MODELING THE RIES IMPACT: THE ROLE OF WATER AND POROSITY FOR CRATER FORMATION AND EJECTA DEPOSITION. K. Wünnemann[1], N. A. Artemieva[2,3], and G. S. Collins[4], [1]Museum für Naturkunde–Leibniz Institute at the Humboldt University Berlin, Germany, [2]Planetary Science Institute, Tucson, AZ 85719 [3]Institute for the Dynamics of Geospheres, Russian Academy of Sciences, Moscow, Russia, [4]Impacts and Astromaterials Research Centre, Dept. of Earth Science and Engineering, Imperial College London, London SW7 2AZ, UK; kai.wuennemann@mfn-berlin.de

Introduction: Ries crater is one of the best-studied impact structures in the world. Ries crater is of particular interest for numerical modeling because (1) the crater morphology is relatively pristine in comparison to most other exposed terrestrial complex crater structures; (2) the proximal ejecta deposits are at least partly well preserved (Bunte Breccia, Suevite) and there exist remnants of the distal ejecta (tektite strewn field, Moldavites); (3) a large data set of the subsurface was obtained by geophysical surveys as well as several shallow and one deep drill hole (Forschungsbohrung Nördlingen, 1973). This rich set of observations is unique for the terrestrial complex crater record and serves as an ideal test for numerical modeling of the formation process. Here we summarize briefly the recent modeling attempts of Ries crater formation and the production and emplacement of impactites using the iSALE [1,2] and SOVA [3] hydrocodes.

Morphology and structural deformation: Numerical modeling [4,5] shows that the inner part of the crater bounded by a ring of crystalline basement rocks marks approximately the size of the transient crater. Subsequent collapse results in significant structural uplift (which corresponds to the relatively flat inner crater floor) and inward collapsing and slumping of large blocky units of the upper sedimentary layers (forming the so-called megablock zone inside the outer rim). A zone of heavily fractured rocks reaching probably several kilometers below the crater floor is consistent with the observed geophysical anomalies (gravity low, increased electrical conductivity, reduced seismic velocities [6, 4]). The models show that the rheological contrast between the weak sedimentary layers on top of much stronger crystalline basement rocks affected the crater formation processes [5].

Impact melt All models predict the production of large quantities of impact melt forming an approximately 200 m thick melt pool in the inner crater. The presence of porous sediments may have even increased the production of impact-melt [7]. The lack of impact melt and the genesis of Suevite that occurs as a 350 m thick layer in the inner crater and as patches on top of the ballistically ejected material outside the crater is still unclear and demonstrates the limitations of current models.

Distal ejecta (Tektites): Numerical modeling [8] shows that tektites originate from an extremely thin surficial layer and are ejected with velocities up to 10 km/s at the very beginning of crater formation. The ejected particles are surrounded by high-temperature vapor with similar velocity allowing transportation of the material hundreds of km from the source crater, its devolatalization and solidification in the upper atmosphere. Modeled distribution of particles on the surface resembles the observed fan of Moldavites.

Proximal ejecta: Previous assumptions that the outer Suevite may originate from a collapsing impact plume [9, 10] representing some sort of ignimbrite-forming flow [11], or by a low-viscosity melt flow during the crater collapse [12] can be ruled out by our recent numerical modeling studies [13]. Therein we found that (1) ejecta from all stratigraphic units are deposited ballistically without separation; (2) the impact plume above the crater consists mainly of a sediment-derived vapor/melt mixture, with the total thickness of plume deposits inside the crater < 2 m and much less outside.

Future work: So far the presence of water was neglected; however the explosive interaction of water with hot melt may initiate additional post-impact explosions (similar to the fuel-coolant interaction or hydromagmatic eruptions). Thus, our working hypothesis is that Suevite is the result of the interaction of the Ries melt pool with an external water source (e.g., rivers). Cooling of the Ries melt pool with an assumed thickness of 200 m to below the glass transition T (~1000 K) and water boiling temperature (373 K) would have taken 0.3 – 3 kyr, during which the crater Suevite fill (and outer Suevite) would have to be produced.

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