DETAILED GEOLOGICAL MAPPING (1:80,000-SCALE) OF STEINHEIM CRATER, MARS. A. Pietrek[1], G. Wulf[1], T. Kenkmann[1], [1]Institute of Earth and Environmental Sciences – Geology, Albert-Ludwigs-University Freiburg, Germany, alexa.pietrek@neptun.uni-freiburg.de.

Introduction: Steinheim Crater on Mars (190.65°E 54.57°N, Arcadia Planitia) is a well preserved 11.3 km diameter double layered ejecta crater that provides excellent opportunities to analyse crater and ejecta morphologies in detail. The textbook like occurrence of its layered ejecta blanket makes it a prime candidate for detailed investigations of mid-sized craters on Mars.

Craters with layered deposits appear in both hemispheres, preferentially in mid-latitudes and more frequently in the Northern lowlands [1-5]. Double layered ejecta craters possess two distinct ejecta layers that show a thinning in the middle distances ("moat") before thickening at its outer extensions ("rampart") [2]. The inner layer shows a radial texture of continuously extending grooves and ridges whereas the outer layer is characterized by relatively thin deposits that terminates in ramparts with flow lobes [2]. The sequence of deposition of both layers is controversial. Some authors suggest that the inner layer overlays the outer layer [6, 7, 8]. Others propose the inner layer formed first and was overridden by the outer layer thereby carving the radial grove and ridge pattern [1, 2]. New results of the Bunte Breccia ejecta morphology of the Ries impact crater shows striking similarities to double layered ejecta craters confirming Martian impact structures as analogy for terrestrial impact craters [9].

Here we present the geological map of the ejecta blanket and crater interior of Steinheim crater on the basis of high resolution images (HiRISE, CTX and MOC) (Fig.1). Our detailed map provides a sound base for further studies that will help to understand the processes of ejecta emplacement and the underlying mechanisms.

Mapping units: The 2.8 km diameter Central peak is divided into a rocky, mostly preserved unit (*ecpm*) and degraded material displaying flow features (*scpm*). A pitted floor unit (*pcf*) known from other craters [10] as well as two terrace units (*stb,* more degraded*,* and *tb*) and pooled smooth material on the terraces (*pm*) were identified. The wall above the terraces is subdivided into a debris covered wall unit (*dwr*), a gully covered wall unit (*gwr*), possibly accordant to exposed wall rock with badland topography described by other authors [10], and the ejecta crosscut (*ec*) exposed throughout the crater rim region. The inner ejecta layer possesses a hummocky, unstriated unit directly adjacent to the crater rim (*hil*) extending up to 1.3 crater radii (R_c). It is followed by the radially grooved and ridged inner layer (*sil*) and the crenulated termination of the inner layer into a rampart area (*cil*). Additionally, concentrically oriented troughs and ridges are partially present. The inner layer extends between 2.3 and 3 R_c. The outer layer (*ol*) has a lobate morphology and terminates between 3.4-4.9 R_c. Some lobes terminate in thickened, distal ramparts (*dr*).

In regions with HiRISE coverage it was possible to map small-scaled surface features, such as polygonal textures, debris fields and smooth material (hatchures). A multitude of secondary craters surround the crater forming strings and chains of craters or appear in clusters with V-shapes and Herringbone patterns.

Discussion: The Martian Steinheim crater makes an overall regular and homogenous appearance. The structure of the central uplift and the shape of the ejecta blanket suggest that the impact occurred at a relatively steep angle >45°. However the detailed mapping shows remarkable heterogeneities.

The crater shows well-preserved crater units on protected, north-facing slopes and a much higher degree of decomposition on south-exposed surfaces, presumably caused by different illumination conditions. The pattern of concentric grooves and ridges of the inner layer changes in different sectors, indicating varying regimes of compressive and extensive forces, in some regions even mixtures of both. We consider topography as the main control. The distribution and structure of debris fields vary significantly with distance from the crater center in such a way that the block clusters of the inner layer predominantly occur in the moat region and are radial oriented whereas block clusters of the outer layer are patchy and rampart-related [11]. The formation of polygonal surface occurs mainly on north facing slopes and certain trends in its distribution with distance from the crater center might be linked to changes in the composition of the ejecta, e.g., the volatile content. Smooth material primarily form in the southern parts of the crater units. On the terraces, flow of smooth material between terraces can be observed. On the smooth material of the inner ejecta layer no clear flow features are visible. In areas where the outer ejecta layer shows irregularities, such as badly-developed ramparts, the amount of secondary craters is relatively high.

Based on this mapping future work will concentrate on the ejecta emplacement process, the rheological properties and the composition of the two distinct ejecta layers.

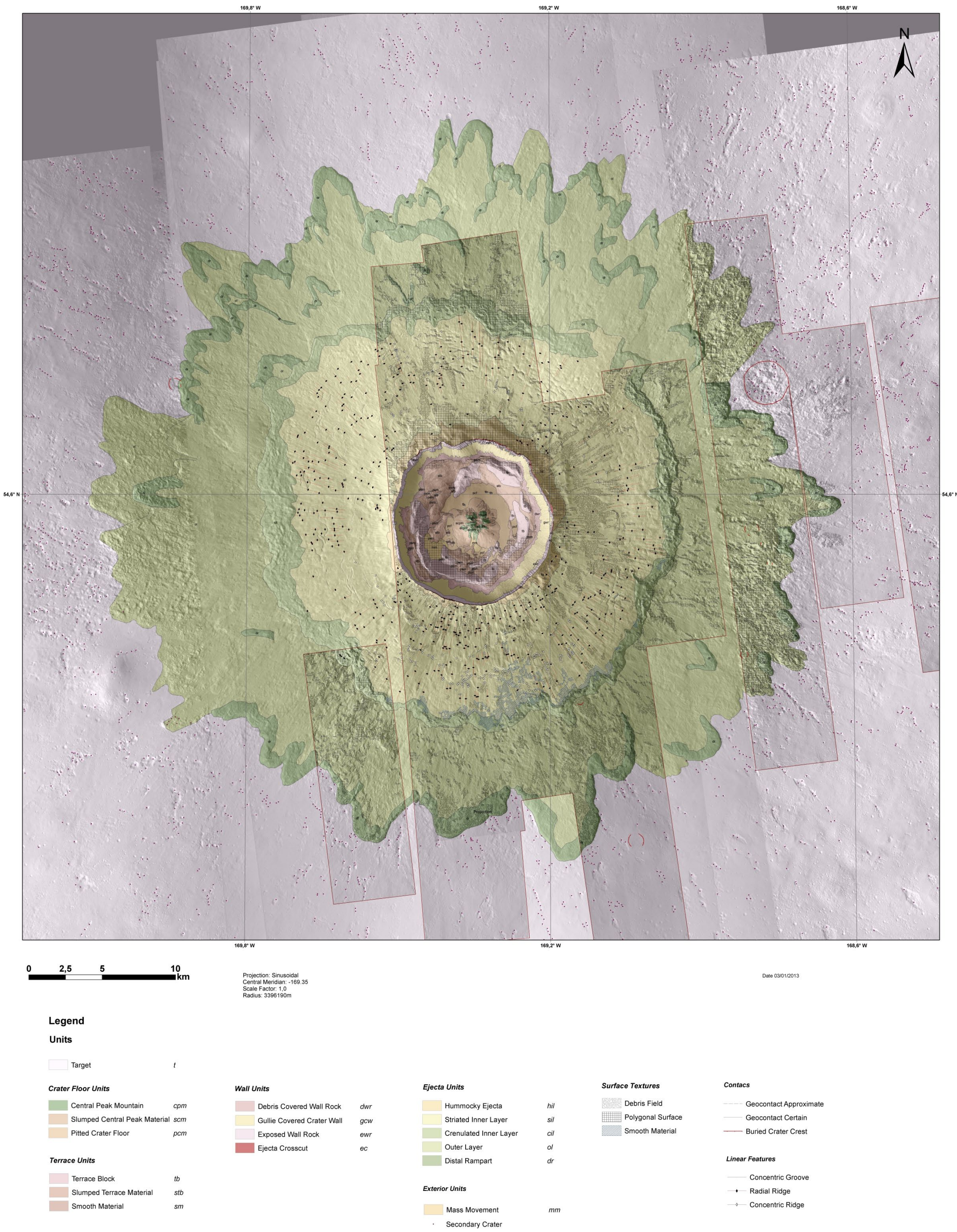

Fig. 1: Geological map of Steinheim crater, Mars.

Acknowledgement: The project was financed by the German Research Foundation DFG, grant KE 732/19-1.

References: [1] Mouginis-Mark, P. J. (1981) *Icarus*, vol. 45, p. 60-76. [2] Boyce, J. M. and Mouginis-Mark, P. J. (2006) *J. Geophys. Res.*, vol. 111, E10005. [3] Barlow, N. G. and Bradley, T. L. (1990) *Icarus*, vol. 87, p. 156-179. [4] Barlow, N. G. and Perez, C. B. (2003) *J. Geophys. Res.*, vol. 108, p. 5085. [5] Barlow, N. G. (2005b) *LPSC XXXVI*, Abstract #1415. [6] Carr, M. H. et al. (1977) *J. Geophys. Res.*, vol. 82, p. 4055-4065. [7] Osinski, G. R. (2006) *Meteoritics & Planet. Sci.*, vol. 41, p. 1571-1586. [8] Wulf, G. et al. (2012) LPS XLIII, Abstract #1744 [9] Sturm, S. et al (2013) *Geology* (accepted). [10] Mouginis-Mark, P. J. and Boyce, J. M. (2012) *Chemie der Erde Geochemistry*, vol. 72, p. 1-23. [11] Wulf, G. et al. (2013) *LPS XLIV*, Abstract (this conference).