STRATIFIED PHYLLOSILICATE-BEARING DEPOSITS WITHIN IMPACT CRATERS IN THE NORTHERN PLAINS OF MARS. C. Gross[1], J. Carter[2], L. L. Tornabene[3], M. Sowe[1] and J. L. Bishop[4,1], [1]Institute of Geological Sciences, Planetary Sciences and Remote Sensing Group, Freie Universität Berlin, Germany (christoph.gross@fu-berlin.de); [2]Institut d'Astrophysique Spatiale, Paris-Sud University, Orsay, France; [3]Dept. of Earth Sciences - University of Western Ontario, London, ON, Canada; [4]The SETI Institute, Mountain View, CA, USA.

Introduction: The Noachian southern highlands of Mars bear old crustal material that appears mostly unaltered [1, 2, 3], but contains abundant occurances of phyllosilicate-rich materials [4]. Phyllosilicates are of particular interest, as they require the presence of water and may indicate habitable environments. Most phyllosilicates may have formed early in Mars' history during the Noachian period [4]. However, a set of Hesperian–aged impact craters, Toro [5] and Majuro [6] bear evidence for impact–induced hydrothermal activity in the southern highlands. Additional studies also indicate that alteration of Noachian materials could be produced over long periods of time [7]. Phyllosilicate outcrops in the northern plains are exclusively found in and around impact craters. This could lead to the conclusion that they might form excavation products of preexisting, buried deposits, exposed by impacting and erosion [8, 4, 9]. Nevertheless, when investigating alteration associated with impact craters, pre-, syn- and post-impact scenarios should be considered [10, 7]. Here we report on a set of impact sites, located in the northern plains of Mars, that contain uplifted, stratified, phyllosilicate-rich material. These craters were previously described by [8], but here we conduct a further investigation to test the theory of impact excavation of old preexisting strata versus impact-induced hydrothermal activity. This can be achieved as coverage of high resolution data has increased since the initial study.

Data Sets and Methods: HRSC, CTX, and HiRISE data was used for visual interpretation. Digital terrain models (DTM) were produced from HRSC data [11, 12] (orbits h7540-Bamberg and h3304-Micoud) with a resolution of ~50 m per pixel, to better assess the stratigraphic context. The data were incorporated into a Geographic Information System (GIS)-project using the ESRI ArcGIS software. Processed HRSC DTMs, geometrically corrected CTX and HiRISE image data, and CRISM spectral parameter maps were displayed in ArcScene. We used CRISM image FRT0000942F with a spatial resolution of ~18 m/px [8]. The analyses are focused on spectra from ~1-2.6 µm where hydrated minerals such as phyllosilicates exhibit representative absorptions. The band near ~1.9 µm is indicative of H_2O in minerals, whereas OH combination bands in clay minerals have diagnostic absorptions at ~2.1-2.5 µm [13]. CRISM Analysis Toolkit (CAT) and its associated tools were used in ENVI to minimize instrumental and atmospheric effects and convert the data to I/F [8, 14]. Spectra were collected for 5x5 pixel spots and ratioed in column to emphasize the spectral features.

Observation and Results: The 55-km diameter Bamberg crater is located at ~39.5 °N and 357 °E ~60 km north of the highlands/lowlands transition in the southern Acidalia Planitia region, close to the transition to Arabia Terra (Fig.1A). The impact crater has well preserved terraced walls and a distinct ejecta blanket. The most prominent feature of the crater is the central uplift, which displays an asymmetric central pit structure. Some sporadic outcrops of breccia can be recognized on the northern wall of the pit (Fig.1 D). Upon closer inspection, layered strata are observed. This layered material displays a phyllosilicate signature in CRISM spectra (Fig. 1B/C/E). Ratioed spectra of the hydrated outcrops show absorptions at ~1.41, 1.91 and 2.29 µm, which best match the Fe-smectite nontronite. HiRISE images also reveal irregular layering within isolated blocks a few 100s of meters in size, and with layers as thin as 1-2 meters visible cropping out at the -4600 m level (Fig. D and E). Intact layered blocks were mapped and a detailed stratigraphic column was compiled. Brecciated phyllosilicate-rich material can be traced down into the central pit to -5050 m. Surprisingly, the phyllosilicates appear to be bound to specific horizons, often following morphologic features such as escarpments and spurs. Chlorite and mixed-layered smectite/chlorite (S/C) are also observed within the central peak, but are not associated with the layered blocks. Micoud crater also contains isolated layered, phyllosilicate-rich blocks, similar to those found in Bamberg crater.

Acknowledgements: The work of CG was supported by the DLR Space Administration, grant 50QM1301 (HRSC on Mars Express), on behalf of the German Federal Ministry of Economic Affairs and Energy. JLB thanks the Helmholtz Foundation for support.

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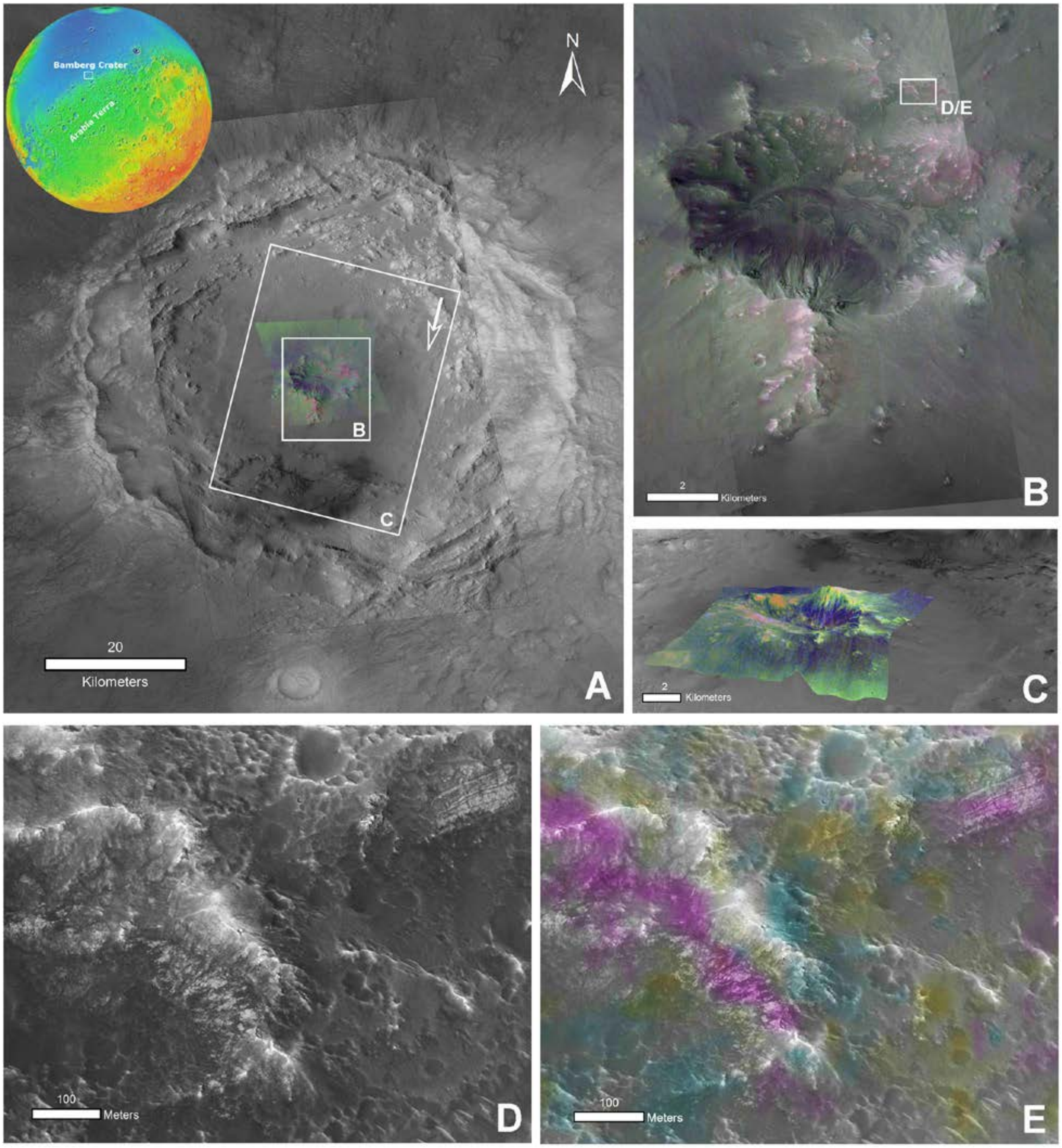

Figures 1 A: Overview of Bamberg crater. HRSC image h7540, CTX image B02_010301_2200_XN_40N003W, HiRISE image PSP_006794_ 2200 and CRISM image FRT0000942F. Inset boxes B Central peak and pit area. Inset Box C - arrow indicates viewing direction. **B:** Central peak and Pit of Bamberg with CRISM overlay. Inset box D/E shows location of stratified blocks. **C:** Oblique view on the central uplift complex with CRISM summary products overlain. **D:** Contrast enhanced image of phyllosilicate-rich outcrops located on the northern flank of the central uplift at -4600 m. HiRISE observation PSP_ 006794 _2200. **E:** Same image as D, but pan-sharpened with CRISM observation FRT0000942F showing the northern wall of the central pit in Bamberg crater. Note the isolated layered block in the upper right corner of the inset. BD2300 index is represented in purple. HCPINDEX + BD1900 band is shown in turquois. Yellow colors represent BD2300 + HCP-INDEX.