ABSOLUTE MODEL AGES AND STRATIGRAPHY OF NEUKUM CRATER GEOLOGIC UNITS H. Hiesinger[1], H. Bernhardt[1], D. Reiss[1], D. Tirsch[2], R. Jaumann[2,3], E. Hauber[2], J. W. Head[4], G. Michael[3], D. A. Williams[5], J. L. Bishop[6], F. Poulet[7], J. P. Muller[8], C. Gross[3], K. Gwinner[2], S. Adeli[2], L. Fanara[2], HRSC Co-I Team; [1]Institut für Planetologie, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany (hiesinger@uni-muenster.de), [2]DLR Inst. für Planetenforschung, Berlin, Germany, [3]FUB Inst. of Geological Sciences, Berlin, Germany, [4]Brown University, Providence, USA, [5]Arizona State University (ASU), Tempe, USA, [6]Seti Institute, Mountain View, USA, [7]Inst. d'Astrophysique Spatiale, Université Paris-Sud, Orsay, France, [8]University College London (UCL), London, UK.

Introduction: Gerhard Neukum was a German planetary scientist well known for his expertise in crater size-frequency distribution (CSFD) measurements throughout the Solar System, but particularly for the Moon and Mars. He was PI of the High Resolution Stereo Camera (HRSC) on board the European MarsExpress mission, launched in 2003 and still in orbit around Mars. After his untimely death more than three years ago, Neukum recently became eligible to have a crater named in his honor. Thus, the HRSC science team proposed to the IAU to name a crater on Mars after him. This request was approved in mid 2017 for a 102 km-crater in Noachis Terra (~28°E/~45°S). This contribution is part of a greater effort by the HRSC team to scientifically investigate Neukum crater in detail [e.g., 1].

Geology: Neukum crater is a geomorphologically complex crater that reflects a diverse geological history and evolution over the past 4 Ga [1]. We mapped the crater using a variety of data sets, including HRSC, CTX, MOC, HiRISE, THEMIS, CRISM, and MOLA, and identified 21 geomorphologic units (Fig. 1). There are several plains units exposed on the crater floor that are distinct in their morphology (smooth, rough, hummocky, furrowed), albedo, surface roughness, and thermal inertia. Pits on the crater floor, also recognized in some craters in the vicinity, show fine-scale layering, likely related to the deposition of a regional unit that filled these craters. The wider regional distribution of pits indicates that the degradational process that created these pits must have been active at regional scale. Thus, Neukum crater can serve as a case study for processes that shaped significant portions of Noachis Terra. The crater floor hosts a large dark dune field with a basaltic composition, enriched in high-calcium pyroxenes. Thus, the composition of the Neukum crater dune field is similar to those of other dark dunes found elsewhere on Mars. The pits are possible local sources of the materials that comprise the dark dunes. We observed avalanches on the dune slip faces and interpret them as evidence for recent mass movement processes. The crater floor is criss-crossed by numerous dust devil tracks and transverse aeolian ridges, e.g., within the pits, implying recent aeolian activity. Moraine-like features and evidence for mass movement in smooth terrain along the crater wall might indicate glacial and periglacial processes in the study region. Superposed ejecta on these landforms allow determination of the minimum age of the features, and thus, help constrain the timing of geological processes [1].

Absolute Model Ages (AMAs): We used CTX images to perform CSFD measurements. The images have a pixel scale of about 6 m on the surface and were calibrated and map-projected with ISIS 3 and imported into ArcGIS. Within ArcGIS, we used CraterTools [2] to perform our crater size-frequency distribution (CSFD) measurements, which were then plotted with CraterStats [3], using the production of [4] and the chronology of [5]. For our CSFD measurements, we selected homogeneous areas within the mapped geologic units (Fig. 1, yellow boxes) and paid particular attention to avoid obvious secondary craters. We derived CSFD measurements for 7 map units, including units Nr, $NHpu_2$, Hfs, Hfr_1, Hfr_2, Hfh_1, and Hfh_2 (Tab. 1). Currently our unit names are based on a map-derived preliminary stratigraphy and not AMAs.

Table 1: Absolute model ages (AMAs) and N(1) values for dated units associated with Neukum crater.

Unit	AMA	N(1) [km^{-2}]
Hfh_2	$1.2^{+0.2}_{-0.2}$ Ga	5.98×10^{-4}
	$3.7^{+0.1}_{-0.2}$ Ga	4.93×10^{-3}
Hfh_1	340^{+40}_{-40} Ma	1.65×10^{-4}
Hfr_2	300^{+30}_{-30} Ma	1.48×10^{-4}
Hfr_1	460^{+200}_{-100} Ma	2.24×10^{-4}
Hfs	570^{+100}_{-100} Ma	9.02×10^{-4}
	$1.8^{+0.7}_{-0.6}$ Ga	2.76×10^{-4}
$NHpu_2$	66^{+7}_{-7} Ma	3.23×10^{-5}
	450^{+100}_{-100} Ma	2.18×10^{-4}
	$2.2^{+0.8}_{-0.9}$ Ga	1.09×10^{-3}
Nr	$3.5^{+0.08}_{-0.1}$ Ga	2.69×10^{-3}

Obtaining robust CSFDs for the hummocky units was challenging when surface roughness and crater sizes were similar. However, these crater sizes were not used for the fitting of the production function, and thus, do not affect the derived AMAs. On the basis of our CSFD measurements, we propose that Neukum crater is at least 3.5-3.7 Ga old, as indicated by our age for unit Nr, which represents the crater rim and the older age of unit Nfh_2, which is exposed on the crater floor. However, most units are significantly younger and at least three units show evidence for resurfacing, i.e., units Hfh_2, Hfs, and $Nhpu_2$. The youngest AMA of 66 Ma was found for the floor of the northeastern pit within Neukum crater and from the CSFD of this unit $Nhpu_2$, two additional AMAs of 450 Ma and 2.2 Ga can be derived. Within the error bars, similar ages to the 450 Ma AMA have been measured for units Hfr_1 (460 Ma) and Hfs (570 Ma). Taking into account the error bars, units Hfh_1 and Hfr_2 also show overlapping ages of 340 Ma and 300 Ma, respectively. The oldest ages of units $Nhpu_2$ (2.2 Ga) and Hfs (1.8 Ga) are also similar to each other, considering their errors. Thus, it appears plausible that several units associated with Neukum crater share similar modification histories, implying that the responsible processes affected large areas within the crater. On the basis of our map, we found that the crater and its floor have been substantially modified until the recent past, presumably by aeolian processes. Thus, the CSFD results are consistent with our morphologic observations of deflation of many of our map units. Accumulation of material only occurs in a few places as indicated by transverse and longitudinal dunes.

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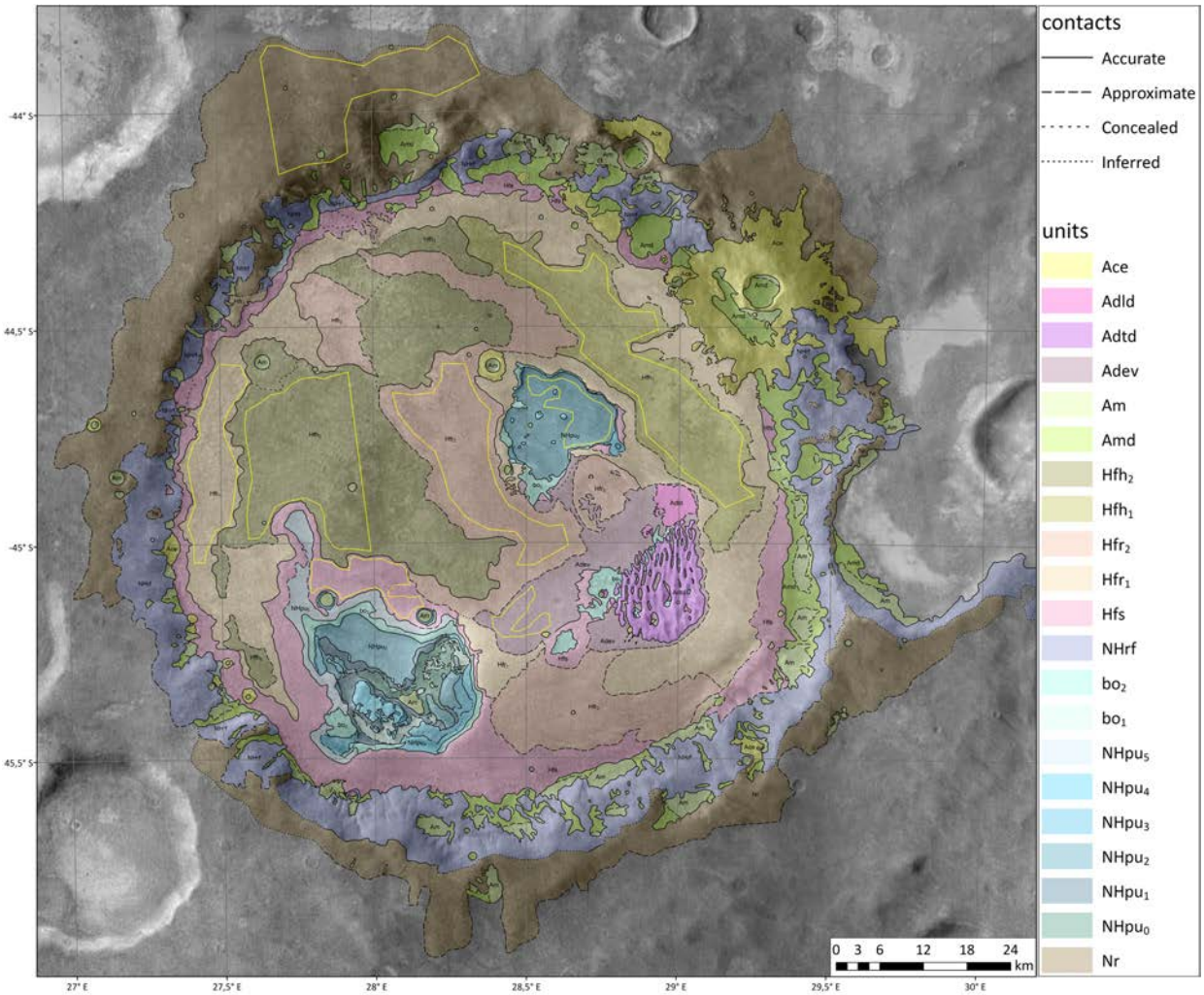

Fig. 1: Geologic map of Neukum crater. Yellow boxes show the count areas for our CSFD measurements