

Exploring Earth's Driest Deserts



In the 1970's, the Viking rover landed on Mars and detected no life.

In 2003, NASA took the same technology to the Atacama Desert in Chile and got the same reading. Was there really no life there?

And by extension, no life on Mars?

You might think that the driest place on Earth is the Sahara. But they're actually *polar* deserts, like the McMurdo Dry Valleys of Antarctica, and high deserts, like the Atacama. There are places there where it hasn't rained in 500 years—if ever.

Surprisingly, the driest deserts are cold, not hot. That's because cold air holds 20 times less water vapor than hot air.

Though average temperatures in McMurdo are below freezing, the Atacama averages 70 degrees—but it's in the rain shadow of both the Andes and the Chilean Coastal Range. It's at 8,000 ft, where the air is very thin. And it's near the equator, where solar radiation is extreme all year long.

This is the most similar environment on Earth to Mars, which is why NASA is testing old and new Martian exploration technology here.

While the Viking equipment missed any signs of life in the Atacama, new understanding of extremophiles—life found in extreme conditions—led NASA scientists to look beneath the soil and within rocks, where they found photosynthetic bacteria.

And if life can exist here, in the most inhospitable place on Earth, we might also find it on the next mission to Mars.

El Valle de la Luna
(Valley of the Moon) in
Chile's Atacama Desert.

Credit: Reinhard Jahn, Mannheim
(CC BY Share Alike 2.0 Germany
[<https://commons.wikimedia.org/wiki/File:ValleLuna-002.jpg>]),
via Wikimedia Commons



BUREAU OF
ECONOMIC
GEOLOGY

Background: Exploring Earth's Driest Deserts

Synopsis: The Atacama Desert of Chile and McMurdo Dry Valleys of Antarctica are the driest deserts in the world. They are so dry and inhospitable that the same tools showing no life on Mars in the 1970's also showed no life in both of these locations on Earth. Today, NASA is using these two deserts to develop equipment and tests for organics that will be more sensitive in future Mars missions.

- If possible, space explorers test their hypotheses and equipment on Earth before trying them out in space.
 - Apollo astronauts learned about geology and practiced driving moon rovers in the deserts of the southwestern United States.
 - To emulate the Martian environment with its extremely limited atmosphere, scientists look to the driest possible deserts.
- When we think of the driest places on Earth, most of us think of scorching hot places like the Sahara, Gobi Desert, Arabian Desert, or deserts in the southwestern United States. But the driest places in the world aren't hot—they're cold!
 - Deserts cover one-third of Earth's surface and are defined as places where less than 9.75 inches (250 mm) of rain falls per year. The largest deserts on Earth are polar—the Antarctic and Arctic.
 - Cold air holds less water vapor than warm air. Air at freezing temperature (32°F) holds ten times less moisture than air at 100°F, and more than 20 times less moisture than air at 130°F.
 - The driest places on Earth are also cold deserts: Antarctica's McMurdo Dry Valleys and Chile's Atacama Desert. Wind-shadow effects, which characterize both locales, occur when prevailing winds are stripped of their moisture as mountains force them upward, condensing their water vapor and causing rain on the windward side of the mountains—but leaving only dry air in the leeward side beyond the mountains.
- The McMurdo Dry Valleys of Antarctica have no recorded precipitation—ever—in some areas. Temperatures range from -20 to 20°F.
 - These bare rock valleys without any surface snow or ice cover more than 1500 sq miles of Antarctica. Rocks may be ice cemented below the surface.
 - Dense winds of the rain shadow (the dry area on the leeward side of mountains) rush from the mountains down through the valleys at more than 200 mph, evaporating any moisture. These are known as *katabatic* winds.
 - Although this is a harsh environment for life, photosynthetic bacteria have been shown to live below the surface in the interior of rocks.
- In Chile's Atacama Desert, no rain has been recorded in more than 500 years in some areas. A few of its port cities on the Pacific report less than 0.2 inches (5 mm) of rain per year. Temperatures range from 55 to 100°F.
 - The Atacama Desert covers about 49,000 sq miles and runs from Chile's Peruvian border 600 miles southward along the Andes Mountain Range at an elevation of about 8,000 ft. The high elevation and dry air are perfect for observing space through high-powered telescopes, three of which operate in the Atacama.
 - The desert became hyper-arid more than 15 million years ago. Located between the Andes and the Chilean Coastal Range, it ended up in the rain shadow of both.
 - This hostile environment has been exposed to ultraviolet radiation for millions of years. Although soil from some areas of the Atacama Desert was so organics-depleted that it would not grow life in lab experiments, recent research has shown that life exists in microbial colonies underground and within rocks.
 - As surprising as it may seem, today more than a million people live in coastal cities, mining camps, fishing villages, and near observatories in the Atacama Desert.

References: Exploring Earth's Driest Deserts

[The World's Largest Deserts | Geology.com](#)

[Atacama Desert | Wikipedia](#)

[McMurdo Dry Valleys | Wikipedia](#)

[Moisture Holding Capacity of Air | Engineering Toolbox](#)

[Mars-Like Atacama Desert Could Explain Viking "No Life" Results | NASA](#)

[NASA Tests Life-Detection Drill in Earth's Driest Place | NASA](#)

Contributors: Juli Hennings, Harry Lynch



BUREAU OF
ECONOMIC
GEOLOGY

EarthDate.org
Fact Sheet:
Episode **ED 042**

Background: Exploring Earth's Driest Deserts

- Mars experiences intense radiation, no precipitation, and wide-ranging temperatures.
 - Winter temperatures can fall to -195°F at the poles.
 - Summer days at the equator range up to 70°F , but summer nights can drop to -100°F .
- Launched in 1975, the Viking project included two landers that arrived on the Martian surface in 1976. *Viking 1* sent data back to Earth until 1982.
 - Viking tested for life on Mars and found nothing. In 2003, scientists ran the same experiments on Earth, in the Atacama Desert, and reached the same conclusion: no life. If the Viking lander had come to Earth and visited the Atacama Desert, it would have reflected a lifeless planet!
 - Earth-bound experiments 3 decades after the Viking mission showed that 1970's Viking technology was insufficient to disprove the existence of life on Mars.
 - We now know there is microbial life in underground colonies and inside rocks in both the Atacama Desert and the even more extreme McMurdo Dry Valleys.
- Discoveries related to extremophiles continue to expand our understanding of life processes.
 - For future Mars missions, scientists are now looking to the Atacama (and possibly the McMurdo Dry Valleys) to test their hypotheses, experimental strategies, and equipment, reasoning, "If you can find life there, you have a better chance of finding it in a more hostile environment like Mars."
 - Some procedures being tested include drilling below the surface layers of sediment, transferring samples from tool to tool, and automated searching for biomarkers and amino acids.



Scientists test their life-detection tools on material from an 8-ft pit in the Atacama Desert.

Credit: NASA

References: Exploring Earth's Driest Deserts

[The World's Largest Deserts | Geology.com](#)

[Atacama Desert | Wikipedia](#)

[McMurdo Dry Valleys | Wikipedia](#)

[Moisture Holding Capacity of Air | Engineering Toolbox](#)

[Mars-Like Atacama Desert Could Explain Viking "No Life" Results | NASA](#)

[NASA Tests Life-Detection Drill in Earth's Driest Place | NASA](#)

Contributors: Juli Hennings, Harry Lynch