Total Volume Estimates of Volcanic Material of the Elysium Volcanic Region. T. Platz[1], T. Kneissl[1], E. Hauber[2], L. Le Deit[2], G. G. Michael[1] and G. Neukum[1]. [1]Freie Universität Berlin, Institute of Geological Sciences, Planetary Sciences and Remote Sensing, Malteserstr. 74-100, 12249 Berlin, Germany, thomas.platz@fu-berlin.de, [2]German Aerospace Center (DLR), Institute of Planetary Research, Rutherfordstr. 2, 12489 Berlin, Germany.

Introduction: Throughout the history of Mars, volcanism played a significant role. Enormous amounts of magma ascended from deep within the planet and spread onto the surface forming large volcanic edifices and vast lava plains. A major role of magma ascent is attributed to volatiles dissolved in the melt which successively exsolve as the confining pressure reduces and thus, increase the buoyancy of the magma. As a result, the magma rises to subsurface levels or erupt as lava on the surface with large amounts of volatiles being released to the atmosphere. Since there is compelling evidence for fluvial processes on Mars, it is still debated whether there ever was a thicker atmosphere to support the stability of liquid water on the surface. Quantification of the amounts of released volatiles through volcanic eruptions in time are therefore essential. So far, estimates of volatile amounts have been studied on global and regional scales [1-3], however, detailed studies of volatile contributions of individual volcanic centres are still lacking. Here, we present new approaches to estimate unit volumes in the Elysium volcanic region.

Deposits: The Elysium volcanic region consists of three edifices: Elysium Mons, Hecates Tholus, and Albor Tholus. Elysium Mons is the largest volcano and is located on a c.1000 km × 1500 km rise. The summit of Elysium Mons rises c. 17,700 m above the surrounding plain to the west. Hecates Tholus and Albor Tholus are located to the NNE and SSE of Elysium Mons at the periphery of the Elysium rise. Volcanic material erupted from Late Hesperian to Early Amazonian from the Elysium volcanic region was mapped as unit AHEe [4-5]. It spreads over 110° E-W and 35° N-S and covers an area of approx. 3.37×10^6 km^2.

Methods: Unit AHEe consists of six areas; for model purposes we subdivided the largest area 6 into two resulting in a total of seven areas (Fig. 1a). For each region, area and volume calculations were performed. For area calculations, an equal-area sinusoidal projection was used. The basal topography, i.e., the underlying topography of each area, was modelled in a GIS environment using Triangular Irregular Networks (TINs). In order to model this simplified underlying topography, the outline of each area was taken, converted into vertices with each vertex connected to two others forming a triangle. This modelled TIN surface is then subtracted from the present-day topography (i.e., the MOLA DTM). However, due to topography variations, the modelled TIN surface often appears above the topography resulting in negative thickness values for individual pixels. To compensate for these effects, large impact craters and partially flooded craters were used as anchor points to fix the TIN surface below the topography. The pre-topography elevation of each crater was estimated from morphometric crater diameter-rim height relationships [6]. Craters were identified on HRSC, CTX, THEMIS VIS, and Viking imagery. Due to limited coverage of higher resolution images, only flooded craters larger than 300 m in diameter were used. For areas 3 and 5, the unit thicknesses were estimated using crater size-frequency distributions following the method of [7]. The maximum thickness value was used and subtracted from the elevation of single vertices along the area outline from which a TIN surface was created. Area 4 represent the filling of Adams Crater (D=89.4 km). The deposit volume was calculated using an oblate spheroid. As a result, the calculated volume is a maximum volume since it may contain a possible central mountain within the crater.

Volume Estimates: The Elysium rise including the main volcanoes constitute the thickest areas. The estimated total volume of volcanic material produced by the Elysium volcanic region is 3.5×10^6 km^3 (Fig. 1b). Approximately 4.2 % of the total area show thickness values ≤ 0 m (primarily at the peripheral locations) which were discarded from the calculations. It is also noted that with better high-resolution coverage, particularly for area 7, minimum volume estimates could be improved considerably.

Discussion: The estimated total volume of Elysium volcanic material can be used to assess the amounts of volatiles released during the eruption. We applied the average amounts of H_2O=0.5 wt. % and CO_2=0.7 wt. % released during Hawaiian basaltic eruptions for our calculations [3,8]. The inferred total amounts of H_2O and CO_2 released from the Elysium volcanic region would correspond to 4.7×10^{16} kg H_2O and 6.6×10^{16} kg CO_2 assuming a bulk rock density of 2700 kgm^{-3}. In follow-up studies we will look at eruption frequencies at Elysium to identify major periods of activity, and hence, volatile releases into the atmosphere.

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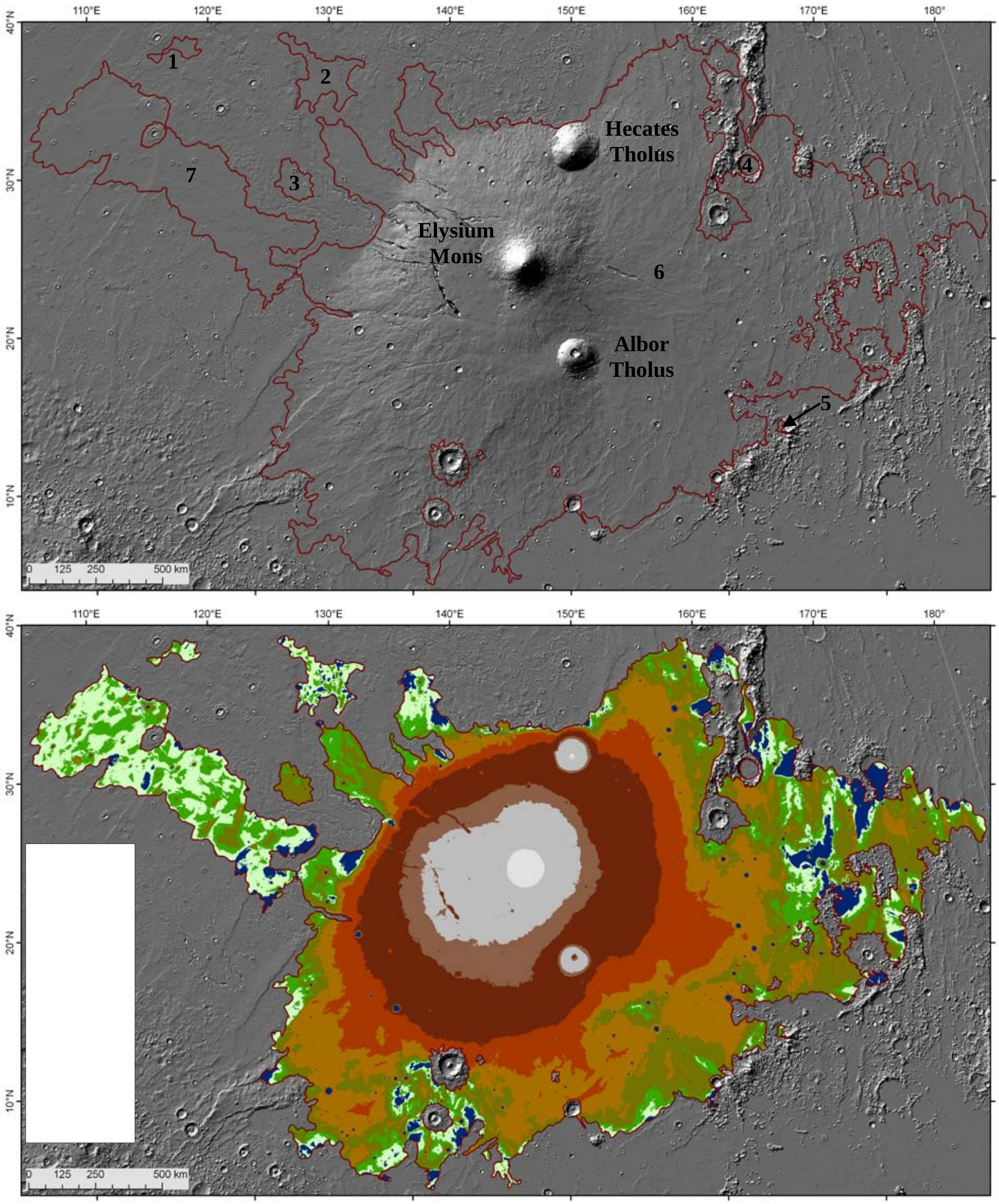

Figure 1: a) Elysium volcanic region with the three dominant volcanic constructs of Elysium Mons, Hecates Tholus, and Albor Tholus. Red lines represent the outline of mapped Elysium rise unit AHEe [4,5]. Numbers refer to areas used for calculations. b) map showing the distribution of unit thicknesses. Blue areas marked thickness below 0 m.