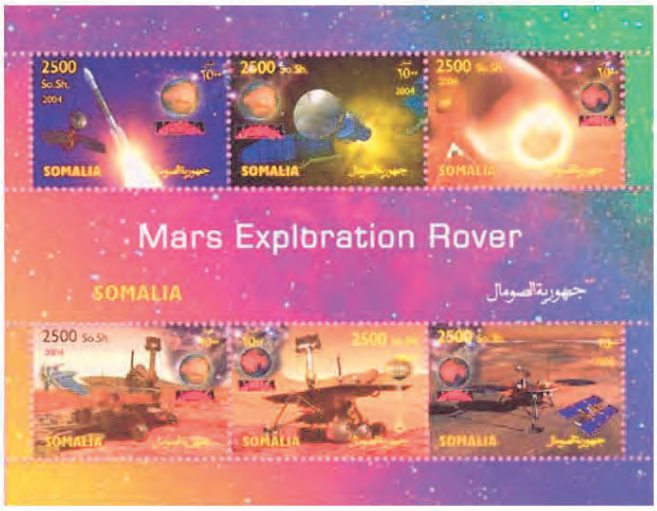
Mars : A Planet Of Robots *continued*

In a series of articles which will appear throughout this year our Features Writer **Nik Steggall** takes us through the exploration of The Red Planet.

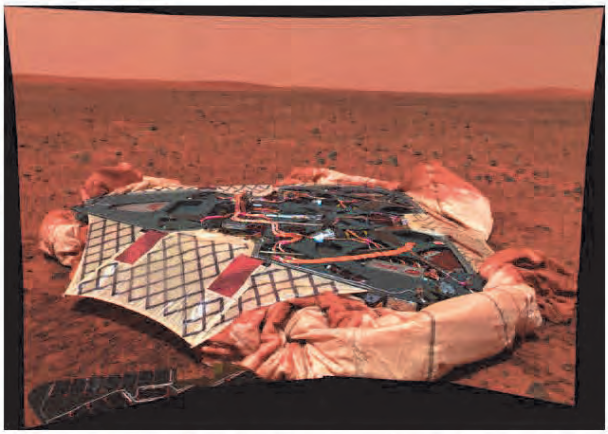
Part 3 : Advanced Surface Exploration

In 2003 NASA launched two rovers- the Mars Exploration Rovers. Each rover had been given a name chosen via a student competition so MER-A was called `Spirit` while MER-B was named `Opportunity`. Spirit landed in the Gusev impact crater in January 2004, with an expected lifetime of 90 SOLS which it exceeded by operating for 2,208 SOLS ceasing on March 22, 2010. During this time the rover had travelled 4.8 miles (7,730.5 metres).



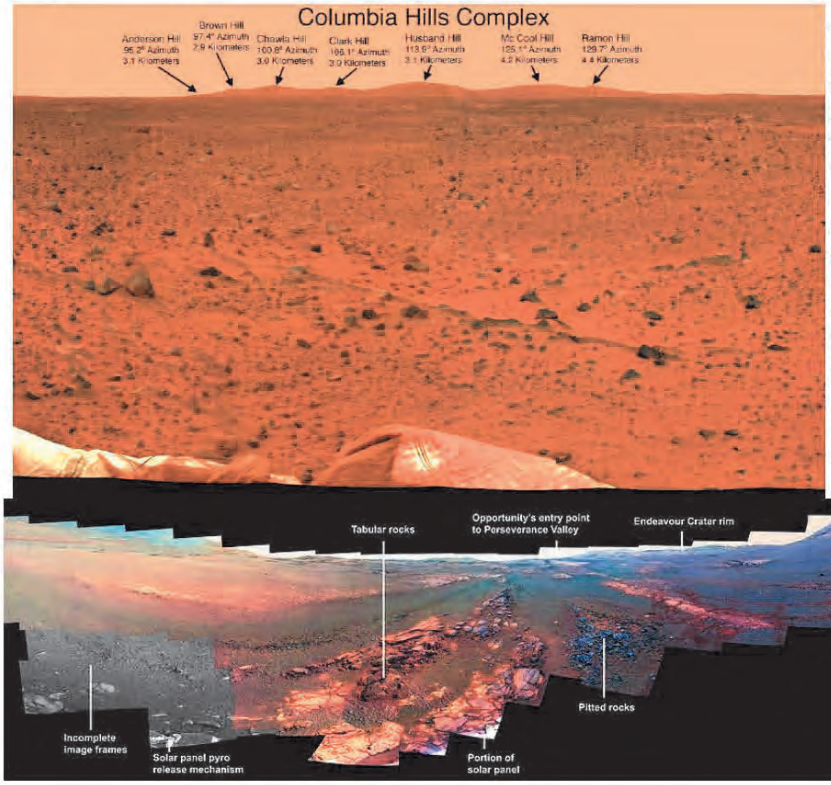
Spirit`s landing site within the crater Gusev was chosen because it looked like it had been affected by water and it might have been a possible lake. After Spirit had rolled onto the surface it took the highest resolution colour image to date

showing (as above) a slightly rolling surface littered with small rocks with hills on the horizon that were 1.9 miles (3 km) away.



Spirit`s landing platform (above) used parachutes to slow it down and airbags to bounce it to a stop in the crater. Its landing site was renamed the `Columbia Memorial Station` in honour of the seven astronauts who lost their lives in the Space shuttle *Columbia* disaster in February 2003.

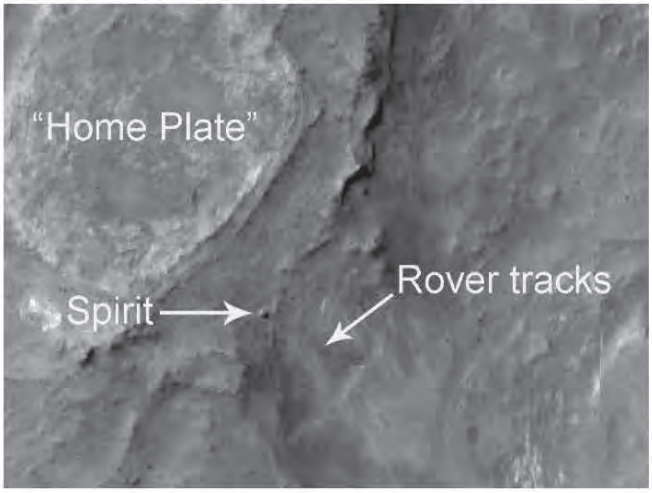
Spirit spent its lifetime investigating and travelling to locations such as Humphrey Rock, Columbia Hills, Husband Hill, McCool Hill and Silicone Valley until on SOL 1892 it reached a location called Troy. Here Spirit went into a sand trap and became stuck. Several attempts were made over the following months to free the rover but to no avail.



was the most successful of the MER rovers. During its lifetime Opportunity or `Oppy` as it was nicknamed travelled a distance of 26.06 miles (45.16 km). The rover operated for 14 years and 45 days in Earth time or 5,111 SOLS—much longer than its planned lifetime of 90 Earth days. It visited a large number of objective sites including spending two years exploring and studying the Victoria Crater and in 2011 Oppy reached Endeavour Crater which was its secondary landing site so fulfilling research at two aim points.

Below across page : Opportunity`s last taken panorama.

In January 2010 at SOL 2155 NASA decided to redefine Spirit as a stationary research platform so the vehicle continued operations in this mode until communications were lost on SOL 2208 with its mission ending on March 22, 2010. (Below Spirit as seen from the MRO).



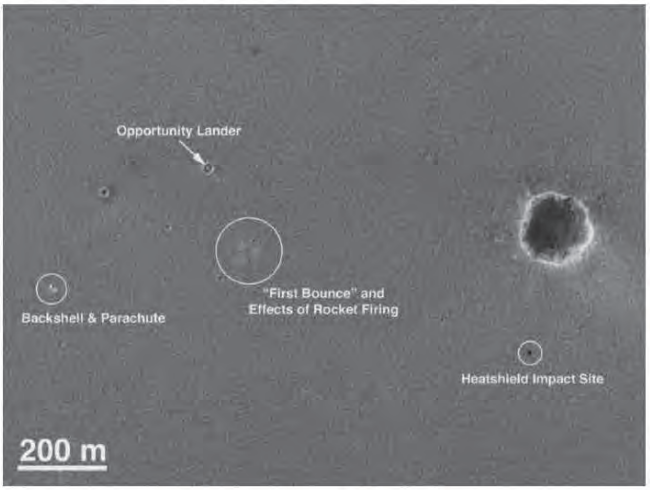
Spirit's lander platform has been regularly identified by the MRO. The 3 petal lander from which the Spirit rover drove off on January 2004 was imaged in January 2012. It showed that the lander was still bright but with a reddish hue most likely due to the accumulation of the Martian dust on the lander.
MER-B or the Opportunity rover landed on January 25, 2004 in the Eagle Crater in the Meridiani Planum which is situated on the opposite side of Mars to the Spirit rover. Opportunity

On its way Oppy found bonus Martian meteorites such as the iron Heat Shield rock on the Meridiani Planum (right).

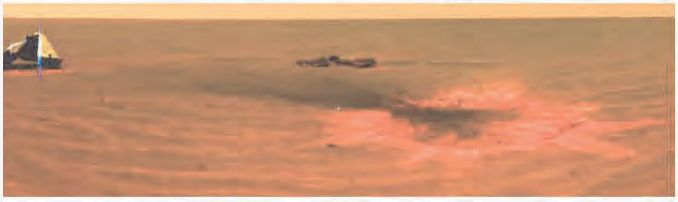
Oppy's demise came in June 2018 following its being engulfed in a global dust storm greater even than the one observed by Mariner 9 in 1971. These storms happen every 3 Martian years or 5 1/2 Earth years. they produce winds of 60 miles (97 km) per hour. It was most likely that the dust coated the solar panels so thickly that the Martian wind which blew and normally cleaned the panels was not of sufficient strength to remove the dust layer. No power being generated, no signals could be received—with more than 835 commands being sent to Oppy in the hope that it would wake up!

The last upload to Oppy was the American jazz singer Billie Holiday with the song "I`ll be seeing you", no response came back so the rover was officially declared dead on SOL 5352. Just as the dust storm was approaching came the last words from Oppy, she said "my battery is low and its getting dark". Oppy spoke in lines of code, fault readings and measurements. It is possible that Oppy encountered low battery power and closed down until it awaited for its power to resume with its systems turn off except for the mission clock. This clock would wake Oppy`s computer back on but this was not the case.

The landing site of Opportunity was found by the Mars Global Surveyor spacecraft from orbit showing the impact point, its first bounce with the heat shield, its backshell with parachute and the lander platform (as below).



Lander site as seen from Opportunity.



Phoenix

The next visitor to Mars was the Phoenix, a name chosen after the mythical bird that was repeatedly reborn from its own ashes. Phoenix contained several parts previously built for the Mars Surveyor 2001 lander which was cancelled in 2000 together with spare parts from the previously unsuccessful Mars Polar Lander mission. It was therefore reborn. Attached to the lander is the Phoenix DVD, a multimedia collection of literature and art about the red planet plus a quarter of a million names on a micro dot, thus forming the first library on Mars.

Phoenix landing (Artist's impression)

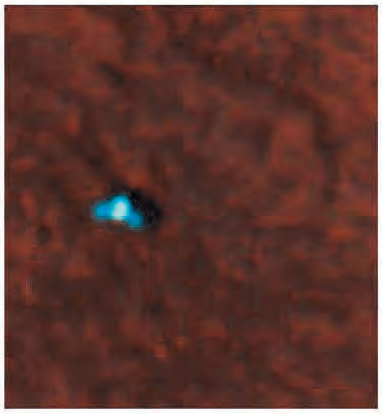
Phoenix lander seen from MRO during landing sequence under parachute

Phoenix landed on Mars on May 25, 2008 in the Green Valley at Vasitas Borealis. It was a robotic spacecraft in the Mars scout programme and was the first successful landing in a Martian polar region.

Phoenix's mission was to search for and dig out evidence of water on the Vasitas Borealis plains of the Martian arctic. During its lifetime it confirmed the presence of subsurface water ice. There were two mission goals : firstly to study the geological history of water in the past climate and secondly to evaluate past and potential habitability in the ice soil boundary.

The Phoenix lander ended operations in November 2008 when it was unable to get sufficient power due to the dwindling sunlight, dust which obscures the light together with the harsh winter temperatures. Attempts were made by the Mars Odyssey orbiter to contact with the lander as it came out of the Martian winter and past the Martian

summer solstice on May 12, 2010 still without success. The Phoenix mission was declared a success after all of its mission objectives were achieved and it was the first lander to return data from a polar region. Researchers had hoped that Phoenix would survive the winter to tell its tale and even witness the polar ice overlaying Phoenix maybe even up to 1 metre thick of solid carbon dioxide ice would have appeared.

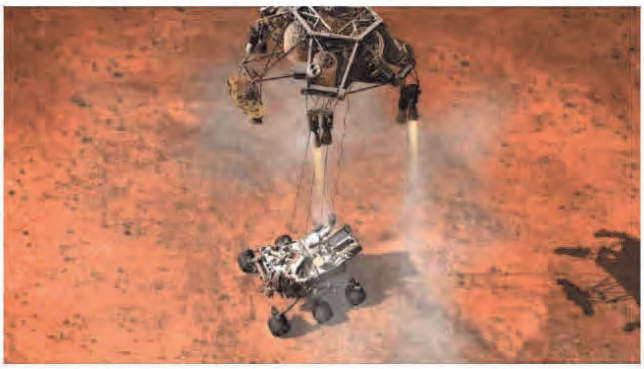


Phoenix lander seen on the surface by the MRO in 2008.

Phoenix image of the horizon showing the polar surface.

Stamps showing Phoenix

Getting Curiosity to the surface required a new landing technique, the Skycrane with the airbag system being ditched. Curiosity went through the normal atmospheric entry with shielding before a parachute descent. There was a powered descent stage which slowed the vehicle down. Tucked below the descent stage was Curiosity which was lowered down beneath a 25 ft (7.6 metre) tether when the rover's wheels were locked down. The whole stage then hovered at the tether altitude with Curiosity touching the surface, the tether was then released and the stage then powered away leaving the rover on the surface. The stage crash landed as planned 2,100 ft (650 metres) away.



The Skycrane in operation.