

# PIONEERING THE RED PLANET

Adventures on Martian soil

***Mars has always obsessed humankind - the Red planet, the 'New Earth'. And with the recent successful landing of NASA's Curiosity rover, Mars is closer than ever. Ever since 1960, we have actively been sending probes and rovers to observe the planet, but not without defeat. The road to the red planet is long, and the landing is rough. And since we do not have the technology yet to bring pieces of Mars to our laboratories, we'll have to bring the laboratories to Mars.***

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## THE EARLY DAYS

Between October 10, 1960 and 1967, six Mars missions were undertaken, five by the USSR and one by USA. This was maybe too ambitious for the early days, because two failed to reach earth orbit, two failed to leave it and two had problems en route. It was December 20, 1967 when the Mariner 4, an American Mars flyby probe, flew by the surface, and sent back 22 close-up photos. Man's first successful flight to Mars was a fact. Reaching it was now possible. Landing was the next logical step.

## PIONEERING THE SURFACE

The USSR had the first landing success. Their 1,210kg Mars 2 lander crashed on the surface of Mars, but was the first man-made machine to actually touch the planet. Only five days later, the Mars 3 lander made a successful landing, but operated for only fifteen seconds, just enough time to take one picture of the horizon. The exact reason for the lost communication was unknown. Researchers suspected a dust storm was responsible for both the destruction of the communication system, and the bad quality of the picture. Fur-

ther attempts, the Mars 4 through 7, were all partially successful. They all gathered some data, but none of them were able to either enter the intended orbit, or make a successful landing.

It was NASA who had the next success. The Viking 1 landed on the Martian surface July 20, 1976, shortly followed by the Viking 2. These identical orbiters and landers were sent to the planet to take photographs, collect scientific data and perform some biology experiments in search of extra-terrestrial life. Unexpectedly, chemical activity was found in the soil, but no evidence of microorganisms. Scientists believe Mars sterilizes itself. They think the combination of extreme dryness, the oxidizing nature of the soil and the solar ultraviolet radiation prevents the formation of living organisms.

The Mars Pathfinder was the next step in Mars exploration. It was the first successful lander that carried a rover, the Sojourner. After the successful landing in 1997, the landing site was renamed the Carl Sagan Memorial Station, in honor of the astronomer. Sojourner was a small rover. With its 10.5kg, the 30cm tall rover travelled at a

velocity of 1 cm/s. The main task of the rover was to examine rocks nearby the landing site. Equipped with an Alpha Particle X-ray Spectrometer (APXS), the composition of rocks could be determined.

The oldest Mars-related spacecraft that is still in use today is the 2001 Mars Odyssey. This spacecraft is orbiting Mars at an altitude of approximately 3,800km. The Odyssey has multiple objectives. It uses its three main instruments for studying the radiation environment, determining the distribution of minerals and determining the presence of twenty chemical elements. A second task is to support other Mars missions. The orbiter provides a communications relay for the rovers Spirit, Opportunity and Curiosity. At this very moment, 95% of all the data collected by the Curiosity is sent through the Mars Odyssey.

The record for the longest operating rovers is held by the Mars Exploration Rovers, named Spirit and Opportunity. Or specifically, in the hands of the Opportunity, which is three weeks younger than the Spirit. Communication was lost with Spirit in 2010, after 2,208 Martian days, a stun-

ning 2,118 days more than planned. Both rovers landed in January 2004. Their main goal was to find information about water on Mars. Therefore, their landing sites were specifically chosen. Spirit landed in Gusev Crater, a possible former lake. Opportunity landed in Meridiani Planum, where minerals could contain clues. The Mars Exploration Rovers have survived a complete change of seasons. They withstood changes in temperature, radiation and dust storms. In doing this, they collected vital information that can and will be used in future Mars missions.

## CURIOSITY

In the evening of August 5, 2012 the Curiosity rover, the most technologically advanced rover ever built, landed in Mars' Gale Crater. The Curiosity's main mission, also known as the Mars Science Laboratory, is to determine whether Mars ever was, or is, habitable to microbial life. To do this the rover is equipped with seventeen different cameras and a robotic arm containing advanced laboratory-like instruments and tools.

One of the most interesting parts of the mission was the unique landing (Fig. 1). This specialized landing sequence, which included a giant parachute, a jet-controlled descent vehicle and a bungee-system called the 'sky-crane', was required because the landing techniques for previous rover missions could not accommodate the larger and heavier rover. The Curiosity actually has the size of a small Mini-Cooper and at \$2.5 billion; it is the most expensive mission to the Red Planet yet.

The hope for the question of life on Mars peaked at the end of November last year, when mission chief scientist John Grotzinger came with the news: "This data is going to be one for the history books. It's looking really good". Of course, a lot of excitement raged in the newspapers and on the Internet. NASA later clarified that Grotzinger's (it is in the name) news referred to the mission itself and not to specific results. Indeed later, they came with the statement that the rover had indeed found something in the dirt, but there was no big news from the first soil test. So far, there is no definitive sign of chemical ingredient necessary to support life.

Now the question can be asked, what did Curiosity find in the soil? Water, sulphur and perchlorate, an oxidizing salt, also detected during a previous Mars mission, and the remnants of an ancient streambed. As said by mission scientist Ralf Gellert: "This is typical, ordinary Martian soil." Some interesting hints of a simple carbon compound have been found in the soil, it only needs to be determined if it is native to the Red Planet, or hitchhiked from Earth or came from space. It is believed by scientists that the best chance of finding life supporting carbon is at Mount Sharp, a five kilometers high mountain in the center of the Gale Crater.

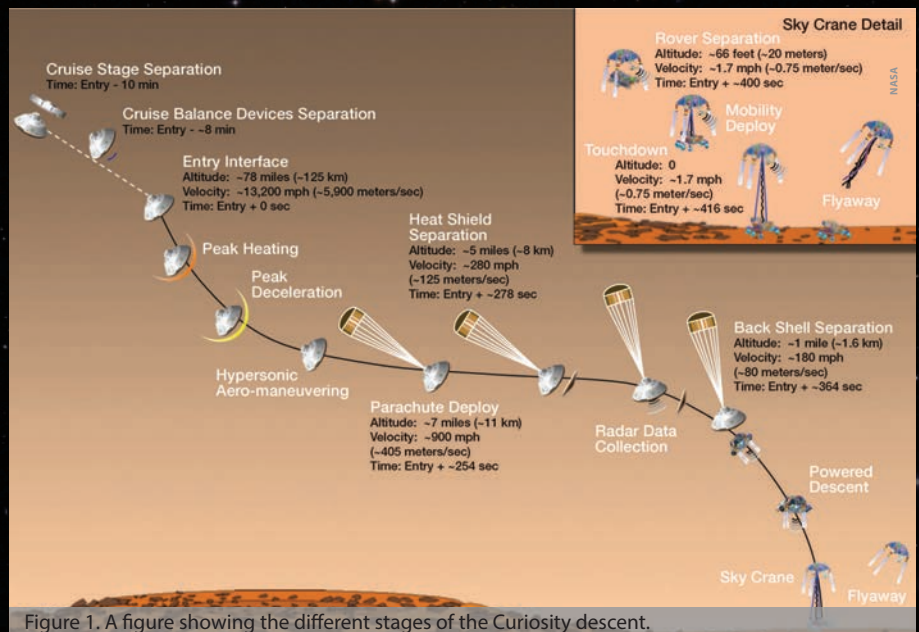


Figure 1. A figure showing the different stages of the Curiosity descent.

Therefore, after the last half year of driving, snapping pictures, scooping up dirt and zapping at rocks, Curiosity has started its trek to Mount Sharp – a trek that will take up 9 months. This road trip brings great expectations, as it is the main reason that the rover was targeted to land in the Gale Crater. Expectations are high as Curiosity's job is to figure out if the landing site had the correct environmental conditions to support basic forms of life. It could also have been a six-month journey when driving nonstop, but scientists will want to command the rover to rest and study the rocks along the way. It now will be a nine-month odyssey...

## THE FUTURE OF MARS EXPLORATION

Recently, a surprising announcement from NASA came with respect to near future Mars exploration. It will send another rover to Mars in 2020. Mixed reactions followed, as to why NASA keeps focusing on Mars while there are ice-covered moons like Saturn's Titan, which remain relatively unexplored. On the other hand it simply makes a lot of sense to conduct this new mission, as it will be built from Curiosity's spare parts, can make use of the same landing technique and has prevailing positive conditions (until now the Curiosity is a big success).

Of course, new instruments will be present in the \$1.5 billion-budgeted Curiosity II. NASA has been hinting that it is interested in a "sample catch" that will collect and store Martian soil samples. These samples would be collected by a future (manned?) mission to Mars, and returned to Earth for further analysis. As said by NASA administrator Charles Bolden: "The Obama administration is committed to a robust Mars exploration program. With this next mission, we're ensuring America remains the world leader in exploration of the Red Planet, while taking another significant step toward sending humans there in the 2030s."

## REFERENCES

- Chronology of Mars exploration:  
<http://history.nasa.gov/marschro.htm>
- Viking mission:  
<http://photojournal.jpl.nasa.gov/catalog/PIA09703>
- Pathfinder mission:  
<http://mars.jpl.nasa.gov/MPF/index1.html>
- NASA Mars Rover Overview  
<http://marsrovers.nasa.gov/overview/>
- NASA Curiosity Overview  
<http://www.jpl.nasa.gov/missions/details.php?id=5918>
- NASA Curiosity article  
<http://www.boston.com/news/science/2012/12/03/mars-rover-curiosity-surprise-soil-test/loYQVJIRSJXTzjJ-q3QW8NO/story.html>  
[http://articles.timesofindia.indiatimes.com/2012-12-31/science/36079075\\_1\\_mars-rover-curiosity-mount-sharp-gale-crater](http://articles.timesofindia.indiatimes.com/2012-12-31/science/36079075_1_mars-rover-curiosity-mount-sharp-gale-crater)
- Future of Mars exploration  
<http://www.extremetech.com/extreme/142414-nasa-will-send-a-second-curiosity-rover-to-mars-in-2020>

## SPACE DEPARTMENT

The Space Department promotes astronautics among the students and employees of the faculty of Aerospace Engineering at Delft University of Technology by organizing lectures and excursions.

