The Geological Evolution of Mars as Seen through the Mars Express High Resolution Stereo Camera (HRSC)

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After two years of orbital acquisition of high-res. stereo and color data by the HRSC experiment on the ESA Mars Express Mission and nearly 30% coverage of the martian surface at a resolution of better than 20m/pixel, we are beginning to understand the geological evolution of Mars at different scales (globally, regionally, and locally) considerably better. The combination of the new HRSC data with MOC data where high-res context information can be merged with detailed local information, and the combination with color data giving the distribution of different materials as well as stereo viewing capability open up a new domain of photogeological high-precision interpretation. We can demonstrate that there has been episodic volcanic, hydrothermal, fluvial, and glacial activity throughout the whole history of Mars though declining in magnitude through time and peaking at certain periods in the past, becoming confined more and more to certain regions or locales, such as the poles, the highland-lowland boundary and in particular the Tharsis and Elysium regions and vicinities. What is becoming much clearer now is that in parallel to the cessation of the martian highland volcanism ˜3.5 Ga ago and probably the rapid loss of the martian atmosphere within a few 100 Ma by that time, Mars fell dry on a global scale. It is now very clear on the basis of our analysis of HRSC data the early “wet and warm” Mars as put forward after Viking, is more of a fiction than reality. Whether a global large ocean in the north ever existed is less clear than ever, the odds seem to be against it. At least by 3.5 Ga ago, probably already around 3.8 Ga ago, our data tell us, it was gone if it was there before and Mars fell dry rapidly on a global scale. Nevertheless, from time to time through the Aeons until today Mars has been volcanically active in periods, and largely through this activity water seems to have been released from ice-rich layers on the surface or sub-surface or from aquifers which formed fresh small-channel systems locally and triggered glacial processes through the freezing water. The most outstanding recent finding is that the ages of activity periods derived from the analysis of the imaging data in terms of superimposed crater frequencies coincide with age groups of martian meteorites whose ages have been determined by isotope measurements in the lab.