New advances in our understanding of the martian surface: implications for European landing missions

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Within the Aurora Programme two of the next possible Mars landers are the Technology Demonstrator of 2009 or 2011 and *ExoMars* in 2013. Ongoing studies suggest that landing constraints for this next generation of Mars landers are likely to be ≤0 km elevation, ≤75 x 10 km landing ellipse (or smaller in the case of descent from an orbiter), latitude ±20°N/S and possibly ±45°N/S. The landing systems are likely to be based on vented airbags or partially controlled descent. Many critical decisions regarding the approach and descent to Mars remain to be taken; the 2011 and 13 oppositions are less favourable than recent oppositions for a direct, rapid approach to Mars. However, the smaller landing ellipses and higher possible elevations mean that much more of the martian land surface could be reached than was the case for the *Beagle 2* lander [1]. This has the benefit of allowing both improved safety margins and access to sites of exobiological interest. For the landing constraints outlined above – 75 km long ellipse, 45°N/S – there are 17 main potential landing areas. These lie within the Noachian exhumed terrain of Arabia Terra (including the *Opportunity* landing site); large craters in the ancient highlands preserving layered sedimentary terrains; the flood channels of Chryse Planitia; layered deposits within Valles Marineris; a variety of northern lowlands sites including Elysium Planitia, Isidis, Athabasca Vallis. Therefore it is from within these regions that sites compatible with recent advances in our understanding of the geology of Mars should be selected.

Current and recent missions to Mars have deepened our understanding of the planet in five main ways: 1. The identification of metre-scale layering in the sides of craters and canyons by the Mars Orbiter Camera (MOC) followed by the MER lander photographing cm-scale layering at the *Opportunity* landing site. The fine-scaled textures are consistent with origin as water-borne sediments. 2. The identification of ~1 Ma gullies. These gullies are concentrated in mid-south latitudes and resulted from the melting of near-surface water-ice deposits [2]. One of the clearest examples of this is the 290 km wide Newton Crater in Terra Sirenum (41°S, 200°E). On the main crater floor a smaller 2 km crater contains numerous water-formed gullies and debris aprons. 3. The distribution of H_2O-ice in the top few metres of the martian surface has been mapped by the gamma ray spectrometer on *Mars Odyssey*, with high concentrations located in Arabia Terra and >45°N/S [3]. 4. Ongoing work such as the *Mars Express* Fourier Spectrometer analyses of methane concentrations promises to give new information about the atmosphere. 5. MOC THEMIS and HRSC have now provided extensive imaging at a range of resolutions from <1 m/pixel upwards in visible and IR. In combination with high resolution topographic data from MOLA and improved areocentric models for Mars we can now make detailed maps of areas of exobiological interest.

Each of these five topics should influence the choice of landing sites. However, sampling debris fans below the ~1 Ma gullies within large craters would require delivery from orbit and small landing ellipses (10 km) together with long range i.e. ~10 km rover mobility. Landing on sedimentary rocks within Noachian terrain is one of the most promising possibilities from a combination of scientific and terrain considerations (e.g. rock abundances, slopes).

References

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