The European Robotic Exploration of the Planet Mars

AGUSTIN F. CHICARRO
Solar System Missions Division, ESA-ESTEC, The Netherlands

The ESA Mars Express mission was launched in June 2003 and has been orbiting Mars for over six years providing data with an unprecedented spatial and spectral resolution on the surface, subsurface, atmosphere and ionosphere of the red planet. The main theme of the mission is the search for water in its various states everywhere on the planet by all instruments using different techniques. A summary of scientific results includes: the distribution of minerals by the OMEGA spectrometer provides new constraints on Mars aqueous history and early climate; the presence of methane has been confirmed from orbit by the PFS spectrometer, and its spatial and vertical distribution is being mapped; the HRSC imager reveals that glacial landforms in tropical and equatorial areas were active perhaps only a few million years ago; the MARSIS radar indicates that the north and south polar layered deposits consist of nearly pure water ice; the escape rate of energetic ions in the upper atmosphere has been estimated by ASPERA to be low and the composition of the escaping plasma has been determined; the analysis of HRSC crater counts indicates recent and episodic volcanic activity on Mars; the SPICAM spectrometer discovered the first ever night-side airglow and auroras on Mars; the first unambiguous observation of CO2 ice clouds has been reported by OMEGA and supported by SPICAM and HRSC; the radio science experiment discovered a hitherto undetected low-altitude ionospheric layer associated with the burning of meteors in the atmosphere; the most accurate estimate for the mass of Phobos has been derived from radioscience data. Mars Express will be followed by the new joint ESA-NASA Mars Exploration Programme, starting in 2016 with an Orbiter focusing on atmospheric trace gases and in particular methane. The ExoMars rover will follow in 2018 to perform geochemical and exobiological measurements on the surface and the subsurface. Then in 2020, a Network of 3-6 surface stations would be launched, in order to investigate the interior of the planet, its atmospheric dynamics and the geology of each landing site. This Network would address: i) the internal geophysical aspects concern the structure and dynamics of the interior of Mars including the state of the core and composition of the mantle; the fine structure of the crust including its paleomagnetic anomalies; the rotational parameters (axis tilt, precession, nutation, etc) that define both the state of the interior and the climate evolution; ii) the atmospheric physics aspects concern the general circulation and its forcing factors; the time variability cycles of the transport of volatiles, water and dust; surface-atmosphere interactions and overall meteorology and climate; iii) the geology of each landing site concerns the full characterization of the surrounding area including petrological rock types, chemical and mineralogical sample analysis, erosion, oxidation and weathering processes to infer the geological history of the region, as well as the astrobiological potential of each site. To complement the science gained from the Martian surface, investigations need to be carried out from orbit (possibly with the 2016 Orbiter) in a coordinated manner, such as global

atmospheric mapping to study weather patterns, opacity and chemical composition as well study of the planet rotation and climate evolution. The Network Mission concept is based on the fact that some important science goals on any given terrestrial planet can only be achieved with simultaneous measurements from a number of landers located on the surface of the planet (primarily internal geophysics, geodesy and meteorology) coupled to an orbiter. The long-term goal of Mars robotic exploration in Europe remains the return of rock and soil samples from the Martian surface before Humans go to Mars. For more details on ESA's Mars Exploration Programme, see: http://exploration.esa.int/