MARS EXPRESS – SCIENCE SUMMARY AFTER ALMOST SIX YEARS IN ORBIT

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The Mars Express mission, launched on a Soyuz rocket from Baikonur in June 2003, has provided a comprehensive and multidisciplinary view of Mars, including the surface morphology, geology and mineralogy, the subsurface structure, the state of the interior, the climate's evolution, the atmospheric dynamics and composition, and the aeronomy. Originally planned for one Martian year (687 days), the mission has been extended several times and has led to the publication of over 350 peer-reviewed papers in international scientific journals. A summary of scientific results is presented below.

The **High-Resolution Stereo Colour Imager** (HRSC) has shown breathtaking views of the planet and provided new insights into the planet's topography, allowing a much better understanding of the formation and evolution of the surface geological features. In particular, the combination of digital terrain models with coverage at high resolution (better than 20 m/pixel) indicates very young ages for both glacial and volcanic processes, from hundreds of thousands to a few million years old, respectively.

The **OMEGA infrared mineralogical mapper** has provided unique maps of H_2O ice and CO_2 ice in the polar regions. It has also shown that the minerals resulting from alteration (phyllosilicates) in the early history of Mars reflect the abundance of surface liquid water, while the post-Noachian products (sulfates and iron oxides) suggest a colder, drier planet with only episodic water on the surface. Also, OMEGA recently detected high-altitude CO_2 ice clouds in the equatorial region of Mars.

The **MARSIS ionospheric and subsurface sounding radar** recorded strong echoes coming from the surface and the subsurface allowing to identify the very finely layered structure of the polar caps and other areas of interest. Radar probing of the topside ionosphere revealed a complex and time-varying ionosphere. Quite unexpectedly, the identification of the local electron gyro-frequency in the MARSIS echoes can be used as a measurement of the magnetic field, which provides new information on the distribution and strength of residual crustal magnetic pockets, and the draping of the solar wind induced magnetic field around Mars and its interaction with the ionosphere.

The **Planetary Fourier Spectrometer** (PFS) has confirmed the presence of methane for the first time from orbit, pointing to current volcanic activity and/or biological processes. PFS has also studied the thermal structure of the atmosphere when a global dust storm occurred (temperature increase due to dust). PFS supported the entry, descent and landing (EDL) of the Phoenix spacecraft by providing atmospheric profiles to NASA.

The **ultraviolet and infrared atmospheric spectrometer** (SPICAM) has provided the first complete vertical profile of CO_2 density and temperature. It has also discovered the existence of nightglow, as well as auroras over mid-latitude regions linked to crustal paleomagnetic signatures, and very high-altitude CO_2 clouds. It has revealed the ozone density vertical profile, and very recently has shown the possibility to measure the O_2 density.

The **analyser of space plasma and energetic atoms** (ASPERA) has found that the solar wind is slowly stripping off the high atmosphere down to 270 km altitude, and measured the current rate of atmospheric escape of planetary ions. The composition of the escaping plasma has been precisely measured. For the first time, the backscattered hydrogen was used to image regions of the precipitating solar wind.

Finally, the **Mars Radio Science experiment** (MaRS) has studied the surface roughness by pointing the spacecraft high-gain antenna at the planet and recording the echoes. Also, the Martian interior has been probed by studying the gravity anomalies affecting the orbit. Very interesting results on the ionosphere have been obtained, in the lower part where a layer created by meteoric activity was found, and in the upper part by detecting the ionopause.

Multi-disciplinary investigations have become a regular feature of the extended mission. For example, water vapour is being measured in concert by SPICAM, PFS and OMEGA, allowing to clarify all aspects of the water cycle in more detail. **Phobos observations** are also being closely coordinated, as Mars Express is flying at the closest distance ever of Phobos (less than 100 km), allowing to determine the mass of Phobos with great accuracy, to sound its interior with a radar for the first time, to obtain the sharpest images ever, to observe the satellite in the visible, UV and IR, and to monitor the solar wind interaction with Phobos.

An effort to enlarge the scope of **existing cooperation** is being made, in particular with respect to other missions at Mars (such as MER, Mars Odyssey and MRO) and also missions to other planets carrying the same instruments as Mars Express (i.e. Venus Express). Mars Express is also providing valuable data for the preparation of ESA's Exploration Programme first mission to Mars (called ExoMars and including a capable rover to perform geochemical and climatological investigations), in terms of helping to assess areas of interest for exploration and to avoid areas of potential risks for future landings on Mars.

Several years worth of **scientific data** are now in ESA' s Planetary Science Archive. The data is being used all over the world, and several hands-on data analysis workshops have further stimulated its use. The spacecraft and the instruments have recently been confirmed to be in good health, and thus the mission is expected to last for a significant number of years. Further details can be found at: http://sci.esa.int/marsexpress/