NEW INSIGHTS INTO THE EVOLUTIONARY HISTORY OF THE MAJOR VOLCANIC CONSTRUCTS FROM MARS EXPRESS HRSC DATA. S. C. Werner[1], G. Neukum[1], and the HRSC Co-Investigator Team, [1] Institut fuer Geologische Wissenschaften, Freie Universitaet Berlin, Malteserstr. 74-100, Bldg. D, 12249 Berlin, Germany. (swerner@zedat.fu-berlin.de).

Introduction: During the first half year of the ESA Mars Express mission in orbit, the High Resolution Stereo Camera, a multiple line scanner instrument, is acquiring high-resolution colour and stereo images of the surface of Mars[1]. Resolution down to 10 meters per pixel coupled with large areal extent (swaths typically 65-100 km wide and thousands of km long) means that small details can be placed in a much broader context than was previously possible. Most of the major volcanic constructs have been covered in the first half year of the mission. The ability to image in colour and stereo simultaneously gives us new opportunity to better characterize most of the volcanoes in the Tharsis and Elysium region and some highland volcanoes geomorphologically and chronostratigraphically. We have remapped major parts of the volcanic shields and calderas on the basis of the high-resolution (as good as 10 m/pixel) HRSC imagery in colour and stereo and in combination with nested MOC imagery [2] and the Super Resolution Channel (SRC) (as good as 2.5 m/pixel) of the HRSC.

Method: To determine absolute ages on Mars we measure the crater size frequency distribution for a geomorphologically mapped unit and fit the crater production function [3,4] to the data set, extract a size-frequency value for craters of one kilometer and larger, and apply the Hartmann/Neukum chronology model [5] for the derivation of an absolute age.

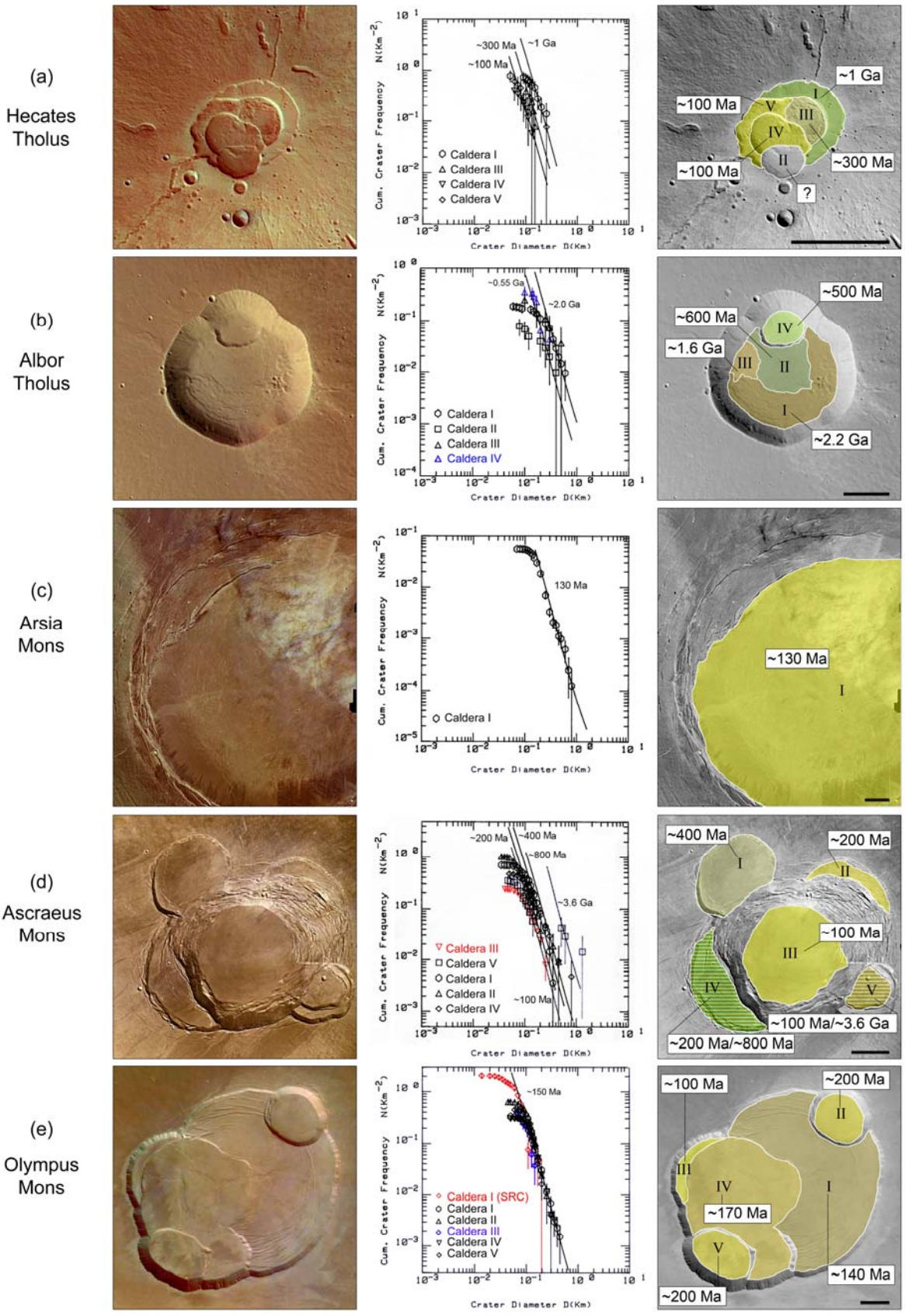
Figure 1 a) and b) show Hecates and Albor Tholus observed in Orbit 32. Both belong to the Elysium region, one of the smaller volcanic bulges in the northern lowlands. The caldera morphologies indicate step-wise volcanic activity and the ages derived from crater size-frequency measurements yield a period of activity over 2 billion years for Albor Tholus. For Hecates Tholus the recorded ages range between 1 billion and 100 million years.

Figure 1 c) and d) show two of the three Tharsis Montes, belonging to the largest volcanic region of Mars: Arsia Mons (c), covered in Orbit 263, is the southernmost construct of that unit. It is characterized by a single caldera floor of an age of about 130 Ma. Small volcanic domes in the Arsia Mons caldera, following the major fault direction of the Tharsis Montes group, hint to possibly still active volcanism. Ascraeus Mons (d) has been covered in Orbit 68 (and Orbit 16) and is the northernmost of the volcano triplet. Its caldera is represented by a number of floor levels indicating again repeated eruption activity in the last one billion years. Possibly the caldera V has been formed much earlier in the life time of the volcano.

In figure 1 e) the caldera of the largest Martian volcano Olympus Mons is shown. The caldera unit has been covered in Orbit 37. Again the caldera floor level and morphology indicate repeated eruption activity. The age measurements yield an activity phase between 100 and 200 million years ago. Crater frequencies measured on the different caldera floors indicate ages, which slightly deviate from the morphologically expected time-stratigraphic derived volcanic sequence for the formation of the calderas. A detailed study of the caldera morphology show for the larger caldera floors tectonic and volcanic resurfacing affecting the age results [6].

Results: Crater size-frequency measurements confirm that the edifices have been constructed over billions of years[7] and are characterized by episodically repeated phases of activity[8] continuing almost to the present. The youngest ages determined by the crater size-frequency measurements are about 2 Ma suggesting that the volcanoes are potentially still active today. A number of caldera floor ages cluster around 150 Ma indicating a relatively recent peak activity period and practically coinciding in age with radiometrically measured crystallization ages of a group of basaltic meteorites from Mars (SNC meteorites)[9].

References: [1]Neukum, G. et al. (2004) *ESA SP-1240*, 17-35. [2]Malin, M. C., K. S. Edgett (2001) *J. Geophys. Res.*, 106(E10), 23429-23570. [3]Ivanov, B. A. (2001) *Space Sci. Rev.* 96**,** 87-104. [4]Neukum, G. (1983) Habilitation Dissertation, LMU Munich. [5]Hartmann, W. K. and Neukum, G. (2001) *Space Sci. Rev.* 96**,** 165-194. [6] Hauber, E. et al. (2004) *EGU Gen Assembly 1st*, abstract EGU04-A-07922. [7]Neukum, G. and Hiller, K. (1981) *J. Geophys. Res.* 86, 3097-3121 (1981). [8]Wilson, L. et al. (2001) *J. Geophys. Res.* 106, 1423-1433. [9]Nyquist, L. E. et al. (2001) *Space Science Rev.* 96, 105-164.


(a)
Hecates Tholus
~300 Ma
~1 Ga
~100 Ma
Caldera I
Caldera III
Caldera IV
Caldera V
Cum. Crater Frequency N(Km⁻²)
Crater Diameter D(Km)
~1 Ga
~100 Ma
~300 Ma
~100 Ma
?
(b)
Albor Tholus
~0.55 Ga
~2.0 Ga
Caldera I
Caldera II
Caldera III
Caldera IV
~500 Ma
~600 Ma
~1.6 Ga
~2.2 Ga
(c)
Arsia Mons
130 Ma
Caldera I
~130 Ma
(d)
Ascraeus Mons
~200 Ma
~400 Ma
~800 Ma
~3.6 Ga
~100 Ma
Caldera III
Caldera V
Caldera I
Caldera II
Caldera IV
~400 Ma
~200 Ma
~100 Ma
~100 Ma/~3.6 Ga
~200 Ma/~800 Ma
(e)
Olympus Mons
~150 Ma
Caldera I (SRC)
Caldera I
Caldera II
Caldera III
Caldera IV
Caldera V
~100 Ma
~200 Ma
~170 Ma
~140 Ma
~200 Ma