UNDERSTANDING MARS: THE GOLDILOCKS PLANET

Since its discovery, Mars has remained an intriguing planet to humans due to its proximity and ability to support life. Furthermore, the immediacy of Earth helped astronomers make significant observations about the red planet through telescopes. One of the most notable features of Mars is the contrast between the Southern and Northern hemispheres, known as the Martian dichotomy. This difference in elevation, ranging from 1 to 3 km, makes it challenging to produce a accessible cartographic map. The geography of the two hemispheres also varies because of this distinction. The map depicts **Areography** (Geography of Mars) which is the characterization of regions. Moreover, The Martian dichotomy boundary includes **Deuteronilus Mensae, Protonilus Mensae, and Nilosyrtis Mensae**. These three regions have received a lot of attention due to the presence of landforms thought to be created by the movement of ice. [1]

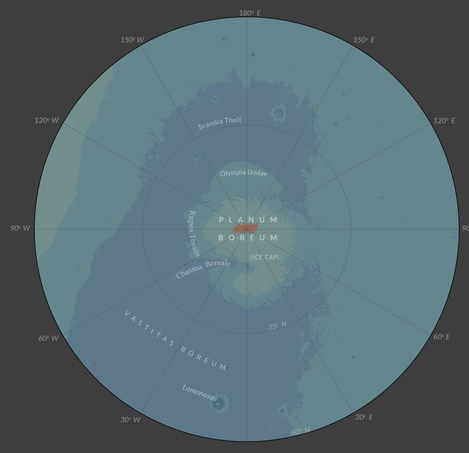
ELEVATION PROFILE

21 KM · 10 KM · 0 KM · -8 KM

95% of Elevation

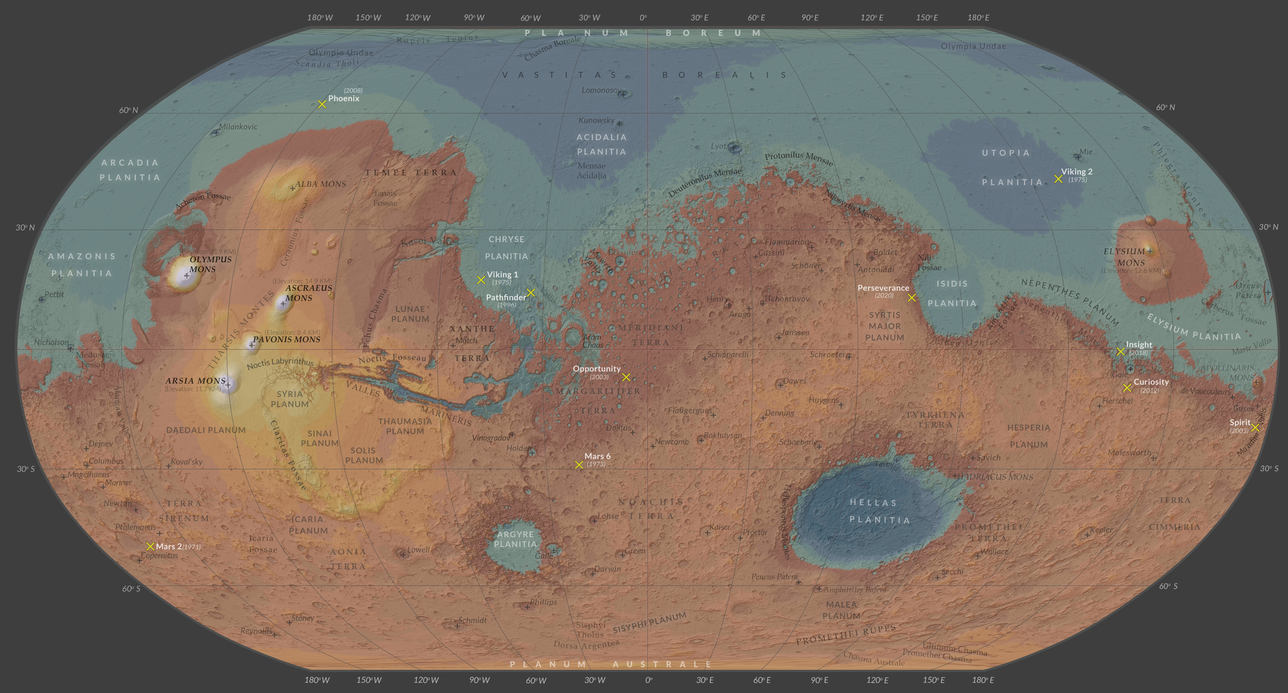
NOMENCLATURE EQUIVALENT (MARS – EARTH)

- **Chasma** - *Canyon*
- **Fossa** - *Narrow depression*
- **Labyrinthus** - *Valley Complex*
- **Mensa** - *Mesa*
- **Mons** - *Mountain, Volcano*
- **Vastitas** - *Extensive Plain*
- **Patera** - *Shallow Volcano*
- **Planitia** - *Basin, Low plain*
- **Planum** - *Plateau, High plain*
- **Terra** - *Land, Region*
- **Tholus, Tholi** - *Domical Volcano*
- **Valles, Vallis** - *Valleys, Valley*

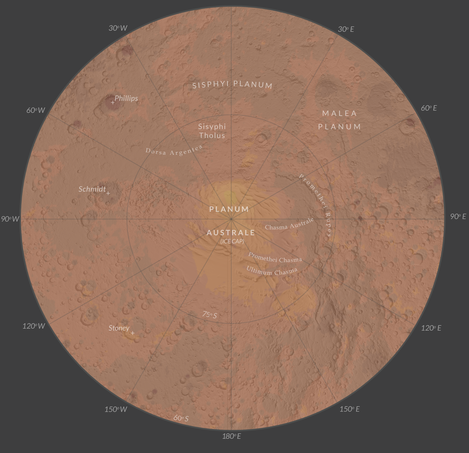


NORTH POLE

Projection: Mars 2000 North Pole Stereographic (Sphere)



Projection: Robinson Clono Mars 2000 (Sphere)

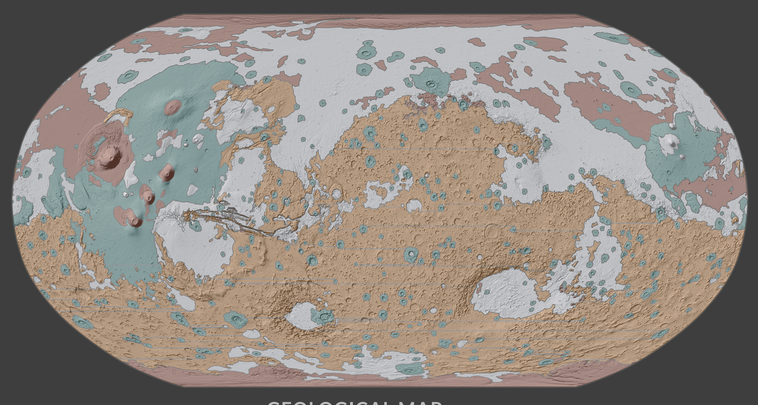


SOUTH POLE

Projection: Mars 2000 South Pole Stereographic (Sphere)

LEGEND

+ Point Label: *Craters*, *Shallow Volcanoes (Patera)*
× NASA Missions Landing Sites



GEOLOGICAL MAP

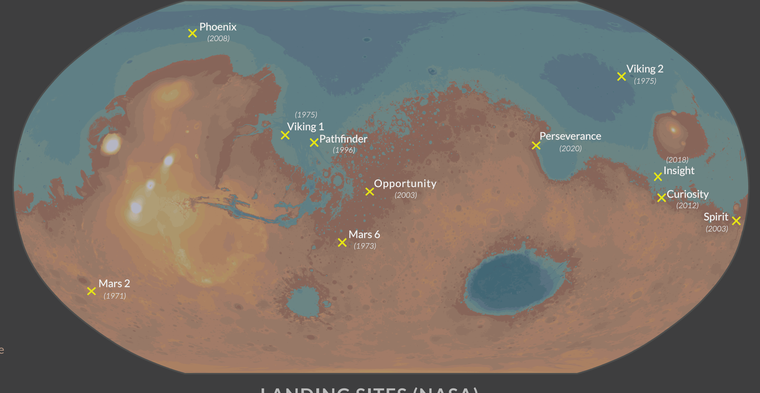
Major Geological Unit

Amazonian · Amazonian and Hesperian · Hesperian · Noachian

Projection: Robinson Clono Mars 2000 (Sphere)

The polar ice caps were first identified by **Christiaan Huygens** in 1672. [2] Both residual ice caps overlie thick layered deposits of interbedded ice and dust. In the north, the layered deposits form a 3 km-high, 1,000 km-diameter plateau called **Planum Boreum**. A similar kilometers-thick plateau, **Planum Australe**, lies in the south. The north polar ice cap is about 1100 KM in diameter compared to the south polar ice cap of 400 KM in diameter. One large valley, **Chasma Boreale** runs halfway across the cap. It is about 100 km wide and up to 2 km deep. **Chasma Australe**, a major valley, cuts across the layered deposits in the South Polar cap. The northern ice cap is composed of water ice, whereas the critical composition of the southern ice cap is dry ice or carbon dioxide (CO_2). The polar ice caps change in diameter with their exposure to heat due to the seasons on Mars. During summers, the ice caps undergo sublimation creating Martian dust storms. Scientists identified the changes in gravity field owing to the deposition of thin layers of CO_2.

Mars is a planet that has undergone **planetary differentiation**, a process in which certain regions of the planet have developed unique chemical and physical characteristics due to the accumulation of various elements. The study of these geologic processes and features on Mars is known as **areology**. Some of the notable regions on Mars include the hemisphere dichotomy, Tharsis and Volcanic provinces, Impact basins, Equatorial Canyon Systems, and Ice caps. These regions show how geological processes such as volcanism, tectonism, water, ice, and impacts have shaped the planet on a global scale. The **Insight lander** mission is designed to study the deep structure of Mars using a seismometer that can create a 3D map of the subsurface. The Tharsis region, located in the western hemisphere, is a volcanic-tectonic region that covers 25% of the planet's surface and is home to the **largest known volcanoes** in the solar system - **Olympus Mons**. Also the ranges **Ascraeus Mons, Pavonis Mons, and Arsia Mons**, are collectively known as the **Tharsis Montes**. The **Hellas Planitia**, a large impact basin in the southern hemisphere, is one of the lowest points on Mars, with a depression of 8 km and a diameter of 1800 km. **Valles Marineris**, an extensive system of canyons and troughs located near the equator in the western hemisphere, stretches for over 4,000 km, nearly a quarter of the planet's circumference. If it were on Earth, the Valles Marineris would span the width of North America.



LANDING SITES (NASA)

× Landing sites

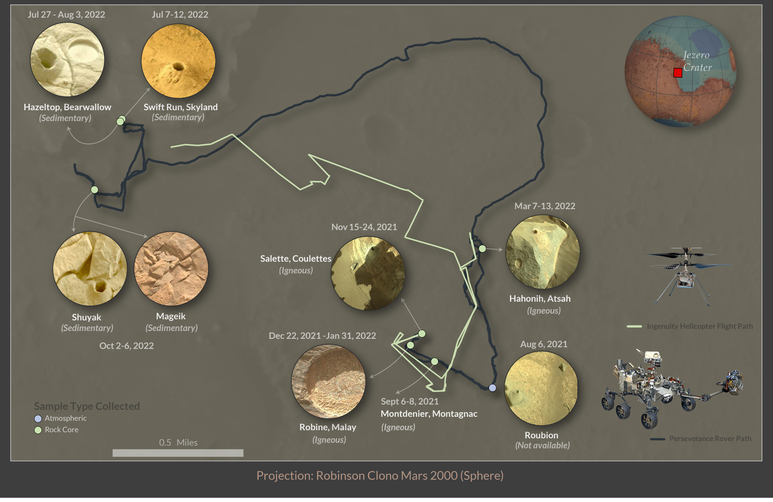
Projection: Robinson Clono Mars 2000 (Sphere)

The Mars Ocean hypothesis proposes that the **Vastitas Borealis** basin was the site of an ocean of liquid water at least once. A study in June 2010 concluded that the more ancient ocean would have covered 36% of Mars.[3] This ocean, dubbed **Oceanus Borealis**, would have filled the Vastitas Borealis basin in the northern hemisphere, a region that lies 4–5 km below the mean planetary elevation. The Mars Orbiter Laser Altimeter (MOLA) is a tool that was used in 1999 to measure the height of the surface of Mars. The data collected by MOLA was used to determine that an ocean on Mars would have covered around 75% of the planet. In March 2015, scientists stated that evidence exists for an ancient Martian ocean, likely in the planet's northern hemisphere and about the size of Earth's Arctic Ocean, or approximately 19% of the Martian surface.[4] This digital elevation model (DEM) is based on data from the MOLA, an instrument on NASA's **Mars Global Surveyor (MGS)** spacecraft.[5] The MOLA DEM represents more than 600 million measurements gathered between 1999 and 2001, adjusted for consistency and converted to planetary radii. The DEM model is used to generate the hillshade, slope and shaded relief which are blended to generate graphics of Mars geography.

References:

1. Baker, D. M., Head, J. W., & Marchant, D. R. (2010). Flow patterns of lobate debris aprons and lineated valley fill north of Ismeniae Fossae, Mars: Evidence for extensive mid-latitude glaciation in the Late Amazonian. Icarus, 207(1), 186-209. https://doi.org/10.1016/j.icarus.2009.11.017
2. Sheehan, W. (1996). The Planet Mars: A History of Observation & Discovery; University of Arizona Press: Tucson, p. 25.
3. Di Achille, G., Hynek, B. Ancient Ocean on Mars supported by global distribution of deltas and valleys. Nature Geoscience 3, 459–463 (2010). https://doi.org/10.1038/ngeo891
4. "Evidence for a Martian Ocean – NASA Mars Exploration." NASA, NASA, 19 Sept. 2017, https://mars.nasa.gov/news/evidence-for-a-martian-ocean/.
5. Smith, D. E., Zuber, M. T., Frey, H. V., Garvin, J. B., Head, J. W., Muhleman, D. O., Pettengill, G.H., et al. (2001). Mars Orbiter Laser Altimeter—Experiment summary after the first year of global mapping of Mars. Journal of Geophysical Research, 106(E10), 23689–23722. https://doi.org/10.1029/2000JE001364

PERSEVERANCE ROVER MAP



Projection: Robinson Clono Mars 2000 (Sphere)

Credits:

University of Wisconsin - Madison, Professor Robert Roth, Gareth-Baldrica Franklin (*Teaching Assistant*), Jaime Martindale (*GIS librarian*), Daniel P Huffman (*Somethingaboutmaps*), John Nelson (*John Nelson Maps*), National Aeronautics and Space Administration (NASA), United States Geological Survey (USGS), Google Mars, Environmental Systems Research Institute (ESRI), Tom Patterson, Natural Earth Project, University of Wisconsin - Madison Cartography Lab (UWCL).

Color Palette Inspiration: Ralph Aeschliman (2002)

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Scale: 1:33,000,000 (*Topographic Map*), 1:52,000,000 (*Geology Map, Landing Sites Map, North Pole Map, South Pole Map*)
1:16,000 (*Perseverance Rover Map*)

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A detailed tutorial is created for enthusiasts who wants to replicate the cartographic design and graphics inclusive of data sources, data processing steps, GIS analysis techniques, cartographic methods and other design consideration. Please scan the QR code and visit the website.

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