

ERUPTION HISTORY OF THE SYRTIS MAJOR VOLCANIC PROVINCE, MARS. P. Jodłowski, T. Platz and G. G. Michael, Planetary Sciences & Remote Sensing, Institute of Geological Sciences, Freie Universität Berlin, Malteserstr. 74-100, 12249 Berlin, Germany (piotr.jodłowski@fu-berlin.de).

Introduction: Volcanism is one of the most significant processes shaping the surface of Mars. Volatiles released during volcanic eruptions have a significant impact on the composition and density of an atmosphere, which is crucial to understand the planetary evolution.

Syrtis Major is one of the most prominent Hesperian-aged volcanic provinces on Mars [1], located near the dichotomy boundary, west of Isidis Planitia. It extends over approx. 7.4×10^5 km² and has a N-S elongated central depression containing the calderas of Meroe Patera and Nili Patera. Lava thicknesses range from approx. 0.5 km to 1.0 km and total volume of erupted material has been estimated at about $1.6 - 3.2 \times 10^5$ km³ [1].

This province is another target area of our ongoing study to quantify the global volatile release during volcanic eruptions on Mars. Estimates of eruption frequency, associated volume of erupted material, and gas release to the atmosphere are the key parameters of this research. Reconstruction of the eruption history of volcanic provinces is one of the steps to be taken in order to constrain these parameters.

Approach and Methods: In order to achieve representative statistical data, mapping and crater size-frequency determinations should cover proximal, medial, and distal reaches of the study area. However, this approach is restricted by availability and quality of high-resolution image data. In addition, the degree of dust/ash mantling in various portions of the province as well as the presence of extensive wrinkle ridges partially inhibited clear identification of lava flow boundaries.

Lava flow mapping and crater measurements were conducted in a GIS environment. The global THEMIS IR day time mosaic (100 m/px resolution) was used as the basis for lava flow identification and mapping. Crater size-frequency determinations were carried out on CTX and HRSC data. A comparative study conducted on a training area (Fig. 1) proved both instrument data, with similar illumination angle and solar longitude parameters, as equivalent. Crater diameters were measured using *CraterTools* [2]; derived crater statistics were analyzed with *CraterStats* [3]. Crater model ages were determined by using the Hartmann and Neukum chronology function [4] and the Ivanov production function [5].

Lava Flow Morphology: Most of the mapped lava flows are located in the northern part of the province, within proximal to medial reaches from the centre of

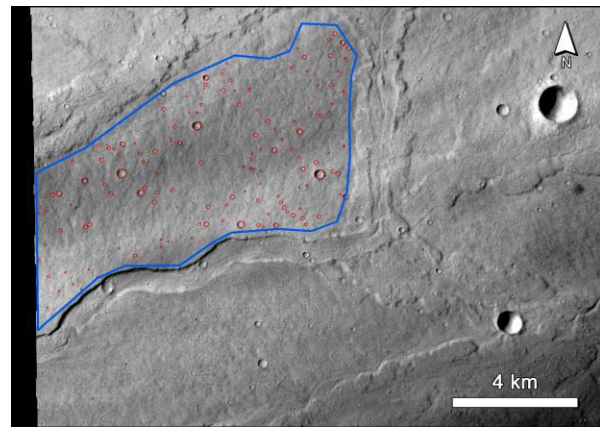


Figure 1: This portion of a lava flow was chosen to determine model ages on HRSC and CTX imagery. Blue outline marks the counting area with measured craters in red. HRSC image 3003_0000.

the volcanic province. Lava flows are predominantly long and narrow with flow widths of 6 to 32 km and runout distances of 28 to 90 km. The average length-to-width ratio is about 4.4. The flows formed smooth surfaces and steep margins, however, neither levees nor flow channels were observed. Impact craters that formed on lava flow surfaces do not exhibit ejecta blankets, likely caused by burial of a thick dust/ash cover. Most of the exposed crater rims are blurred and their interiors flat, which indicates later modification through lava flooding, embaying, and/or dust mantling. Some lava flows exhibit post-emplacement deformation, associated with concentric and radial wrinkle ridge formation.

Crater Model Ages: In total, 58 lava flows were mapped of which 39 were suitable for age determination. In addition, the caldera of Meroe Patera was also dated using crater statistics. Model ages range between 0.87 Ga and 3.63 Ga (Fig. 2). There is no apparent time-space correlation observed.

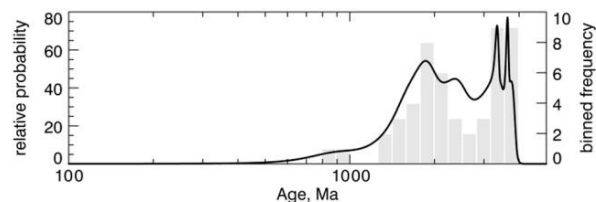


Figure 2: Aggregated age measurements of lava flows and the Meroe caldera. See [6] for more detail on producing this plot.

Discussion: The broad spectrum of model ages, ranging from Early Hesperian to Middle Amazonian [7], points to long-lasting volcanic activity of the studied province. This fact together with post-emplacment deformation of lava flows indicates a much longer eruption and volcano-tectonic history of Syrtis Major than previously thought, extending it to the Middle Amazonian period (Fig. 3).

Amazonian lava flows have a distinct peak at about 2.0 Ga and comprise 38 of 39 flows. This can be explained by the higher preservation potential of younger deposits.

Next steps in our ongoing study will focus on volume estimates of erupted material and eruption rate. These results will provide a more comprehensive un-

derstanding of the eruption record and give insight into the rates of volcanic outgassing and its impact on the atmosphere of Mars.

References: [1] Hiesinger H. and Head J. W. III (2004) *J. Geophys. Res.*, 109, E01004. [2] Kneissl T. et al. (2011) *Planet. Space Sci.*, 59, 1243-1254. [3] Michael G. G. and Neukum G. (2010) *Earth Planet. Sci. Lett.*, 294, 223-229. [4] Hartmann W. K. and Neukum G. (2001) *Space Sci. Rev.*, 96, 165-194. [5] Ivanov B. A. (2001) *Space Sci. Rev.*, 96, 87-104. [6] Platz T. and Michael G. G. (2011) *Earth. Planet. Sci. Lett.*, 312, 140-151. [7] Werner S. C. and Tanaka K. L. (2011) *Icarus*, 215, 603-607. [8] Greeley R. and Guest J. E. (1997) *Map I-1802*, USGS.

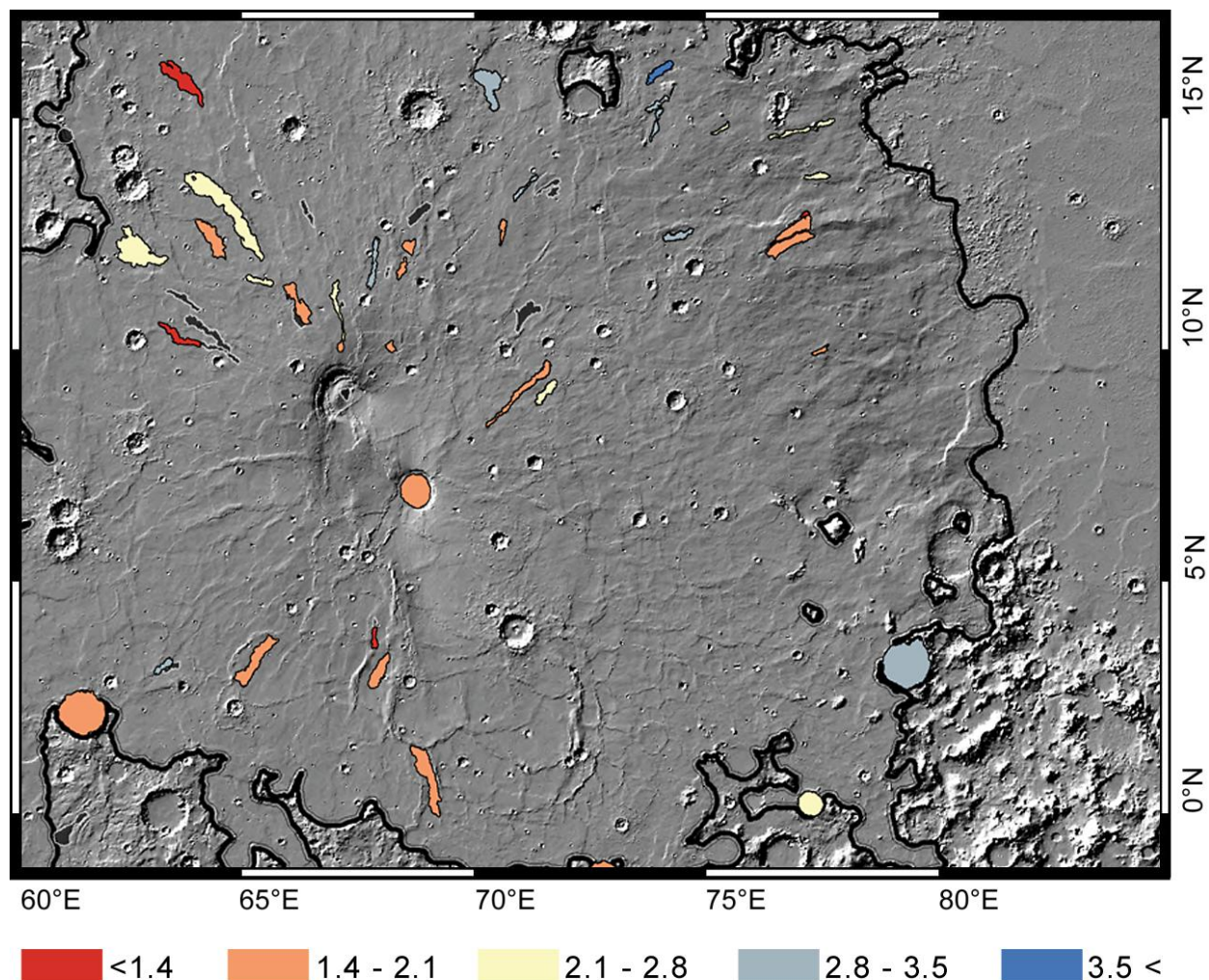


Figure 3: Map of the Syrtis Major Volcanic Province. Formation ages (in Ga) of single lava flows are shown in a color-coded scheme. White outlines depict lava flows which were mapped and where crater counts still need to be performed. Black outline depicts the latest outline of Syrtis Major province, which is based on [8]. Background: MOLA hillshade.