THE RIES IMPACT CRATER: AN ANALOGUE TO DOUBLE-LAYER RAMPART CRATERS ON MARS. S. Sturm[1], G. Wulf[1], D. Jung[2], and T. Kenkmann[1], [1]Institut für Geo- und Umweltnaturwissenschaften - Geologie, Albert-Ludwigs-Universität Freiburg, Germany (sebastian.sturm@geologie.uni-freiburg.de), [2]Landesamt für Umwelt Bayern, Germany.

Introduction: The Ries crater with a diameter of ~26 km represents a relatively pristine, complex impact crater in southern Germany. The oblique impact occured during the Miocene (14.9 Ma) and hit into a two-layered target that consisted of ~650 m partly water-saturated and subhorizontally layered sediments (limestones, sandstones, shales) of Triassic to Tertiary ages underlain by crystalline basement rocks (mainly gneisses, granites, and amphibolites) [1, 2, 3, 4].

The well-preserved ejecta blanket occurs up to 45 km distance from the crater center and is built up of so-called Bunte Breccia deposits (a polymict lithic breccia) (***Fig. 1***). The Bunte Breccia is generally composed of mainly unshocked to weakly shocked sedimentary target clasts plus a minority of basement clasts and reworked surficial sediments. With increasing radial range the ratio of primary crater ejecta to local substrate components decreases and is thoroughly mixed at all scales [5, 6]. The Bunte Breccia is interpreted as a "cold", noncohesive impact formation [5, 6, 7]. Previous interpretations of the Bunte Breccia assumed analogies to the Moon: (I) ballistic emplacement triggering a ground hugging debris surge [6, 8], or (II) a rolling and gliding surge under high localized confining pressures [9].

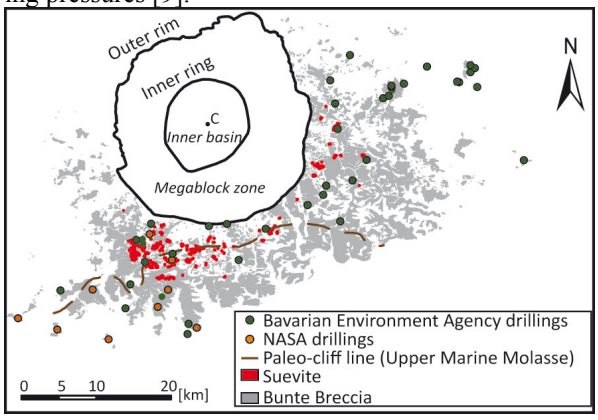

Fig. 1: Distribution of Bunte Breccia and suevite deposits outside the Ries impact crater with plotted Bavarian Environment Agency and NASA drilling site locations and the trend of the paleocliff line formed during the sedimentation of Upper Marine Molasse sediments (dashed brown line) (modified after [11]).

Former interpretations did not account for the role of water in the target and in the ejecta blanket. Underground water and the presence of an atmosphere suggest that the Ries and the other impact craters on Earth may behave more like martian craters [10].

We concerned the question if the Ries impact crater is comparable to a martian double-layer ejecta crater (DLE) [11]. Here we present interpolation results of the morphology of the thickness variation of the continuous ejecta blanket with radial range outside the Ries impact crater to compare those with the ejecta distribution of complex martian impact craters (expecially double-layer rampart craters) [11].

Methods: We combined geologic information of the recent geologic map [12] with nine NASA drilling sites [6], up to to 40 Bavarian Environment Agency drillings and digital elevation data (ASTER DEM) [11] to reconstruct the morphology and thickness varation of the ejected Bunte Breccia material outside the Ries crater. We used extracted mapping information of the autochthonous-allochthonous ("Bunte Breccia base") and allochthonous-suevite ("Bunte Breccia top") intersections from the geologic map [11]. The elevation of the lower contact plane (called "paleo-surface") and the contact between the Bunte Breccia and suevite deposits on top were combined in ArcGIS (ESRI) and RockWorks14 (RockWare) to reconstruct the Bunte Breccia thickness (***Fig. 2***). In regions with missing suevite coverage we included the recent Bunte Breccia surface to obtain minimum thickness estimations of the ejected deposits [11].

Discussion and Results: The final interpolation results show that the morphology and thickness of the Bunte Breccia varies with increasing distance from the crater center. Instead of a steady decrease of ejecta thickness, as seen for impact ejecta blankets on the Moon and Mercury, we observed thickness varation characteristics comparable to double-layer rampart craters on Mars [11, 13]. The interpolation results show that the Bunte Breccia decreases beyond the crater rim to a few meters at 16 km (1.23 crater radii, Rc) forming a depression (called moat) followed by a steady increase in thickness with a point of culmination with up to 121.2 m thickness at a radial distance between 18.80 and 27.55 km (1.45–2.12 Rc) forming a massive concentrically trending ridge (called rampart) (***Fig. 2c***). Beyond this ridge the thickness rapidly decreases to less than 40 m with the farthest extent situated at 43.64 km (3.36 Rc) (***Fig. 2c***) [11]. The ob-

served morphological characteristics of the Ries ejecta blanket show striking similarities with respect to its position, dimension, and shape to those of martian double-layer craters, which show typically depressions (called moats) and subsequent broad, elevated ridges (called ramparts) at distances of ~2.5 Rc [11, 13]; e.g., at the complex martian DLE crater Steinheim.

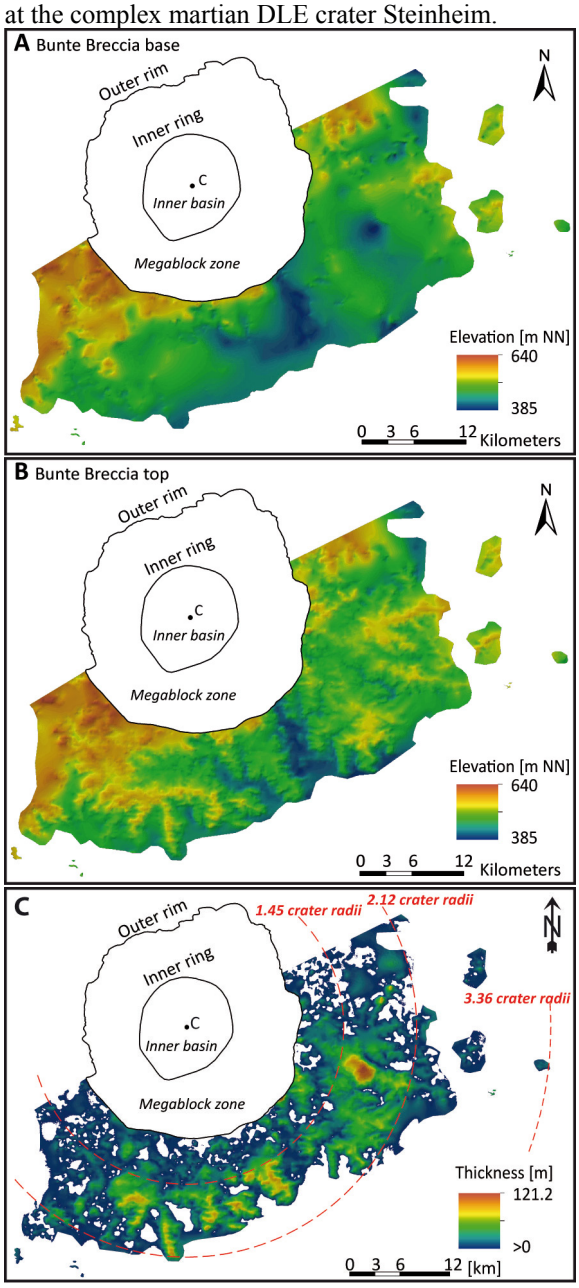

Fig. 2: Results of the final interpolated morphology of the (a) Bunte Breccia base and (b) Bunte Breccia upper surface and (c) Bunte Breccia thickness. White areas represent outcropping weathered autochthonous units (e.g., Malmian limestone) or post-impact sediments (e.g., loess) (C—crater center) [11].

The Ries impact crater was first suggested as a double-layer ejecta crater due to the presence of two distinct ejecta lithologies (Bunte Breccia and fallout suevite), whereas our results illustrate that the Ries crater is comparable to double-layer ejecta crater due to its morphologic characteristics of the Bunte Breccia deposits outside the crater (e.g., rampart structure) [11, 14]. If an analog to the suevite exist at Martian ejecta blanket is still unknown.

Conclusion: The Ries crater ejecta blanket with an observed rampart structure possesses more striking similarities to those of double-layer martian rampart craters, rather than to ejecta blankets on the Moon or Mercury that show a gradational decrease in ejecta thickness with increasing distance from crater center [11]. The results will be used for comparative planetological studies of impact crater formation. Further analysis will be more concentrated on the ejecta blanket formation processes of double-layer rampart craters on Mars with its explicit ejecta charactersistics (e.g., Steinheim crater) [15].

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