THE AGE OF THE SIRENUM AND FORTUNA FOSSAE ON MARS: RESULTS FROM BUFFERED CRATER COUNTING. Kneissl T.[1], Michael G.G.[1], Platz T.[1,2], and S.H.G. Walter[1], [1]Freie Universität Berlin, Malteserstr. 74–100, 12249 Berlin, Germany, email: thomas.kneissl@fu-berlin.de, [2]Planetary Science Institute, 1700 E. Fort Lowell, Tucson, AZ 85719, US.

Introduction and Methods: Formation ages of most tectonic landforms cannot be determined directly using the conventional crater-counting approach. The steep slopes of fault scarps are often affected by subsequent mass wasting events and processes like creep or impact-induced seismic shaking continuously erase or cover impact craters, which post-date the fault formation (e.g., [1-2]). This inhibits the direct determination of the formation age of tectonic structures based on crater size-frequency distributions (CSFDs). As a consequence, studies investigating structural linear features have often used superpositional and crosscutting relationships in order to constrain relative and absolute formation times (e.g., [3-4]). However, this stratigraphic approach often provides only a rough age estimate because the upper and lower age limits do not necessarily constrain a narrow time-span. The buffered crater counting (BCC) approach (e.g., [5-7]) is independent of the surrounding geological units and not affected by subsequent slope-related resurfacing processes and, thus, allows for a direct determination of CSFD-based ages of tectonic structures.

In this study we compare age constraints from the conventional crater counting approach (superpositional relationships) with age results derived from the BCC approach. Furthermore, we investigate to what extent crater ejecta blankets can be used to assess the stratigraphic placement of craters to increase the statistical significance of the BCC measurements. Here, we tested three different buffer widths, 1, 2, and 3 crater radii and compared the results. All BCC analyses were performed using a new feature of the CraterTools software, which provides semi-automatic application of the otherwise time-intensive procedure of BCC analysis [7-8].

Sirenum and Fortuna Fossae: We selected two Martian graben systems to investigate the applicability of the BCC method to structural landforms. Sirenum Fossae is a graben system extending radially from the Tharsis rise across the southern highlands of Mars (Fig. 1 A-C). Sirenum Fossae is characterized by partially parallel segments of graben and fractures, several tens of kilometers long [9]. From superpositional and crosscutting relationships the authors of [4] concluded that Sirenum Fossae developed throughout the Early Hesperian Epoch. Since Sirenum Fossae extends across several geologic units, it provides a promising basis to compare the results from the BCC with the age constraints from the stratigraphic crater counting approach. In order to derive a reliable BCC-based formation age of the graben system, it is important to use as many superposed/postdating craters as possible. At the same time it is necessary that the formation or last reactivation of the investigated set of linear features took place within a distinct timeframe over its entire length. Thus, we only investigated the central portion of the Sirenum Fossae graben system (192.4°E – 209.8°E). This section has a relatively homogeneous morphological state of degradation and, thus, was likely formed over a relatively narrow time span.

Fortuna Fossae is a graben system fracturing an isolated surface located approximately 500 km south of Tharsis Tholus and 500 km north of the western terminus of Valles Marineris (Fig. 1 A, D). It represents a low-relief bulge that is circumvented by lava flows. According to [4], the structural deformation of the Fortuna Fossae occurred during the Early Hesperian, stage 3 extensional period. However, [10] recently mapped the fractured unit accommodating Fortuna Fossae as Late Hesperian volcanic unit. In contrast to Sirenum Fossae, which intersects several different geologic units, Fortuna Fossae cuts only one geologic unit (lHv, [10]) and, thus, the shapes and morphologies of ejecta blankets of similar-sized craters should be comparable across the entire investigation area. This enables us to test the usage of ejecta blankets for the pre-/postdate classification of the adjacent craters.

Results and Conclusions: We found that the investigated section of Sirenum Fossae is younger than previously thought (Late instead of Early Hesperian). The stratigraphic crater counting approach provided robust min and max ages for the Sirenum Fossae formation of 710 ±140 Ma – 3.46 +0.046/-0.064 Ga, respectively (Fig. 1 E, F). The derived formation age from the BCC analysis is 3.44 +0.10/-0.25 Ga (Fig. 1 G) showing that the BCC approach provides equivalent or even more precise age results compared to the conventional stratigraphic approach.

Fortuna Fossae formed shortly after the emplacement of its now-fractured geologic host unit (Late Hesperian), which is in agreement with the findings of [10]. BCC ages derived using different buffer widths are consistent to each other (show overlapping statistical errors) and vary between 3.53 +0.06/-0.11 Ga and 3.50 +0.07/-0.11 Ga (Fig. 1 H). Thus, we recommend the use of crater ejecta blankets to position them in the

stratigraphic sequence and thus improve the crater statistics. However, the accuracy of the results depends on the extent and preservation state of the continuous ejecta blankets in the study region. The applied buffer width should therefore be chosen carefully according to investigated crater sizes and local observations.

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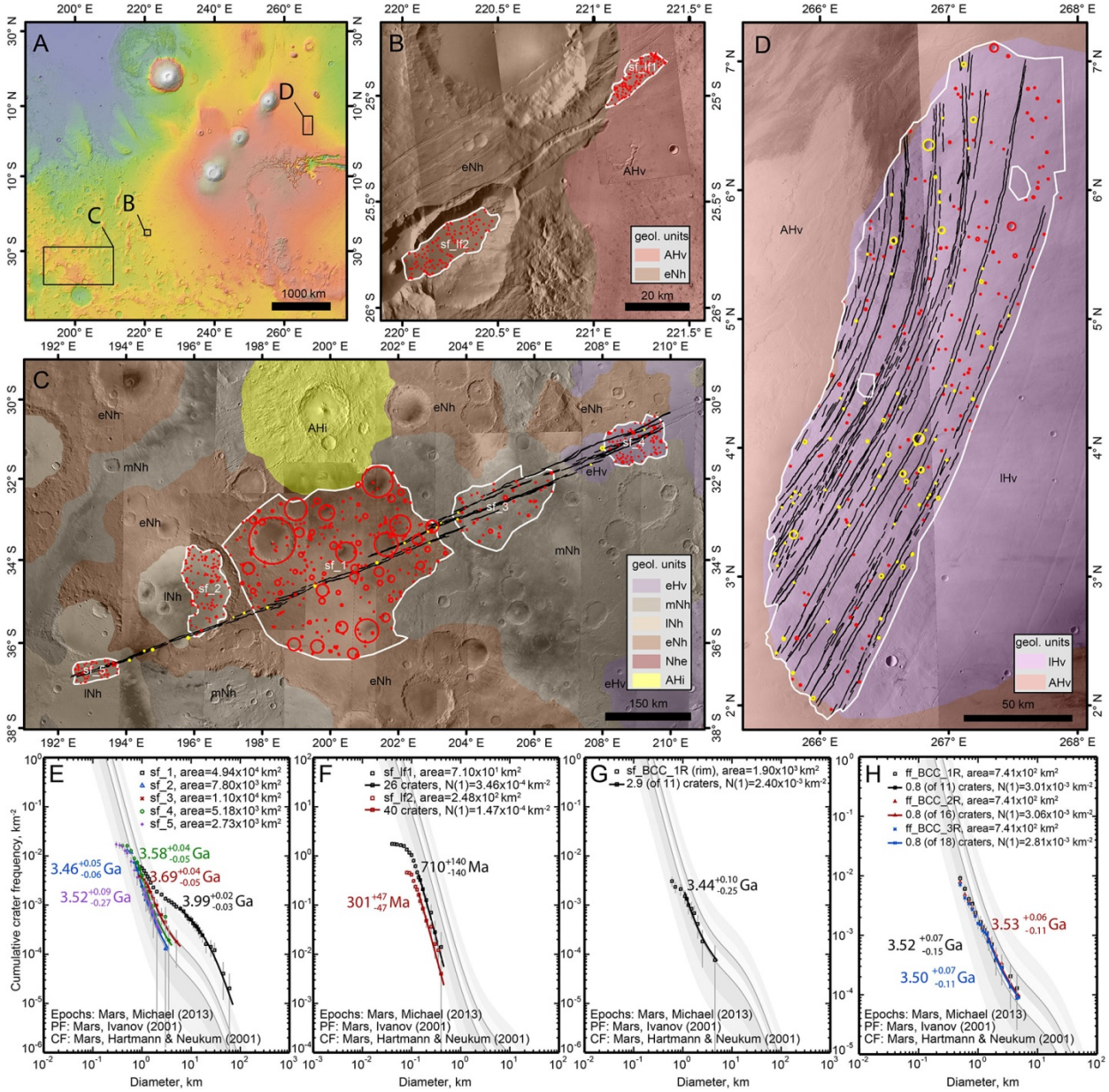

Fig. 1: A: Overview map showing the study areas. B, C, D: Measurement areas (white) and craters (red) used for the conventional crater counting in the Sirenum Fossae (B, C) and Fortuna Fossae (D) case studies. Craters and faults used for BCC analyses are marked in yellow and black, respectively. E, F: CSFDs of geologic units predating (E) and postdating (F) Sirenum Fossae. G: BCC result for Sirenum Fossae. H: BCC-based CSFDs derived for Fortuna Fossae using three different buffer widths (1, 2, and 3 crater radii).