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→ MARS EXPRESS

The Scientific Investigations

European Space Agency

FOREWORD

Mars Express arrived at its destination in December 2003 to investigate most of the facets of the Red Planet – the interior, surface, atmosphere and ionosphere – in unprecedented detail. In addition to these global studies, the unifying theme of the mission is the search for water in its various states everywhere on the planet. The resulting water inventory (so far covering water vapour and water ice) has a great significance for the search for potential life forms, past or present, on the surface and below.

The first ESA volume (SP-1240, *Mars Express: The Scientific Payload*), describing the scientific instruments, was published a few months after arrival. This companion volume focuses on the scientific results up to the end of the mission design lifetime (nominal mission and first extension), bearing witness to the tremendous success of Mars Express, scientifically and technically. The nominal science mission (January 2004 – November 2005) has already been extended twice (November 2005 – September 2007 and September 2007 – May 2009). Funding for a third extension (May 2009 – December 2012) is being requested.

Following a summary of the scientific results so far presented in a thematic manner, the scientific investigations are explained in detail in this volume for each of the instruments. First, the instruments dealing primarily with the solid planet (subsurface and surface): the High Resolution Stereo Camera (HRSC), the OMEGA infrared mineralogical mapper, and the MARSIS subsurface sounding radar. Second, the instruments addressing the gaseous planet (atmosphere and ionosphere): the Planetary Fourier Spectrometer (PFS), the SPICAM UV and IR spectrometer, and the ASPERA Energetic Neutral Atom Analyser. Finally, the MaRS radio science experiment, providing insights into all areas, including interior gravity anomalies, surface roughness, atmospheric and ionospheric structure, and solar corona. Two further chapters, on science planning and operations, and data archiving complete the volume.

Mars Express is the first European mission to another planet, following ESA missions to other Solar System bodies (Giotto to Comet Halley and Huygens to Saturn's moon Titan) by the Science Programme. Mars Express has opened the way to the exploration of Mars in Europe, soon to be followed by missions of ESA's Aurora Exploration Programme. ExoMars will focus on detailed geochemical analysis of the martian surface with an ambitious rover, and Mars-NEXT will establish a network of three or four surface stations complemented by an orbiter to determine the deep internal structure of the planet and the global circulation of the atmospheric, and to analyse the rocks and soil at each landing site. Mars-NEXT will be an important technological milestone in preparation for the international Mars Sample Return mission.

Mars Express has positioned European scientists at the forefront of Mars research in all fields, giving Europe a significant presence at international planetary sciences meetings. In spite of numerous US missions to Mars, Mars Express has provided exciting new and fully complementary scientific results. It has taken its rightful place between NASA's Mars Global Surveyor and the Mars Exploration Rovers, and the Mars Odyssey and Mars Reconnaissance Orbiter missions. Mars Express has given ESA unprecedented visibility among the general public worldwide, unmatched until the later landing of Huygens on Titan. Through its data archive, its data are continuously being made available to the scientific community in all fields of research. Biweekly web releases are reaching a vast portion of the general public on all continents.

From a technical point of view, the legacy of Mars Express is highly significant, showing that first-class planetary missions can be built in record time with limited resources. This made Venus Express possible by using the same spacecraft design and more than half of the Mars Express instruments. From a scientific point of view, in addition to the outstanding results in all areas of Mars science, the legacy of the mission will be measured by the global imaging of its surface at high resolution, largely improving on the 1970s Viking coverage.

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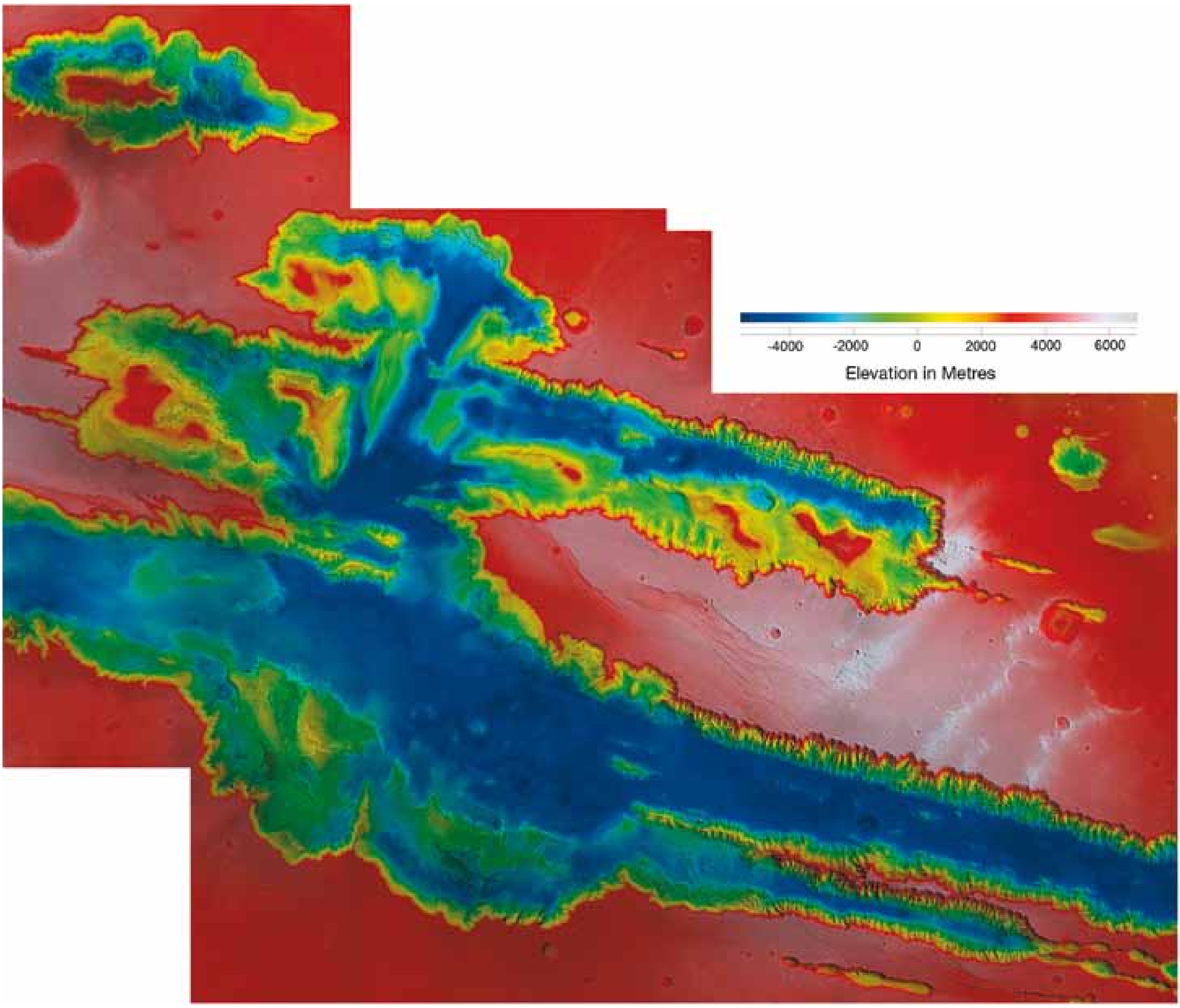
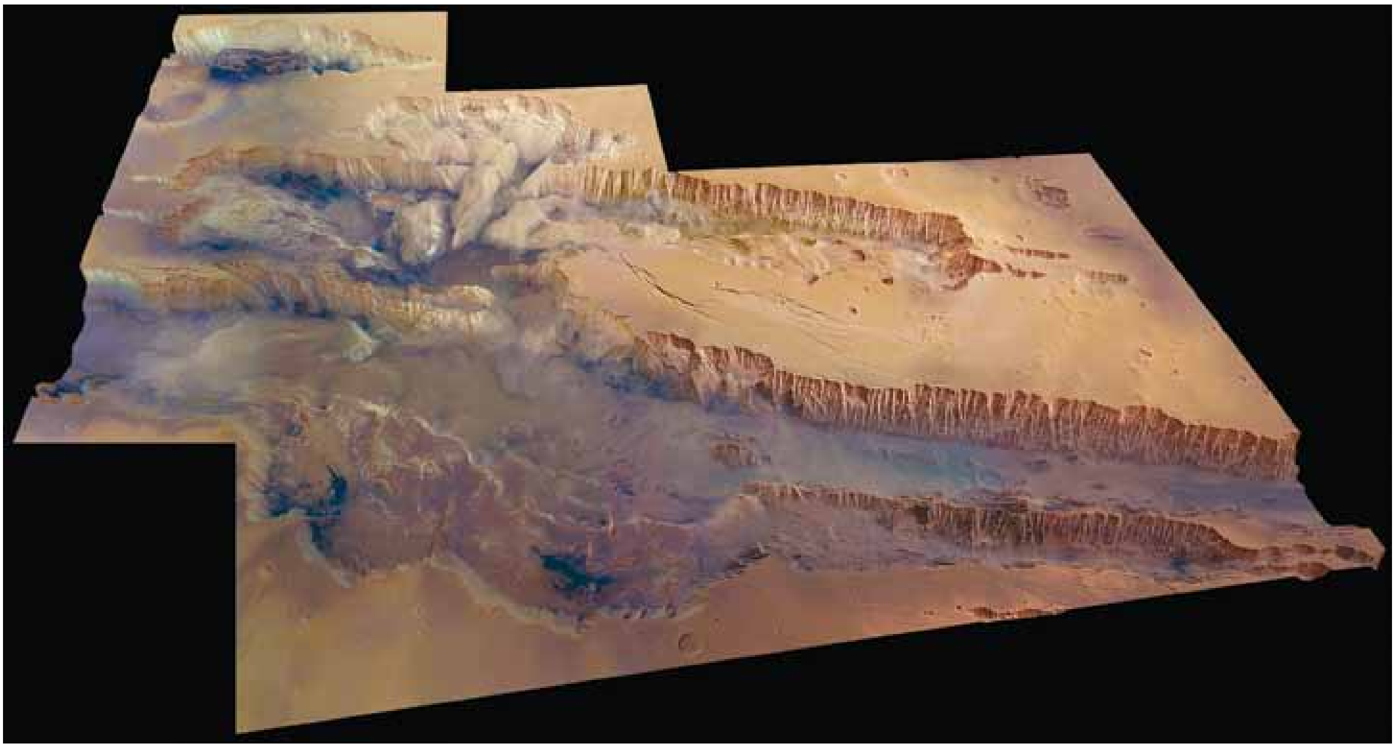
ESTEC, September 2008



First high-resolution colour-coded Digital Terrain Model (DTM) mosaic with superimposed HRSC ortho mosaic of the central part of Valles Marineris.

The stereo information from 20 HRSC individual orbit swaths has been used to generate a DTM mosaic with a ground resolution of 100 m per pixel. The information from the high-resolution panchromatic nadir channel of the HRSC has been used to create an ortho-image mosaic with a ground resolution of 25 m per pixel covering an area of approximately 630 000 km^2. Both sets of processed data have been combined to create this sharpened colour-coded DTM view.



First near-true colour oblique view of the central part of Valles Marineris.

The stereo information from 20 HRSC individual orbit swaths has been used to generate a DTM mosaic with a ground resolution of 100 m per pixel together with the colour information of 12 HRSC orbit swaths to generate this near-true colour ortho-image mosaic covering an area of approximately 630 000 km^2. In order to improve the spatial resolution, the HRSC colour channels and the high-resolution nadir channel have been combined (Hue-Intensity-Saturation Transformation) and then recast into a sharp, improved colour image. This colour image and the DTM data combined have been used to generate the particular bird's eye view of Valles Marineris at an angle of 45° to the surface at four times vertical exaggeration.