



## Mars Facts

- Mars is often called the Red Planet because of the hue of the rocks and dust
- Named for Mars the Roman god of War. (Greek: Ares)
- Mars is the fourth planet from the Sun and the seventh largest.
- Mars has four seasons just like Earth, but each season lasts twice as long.
- Though Mars is much smaller than Earth, its surface area is about the same as the land surface area of Earth because there are no large bodies of water
- There is very clear evidence of erosion in many places on Mars indicating large floods and small river systems.
- Mars has a very thin atmosphere where humans can't breathe unassisted on the planet.
- Both Earth and Mars have canyons, valleys, craters, volcanoes, ice caps and seasons.
- Mars has very strong winds and vast dust storms that on occasion engulf the entire planet for months.
- Mars has permanent ice caps at both poles.

## Comparing Mars with Earth

	Mars	Earth
Average Distance from Sun	142 million miles	93 million miles
Average Speed in Orbiting Sun	24.5 miles per second	18.5 miles per second
Diameter	4,220 miles	7,926 miles
Tilt of Axis	25 degrees	23.5 degrees
Length of Year	687 earth days	365 days
Length of Day	24 hours 37 minutes	23 hours 56 minutes
Temperature	Avg. -81 degrees F	Avg. 57 degrees F
# of Moons	2	1
Atmosphere	95% carbon dioxide, some water vapor	77% nitrogen, 21% oxygen, 2% argon and other

### Websites

<http://www.seti.org>  
<http://www.astrobio.net>  
<http://www.earthsky.org>  
<http://athena.cornell.edu>  
<http://www.mars2030.net>  
<http://www.nasa.gov>  
<http://www.nineplanets.org>  
<http://www.lpl.arizona.edu>  
<http://www.seds.org>  
<http://cmex.ihmc.us/CMEX/index>  
<http://www.spaceref.com>  
<http://www.solarviews.com>  
<http://www.marssociety.org>  
<http://www.tsgc.utexas.edu>  
<http://www-k12.atmos.washington.edu>

### Books

***The Planet Mars: A History of Observation and Discovery*** by William Sheehan The University of Arizona Press, Tucson on line book  
***Infinite Worlds : An Illustrated Voyage to Planets beyond Our Sun*** Ray Villard and Lynette R. Cook  
***The Everything Astronomy Book*** by Cynthia Phillips and Shana Priwer  
***A Traveler's Guide to Mars*** by William K. Hartmann Workman Publishing Company (August 21, 2003)  
***Looking for Life in the Universe*** by Ellen Jackson  
***Cosmic Company: The Search for Life in the Universe*** by Seth Shostak, Alex Barnett  
***Beyond : Visions Of The Interplanetary Probes*** by Michael Benson



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# The Art of Exploration

EXTRAORDINARY EXPLORERS AND CREATORS INSPIRE US ALL TO REACH OUR OWN POTENTIAL



astrobiology • robotics • orbiters • geologic data • expedition • crater • analogs • adaptation • planetary geology • astronomy • orbit •



### Meet Nathalie Cabrol

Nathalie Cabrol, a planetary scientist at NASA Ames Research Center/SETI Institute, specializes in the evolution of water on Mars. Her areas of expertise are astrobiology (life in the universe), robotics, and leading NASA missions to Mars.

- She is a science team member of the NASA Mars Exploration Rover mission and senior scientist on the *Spirit* Rover exploration of Gusev crater on Mars.
- She is the expedition leader of a NASA Astrobiology Institute exploring some of the highest lakes on Earth located in Bolivia as analogs to ancient Martian lakes. Cabrol and her team try to document the life adaptation (or lack thereof) to extreme environmental conditions, the effect of rapid climate change, and the limits of life on Earth.
- She has authored three books, 250 publications, and has been featured in documentary films.
- Cabrol is the recipient of prestigious research awards including the 2005 Wings Women of Discovery Air and Space award.

### Spacecraft to Mars

The mission of the first Viking Landers to Mars was to look for life. Robotic missions have found evidence of a watery past, suggesting that simple life forms may have developed long ago and may persist beneath the surface today. Human exploration could provide answers to some profound questions.



- The first spacecraft to visit Mars was Mariner 4 in 1965.
- The first spacecrafts to land on Mars were the two Viking Landers in 1976.
- Mars Pathfinder landed successfully on Mars in 1997.
- Nathalie Cabrol has been studying Gusev Crater on Mars for 15 years. NASA selected her site for the Spirit Rover to explore on the 2003 mission to Mars. In 2004 the Mars Expedition Rovers *Spirit* and *Opportunity* landed on Mars sending back geologic data and many pictures; they are still operating. <http://marsrovers.jpl.nasa.gov>
- Three Mars orbiters (Mars Global Surveyor, Mars Odyssey, and Mars Express) are in operation.
- Build your own spacecraft at <http://mars.jpl.nasa.gov/classroom/students.html>

Moving from place to place, the rovers will perform on-site geological investigations. Each rover is sort of the mechanical equivalent of a geologist walking the surface of Mars. The mast-mounted cameras are mounted 1.5 meters (5 feet) high and will provide 360-degree, stereoscopic, humanlike views of the terrain. The robotic arm will be capable of movement in much the same way as a human arm with an elbow and wrist, and will place instruments directly up against rock and soil targets of interest. In the mechanical "fist" of the arm is a microscopic camera that will serve the same purpose as a geologist's handheld magnifying lens. The Rock Abrasion Tool serves the purpose of a geologist's rock hammer to expose the insides of rocks. [http://pdsimg.jpl.nasa.gov/Missions/Spirit\\_MERA\\_mission.html](http://pdsimg.jpl.nasa.gov/Missions/Spirit_MERA_mission.html)



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## An Interview with Nathalie Cabrol



**How did you get interested in planetary geology?**  
 I was born and raised in France and came to the US in 1994. I am now a permanent resident and looking forward to becoming a US citizen because this country has helped me make my dream come true. I was born wired to the planets and the universe. Just looking around me when I was a kid and seeing the beautiful Earth and the night skies got me curious and I was always looking for answers to all sorts of "why" questions. According to my Mom, I never wanted to do anything else. She bought me books on astronomy and nurtured my passion. It fascinated me. When I was 5, I saw Neil Armstrong walking on the moon and I knew then that everything I wanted to do involved planets and exploration. Carl Sagan's series *Cosmos* showed me you could actually make a career out of studying planets.

**Is there water on Mars? Will people be able to go there one day?**  
 Oh yes, the current missions are finding a lot of evidence for a lot of water in the past. They have also found ice close the surface in many regions and in the Martian polar regions. And yes, I think we will go to Mars in our lifetime. With the current road map, we should have humans on Mars in 20 years. I am fully supporting human exploration. It has to be supported by a strong science program. A discipline like astrobiology will tell us where to go? What to do? And if it is safe to go. I personally want to go to Mars no matter what the risks. And there are many risks. Radiation is a risk. The whole trip is a risk. But Mars is a new land, a new planet. Exciting doesn't even cut it, it is beyond that. For more information about Mars, go to <http://mars.jpl.nasa.gov>

**What Cabrol loves most about her profession is that she never thinks of it as a job.**  
 "My work gives me a sense of renewed interest and curiosity every day of my life." She faces each new day with a commitment to devise more refined strategies to reconstruct the past of a planet. "We are a bit like archeologists and police investigators: we try to understand what happened with what is left of the evidence and hopefully we'll end up with the real story."

**What advice do you have for others interested in following your path?**  
 Never be afraid of dreaming. Never be afraid to open new paths. Just because no one has done it doesn't mean that you can't do it. Be true to yourself and keep your eye on the horizon. There is only one secret: work hard.

**What are you working on now?**  
 I have worked on a number of NASA projects. Now I am working on three major projects. I am conducting Rover field tests to develop new exploration strategies related to the search for life for future missions on Mars. We test our rover in a terrestrial analog to Mars environment in the Atacama desert, in Chile. I am the principal investigator in the High Lakes expeditions in the Andes, which is supported by the NASA Astrobiology Institute. Spirit and Opportunity continue to keep me busy on Mars. [www.extremenvironment.com](http://www.extremenvironment.com)



**analog = comparison**

**What are you learning in the high lakes expeditions?**  
 If you want to go back in time on Mars you have to go high on Earth just because as you go high on Earth the atmosphere is thinning, it gets cooler and the radiation is more intense. High altitude provides an ice cover on the high lakes on the Andes. All these conditions make them the best analogs on Earth for ancient conditions on Mars. By observing the effects of rapid climate change on Earth in this high region. I can learn more about what happened on Mars. I am studying the impact of climate change on life. Frankly, when I first went there, I was not expecting much life. But I was in for a big surprise: life in these extreme regions is thriving despite rapidly changing environments. This helps me understand conditions on Mars and possibly how long life (if any) may have lasted and perhaps where to look for it if it is still there. Some of the organisms we are studying are the same as the earliest forms of life on Earth. Early on, there was no ozone layer on Earth to protect these microbial organisms. The high radiation in the Andes is also comparable to early Earth environment. So through the organisms, we are learning a lot about life on Earth and how we made it to today.

**The Andes** is South America's longest mountain range, forming a continuous chain of highland along the western coast of South America. It is over 4,400 miles long, 300 miles wide in some parts, and of an average height of about 13,000 feet. The Andean range is composed principally of two great ranges with mountains that extend over seven countries: Argentina, Bolivia, Chile, Colombia, Ecuador, Peru and Venezuela. The Andes mountain range is the highest mountain range outside Asia. The Andes mountain range is the highest mountain range outside Asia. The Andes cannot match the Himalayas in height but do so in width and are more than twice as long.



**Exploring the Highest Lakes on Earth**  
 The Licancabur volcano located at the boundary of Chile and Bolivia hosts a lake that is among the highest and least explored lakes on earth. The lake environment combines low-oxygen, low atmospheric pressure, and high-UV radiation. Sediments are formed in volcanic material. It is ice covered most of the year, but the bottom water temperature remains above freezing. These conditions make Licancabur a unique analog (comparison) to ancient Martian lakes. Go to [www.extremenvironment.com/2003/](http://www.extremenvironment.com/2003/) to read Natalie's journal entry for a night at the summit and find photos and information about the project.

