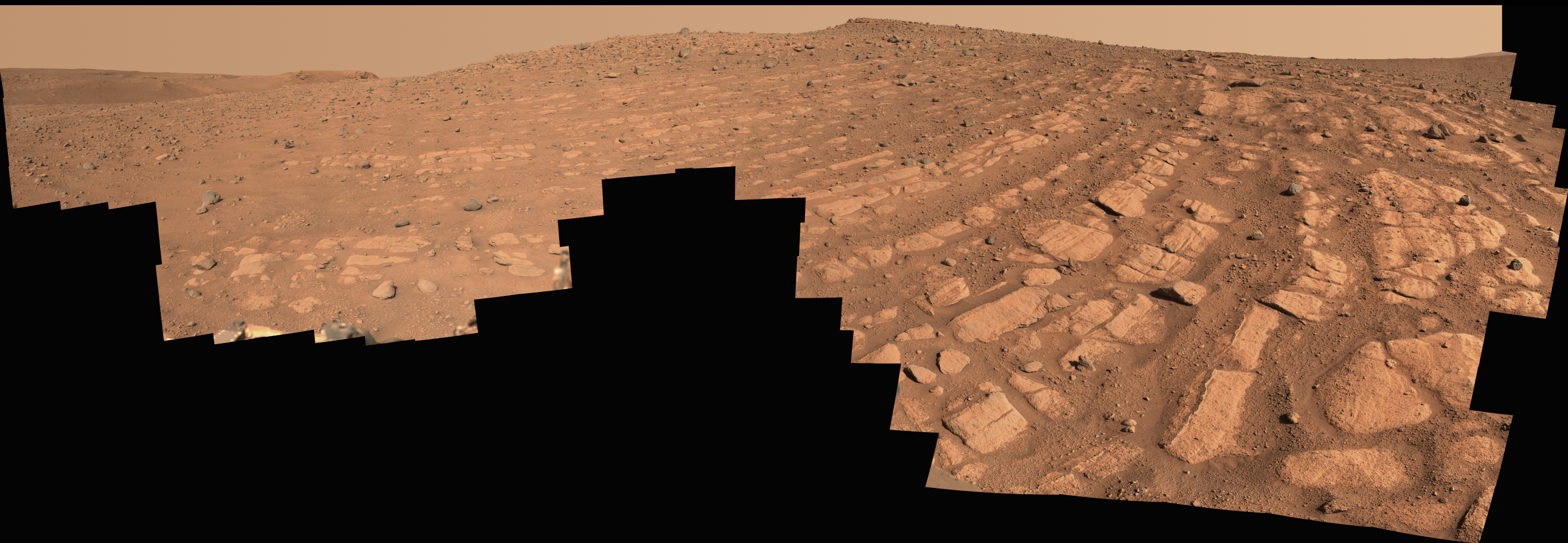




Compared to Earth, the atmosphere of Mars is quite rarefied. The highest atmospheric density on Mars is equal to that found 35 km (22 mi) above Earth's surface. The resulting mean surface pressure is only 0.6% of that of Earth (101.3 kPa) .

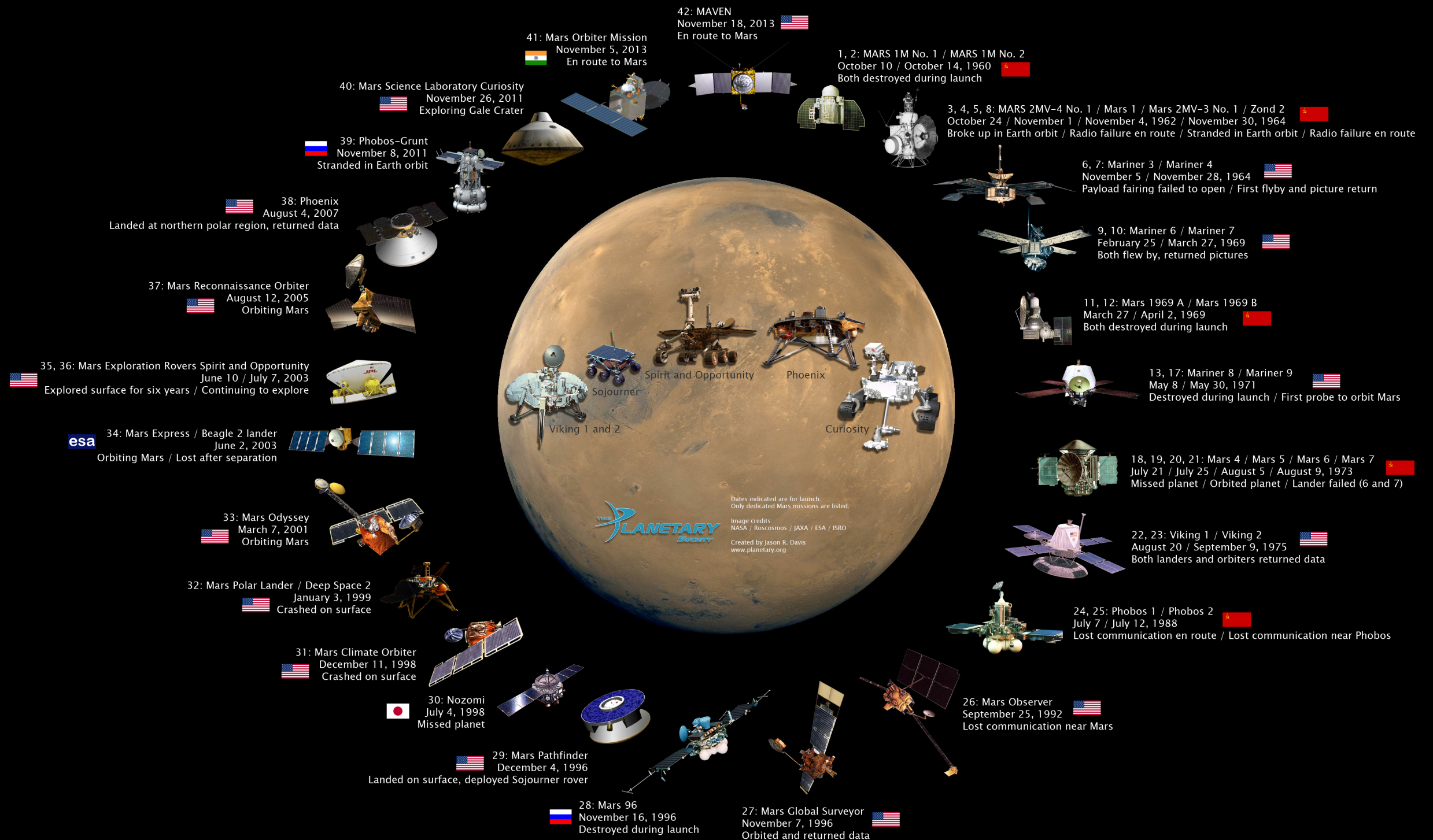
The atmosphere of Mars consists of about 96% CO₂, 2% N₂, 2% Ar and less than 1% O₂. A high noble gas content implies that Mar's atmosphere was much thicker in the past (noble gases do not react with other elements and are heavy enough to stay within the gravitational field of Mars). The atmosphere is quite dusty, containing particulates about 0.015 mm in diameter which give the Martian sky a tawny color when seen from the surface.





Scientists think that the bands of rocks seen in this image may have been formed by a very fast, deep river – the first of its kind evidence has been found for on Mars. NASA's Perseverance Mars rover captured this mosaic at a location nicknamed "Skrinkle Haven" using its Mastcam-Z camera between Feb. 28 and March 9, 2023 (between the 721st and 729th Martian days, or sols, of the mission).

Mars Exploration Family Portrait



MARS ROVERS (1971-2021)

Sojourner
(NASA - 1997)

Spirit
(NASA-2004)

Mars
Astronaut
(?)

Curiosity
(NASA-2012)

Zhurong
(China-2021)

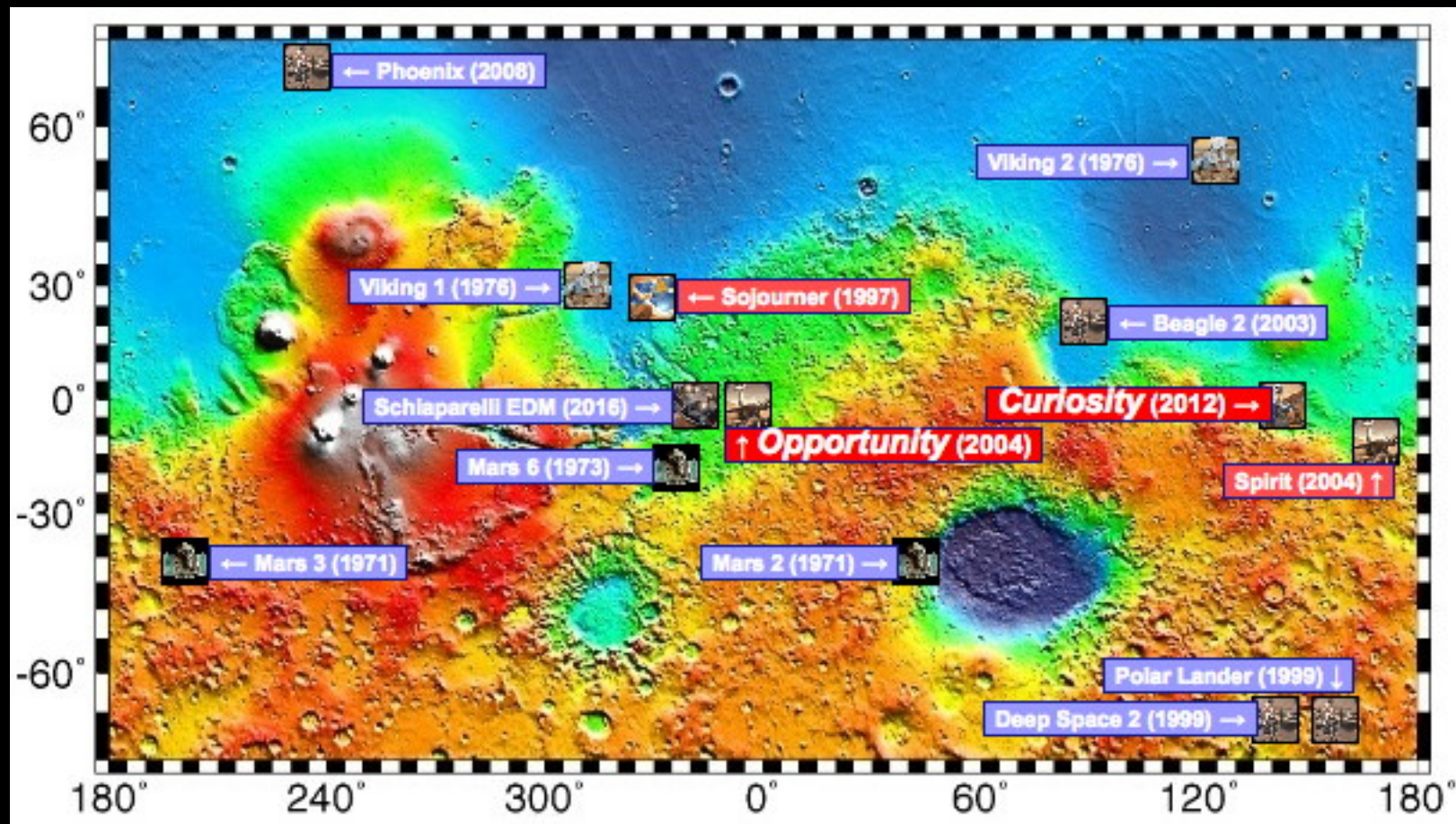
Mars 3 Prop-M
(USSR-1971)

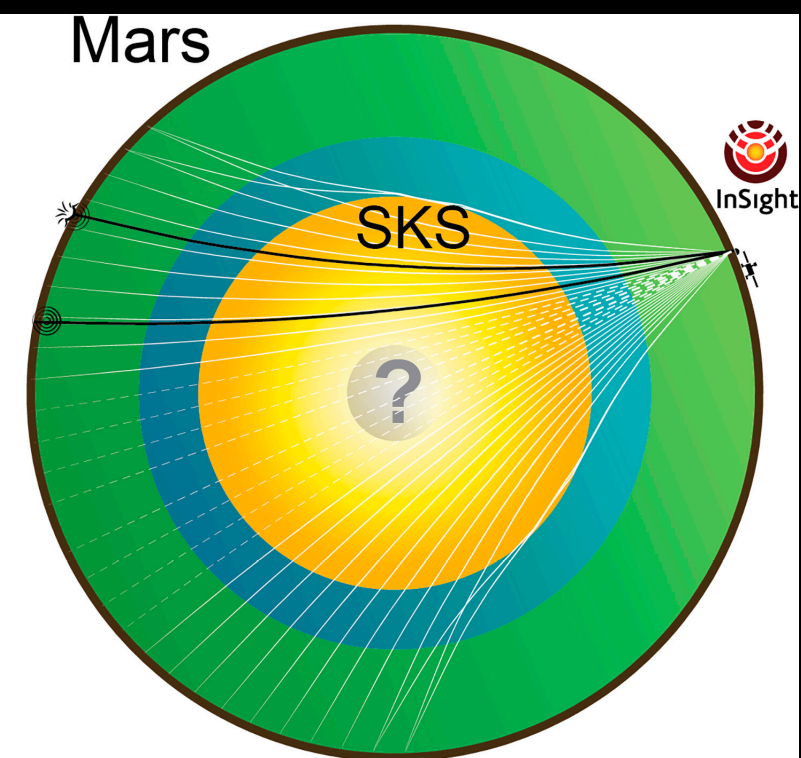
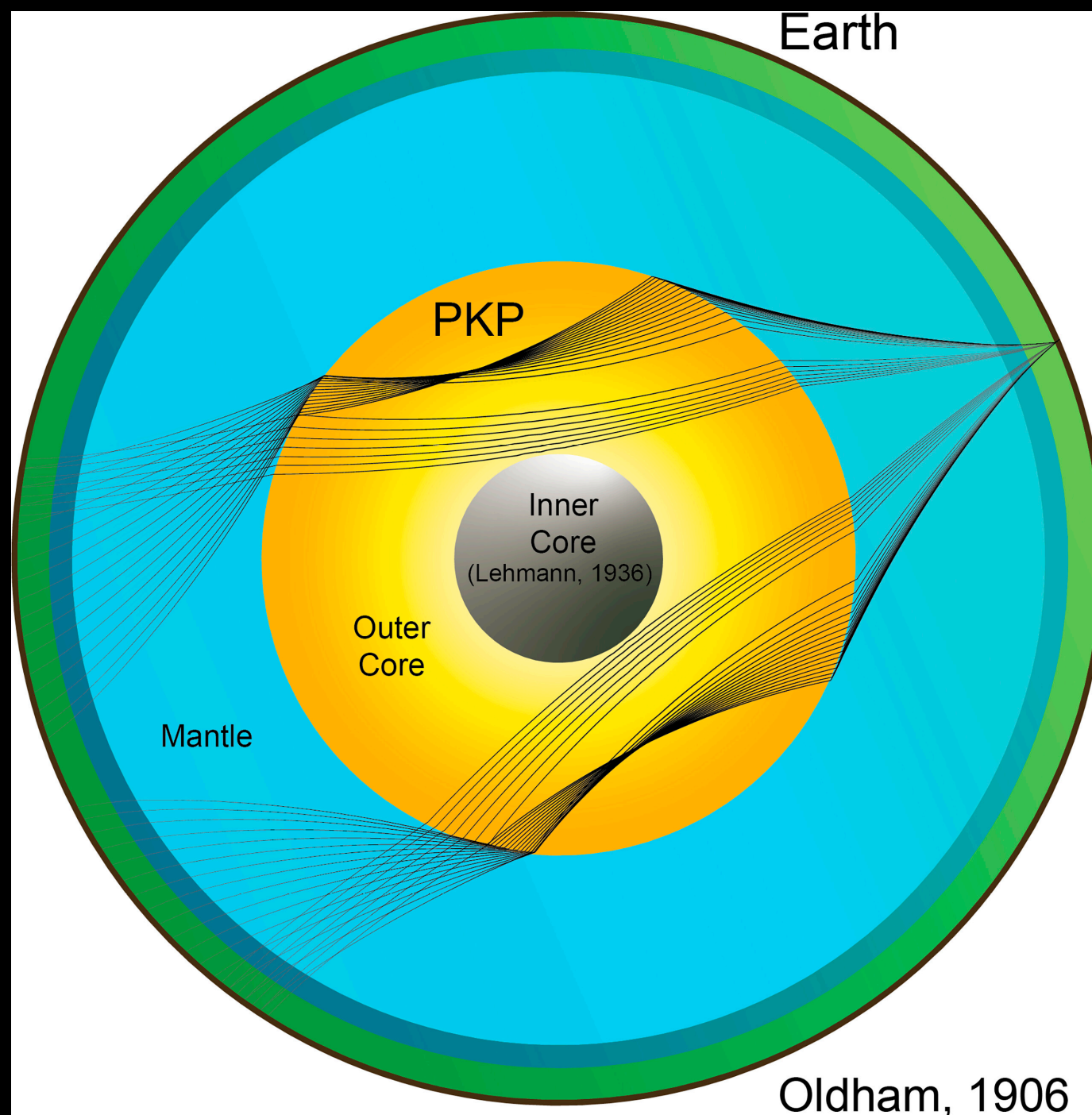
Opportunity
(NASA-2004)

Perseverance
(NASA-2021)

Ingenuity
(NASA-2021)

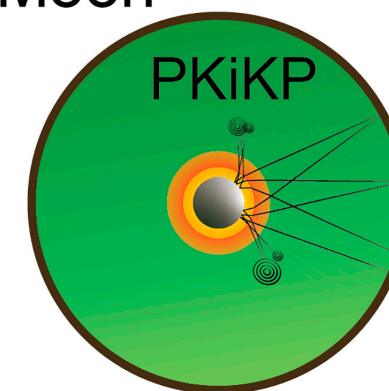
Mars has a surface and soil that is mostly old impact debris with sand-blasted gravel. The soil is rich in Si and Fe, Fe oxide (rust) given Mars its red color.





Irving et al. (this study)

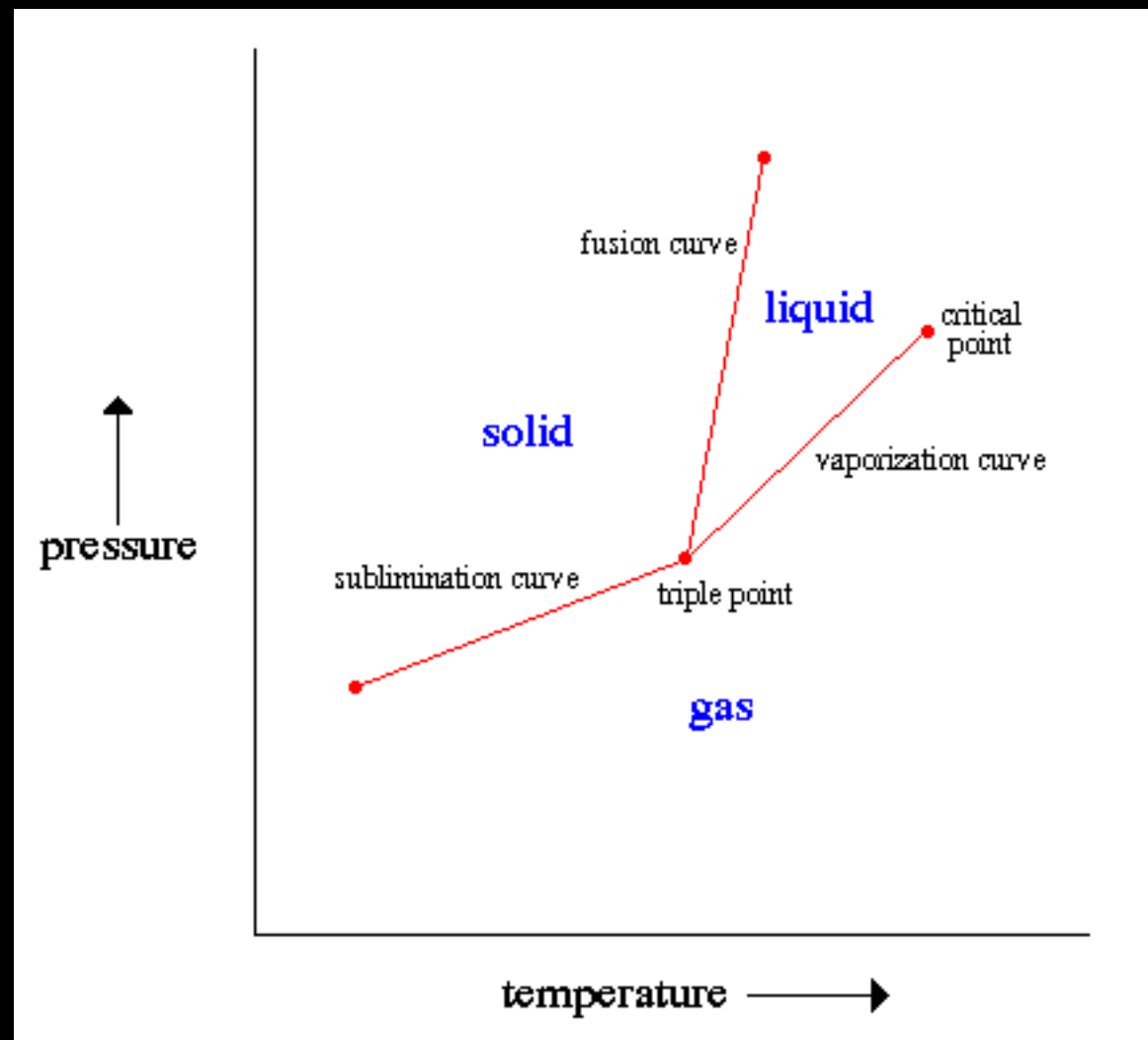
Moon



Weber et al., 2011

Scientists today view Mars as having had three broad ages, each named for a geographic area that typifies it:

The Noachian Era is the name given to the time spanning perhaps the first billion years of Mars' existence after the planet was formed 4.6 billion years ago. In this era, scientists suspect that Mars was quite active with periods of warm and wet environment, erupting volcanoes and some degree of tectonic activity. The planet may have had a thicker atmosphere to support running water, and it may have rained and snowed.



In the Hesperian Era, which lasted for about the next 500 million to 1.5 billion years, geologic activity was slowing down and near-surface water perhaps was freezing to form surface and buried ice masses. Plunging temperatures probably caused water pooled underground to erupt when heated by impacts in catastrophic floods that surged across vast stretches of the surface -- floods so powerful that they unleashed the force of thousands of Mississippi Rivers. Eventually, water became locked up as permafrost or subsurface ice, or was partially lost into outer space.

The Amazonian Era is the current age that began around 2 billion to 3 billion years ago. The planet is now a dry, desiccating environment with only a modest atmosphere in relation to Earth. In fact, the atmosphere is so thin that water can exist only as a solid or a gas, not as a liquid.