MARS: RECENT AND EPISODIC VOLCANIC, HYDROTHERMAL, AND GLACIAL ACTIVITY REVEALED BY THE MARS EXPRESS HIGH RESOLUTION STEREO CAMERA (HRSC). G. Neukum[1], R. Jaumann[2], H. Hoffmann[2], E. Hauber[2], J. W. Head[3], A. T. Basilevsky[1,4], B. A. Ivanov[1,5], S. C. Werner[1], S. van Gasselt[1], J. B.Murray[6], T. McCord[7], R. Greeley[8], and the HRSC Co-Investigator Team. [1]Institut fuer Geologische Wissenschaften, Freie Universitaet Berlin, Germany; [2]DLR-Institut fuer Planetenforschung, Berlin, Germany; [3]Dept. of Geological Sciences, Brown University, USA; [4]Vernadsky Institute of Geochemistry and Analytical Chemistry, Moscow, Russia; [5]Institute of Dynamics of Geospheres, Moscow, Russia; [6]Dept. of Earth Sciences, Open University, Milton Keynes, U.K.; [7]Hawaii Institute of Geophysics and Planetology, University of Hawaii, Hawaii, USA; [8]Dept. Geolog. Sci., Arizona State University, Tempe, Arizona, USA. (Contact: gneukum@zedat.fu-berlin.de).

The HRSC Experiment on the ESA Mars Express Mission has obtained new insight into the geologic activity of Mars. The analysis of the image data taken over the first half year of the mission shows that calderas on five major volcanoes in the Tharsis and Elysium regions have undergone repeated activation and resurfacing during the last 20% of Martian history, with caldera floors as young as 100 Ma, and flank eruptions as young as 2 Ma. The results confirm that the edifices are constructed over billions of years [1] and are characterised by episodically repeated phases of activity [2] continuing almost to the present and suggesting the volcanoes are potentially still active today. It appears that the more recent volcanic activity on both the Tharsis and Elysium volcanoes clustered around 100-200 Ma ago, practically coinciding with radiometric ages of several Martian meteorites [3]. Glacial deposits at the base of the Olympus Mons escarpment [4,5,6] show evidence for repeated phases of activity over the last 5% of Martian history as recently as ~4 Ma ago (Fig. 2). Bright deposits on the flanks of Olympus Mons at the edge of the western scarp are interpreted to be remnants of ice and dust accumulations dating from these times and even earlier periods as old as 3.8 Ga ago. Morphological evidence is found that snow/ice deposition on the Olympus construct at elevations more than 7000 m high led to episode(s) of glacial activity at this height. The data suggest that water ice protected by an insulating layer of dust may now be present at high altitudes at the edge of the Olympus Mons shield. The presence of the young glacial deposits in the tropics of Mars at the base of the Olympus Mons escarpment supports the hypothesis of recent climate changes with snow and ice accumulation possibly due to changes in the obliquity of Mars [7,8,9,10].

A summary of our highlight findings is published in [11]. Since then, new even higher-resolution data of the western and eastern edges of Olympus Mons have been obtained showing in greater detail especially the remains of glacial and hydrothermal activity (Fig. 1). A synthesis of forms and new results will be presented at the conference.

References: [1] Neukum, G. & Hiller, K. J. Geophys. Res. 86, 1981; [2] Wilson, L. et al., J. Geophys. Res. 106, 2001; [3] Nyquist, L. E. et al., Space Science Rev. 96, 2001; [4] Lucchitta, B. K., Icarus 45, 1981; [5] Milkovich, S. M. and Head, J. W., 6th Int. Mars Conf., #3149, 2003; [6] Head, J. W. et al., Nature (in press); [7] Laskar, J. et al., Icarus 170, 2004; [8] Richardson, M. I. & Wilson, J. R., J. Geophys. Res. 107, 2002; [9] Haberle, R. M., et al., Icarus 162, 2003; [10] Head, J. W. et al., Nature 426, 2003; [11] Neukum, G. et al., Nature 432, 2004; [12] Neukum, G. et al., Space Sci. Rev. 96, 2001; [13] Ivanov, B. A., Space Sci. Rev. 96, 2001; [14] Hartmann, W. K. & Neukum, G., Space Sci. Rev. 96, 2001.

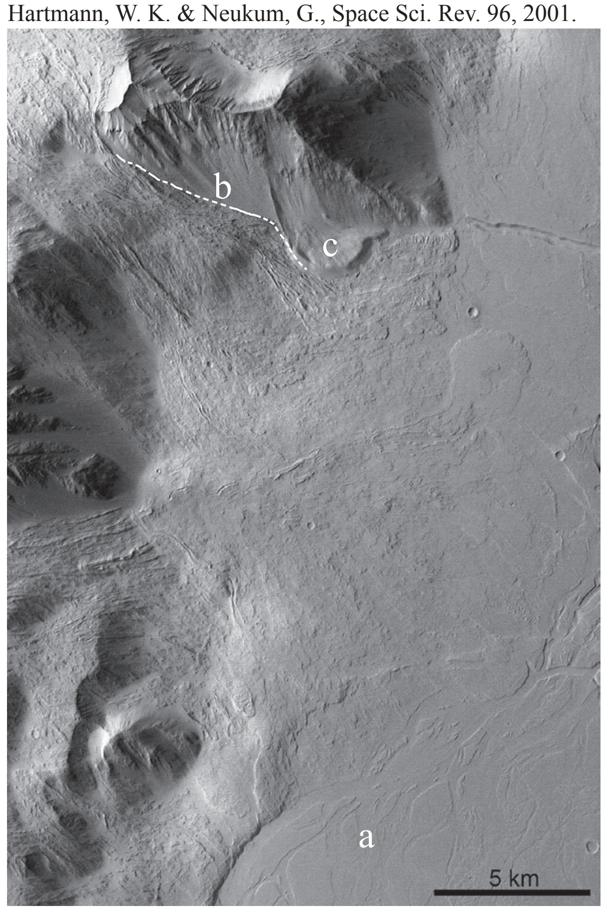

Figure 1: Eastern scarp of Olympus Mons as seen in HRSC image #1089. The area is characterized by an abundance of lava flows that flow down the eastern rim of Olympus Mons and onto the eastern plains. At the termini of individual flow lobes several channel-like features can be observed suggesting a significant release of water due to hydrothermal processes (a). The contact between lava flows and wallrock (b) might have been altered and shaped through a local snow- or ice cover. A large landslide (c) with a distinct terminal lobe suggests the presence of water or ice rich material near the surface. Image center is located at 230.5°E, 15.8°N, North is up.

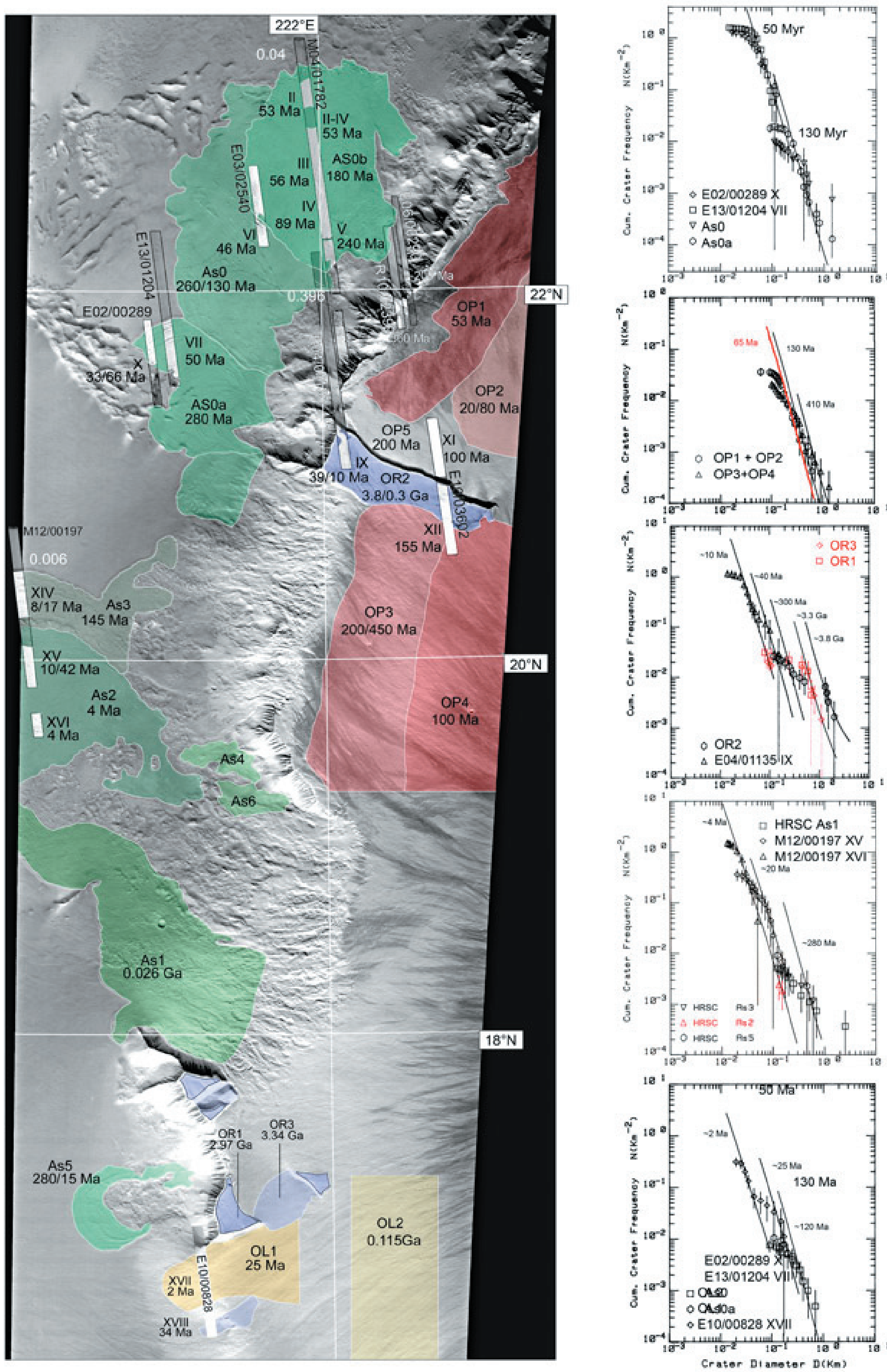

Figure 2. HRSC image base map with nested MOC data and depiction of the counting areas and resulting ages of the western near-escarpment area of the Olympus Mons volcanic shield, the 7 km high escarpment and the adjacent plains area to the west with remnants of glacial features. The counts show different episodes of resurfacing with erosion of craters and following re-cratering. These episodes and processes are reflected in the different steepnesses of the distributions on the log-log plots giving a kinky appearance. The flat parts show erosional effects, the steep parts show the re-cratering after the erosional episodes. The Martian impact crater size-frequency distribution [12,13,14] has been fitted to the individual segments of the distribution giving individual crater-frequency values for the different episodes and by application of the Hartmann/Neukum chronology [14] individual absolute ages can be extracted. In this way it is possible to extract the evolutionary history of the area under investigation in detail. The fits to the crater frequencies here partly have the character of average isochrones for a group of counts yielding similar numbers. The error of the ages usually is around 20-30% for ages younger than 3 Ga (only 100 – 200 Ma for older ages) due to the statistical limitations. The error bars given represent a one-sigma error. All ages < 2 Ga may in the same way be affected by a possible systematic error of about a factor of two in the cratering chronology model [14] used. North is at top.