INDICATIONS FOR FLUIDIZATION OF THE RIES CRATER'S EJECTA BLANKET. A. Wittmann[1a] and T. Kenkmann[1b], [1]Humboldt-Universität zu Berlin, Museum für Naturkunde, Mineralogie, Invalidenstrasse 43, 10115 Berlin, Germany, [a]axel.wittmann@museum.hu-berlin.de, [b]thomas.kenkmann@museum.hu-berlin.de.

Introduction: The Ries crater formed ~14.3 Ma ago as a ~24 km diameter impact structure in a layered target of Permian to Miocene sedimentary rocks on top of a Precambrian to Paleozoic crystalline basement. A continuous ejecta blanket is composed of the Bunte Breccia, a lithic clastic matrix breccia that is mainly composed of sedimentary target clasts, and reworked surficial sediments. This unit is locally overlain by Suevite, an impact melt bearing breccia, which indicates far higher temperatures and degrees of shock metamorphism and is apparently composed predominantly of clasts and melt particles derived from the crystalline basement. The Ries crater's ejecta blanket is tested for the hypothesis of fluidization during emplacement.

Observations: Outcrops in variable distances from the center of the structure were examined for indicators of fluidzation and emplacement mechanisms (Table 1).

Table 1 Outcrop locations at the Ries crater and their lithological settings.

Location	Distance & direction from center	Setting (S=Suevite, BB=Bunte Breccia)
Unterwilfingen	8 km WNW'	S - BB melange
Aumühle	9 km NE'	S - BB contact
Altenbürg	11 km SW'	Limestone blocks in S
Ronheim	13 km SE'	BB - cover rocks contact
Mauren	15 km SE'	BB
Otting	15 km E'	S - BB contact
Seelbronn	17 km SW'	S - BB contact
Bollstadt	17 km SSW'	S - BB contact
Oberringingen	17 km S'	BB
Iggenhausen	20 km SW'	BB megablocks
Gundelsheim	20 km E'	BB - cover rocks contact
Binsberg	22 km SE'	BB

Bunte Breccia sedimentological features. Flow textures in the sandy, silty and clayey matrix [1] occur occasionally and some sub-horizontal planes that may indicate internal gliding or shearing processes were found in Mauren (Fig. 1). The overall chaotic nature and lack of alignment of component clasts within the Bunte Breccia suggest that the matrix behaved thixotropic: It was viscuous under confining stresses and froze upon pressure release before gradations could develop. Moreover, ramps and shear planes accomodated the stacking of blocks (Oberringingen).

Fig. 1 Bunte Breccia outcrop in Mauren-Bräulesberg quarry. Arrow indicates subhorizontal, stepped plane between ejecta sublayers. Outcrop height is ca. 10 m.

Frequently, larger blocks are coated with rims of clays in which smaller clastic debris exhibits alignment. This may indicate the presence of water saturated clays that accreted around the blocks during gliding transport. Injections of clay in deformed allochthonous limestone blocks were found in Iggenhausen.

Contact Bunte Breccia-autochthonous cover rocks. In Gundelsheim, layered limestones exhibit striations that show strict orientation towards the crater's center. However, in hummocky reef facies limestones in Ronheim, striations indicate variable orientations [2]. This suggests that obstacles diverted the erosive ejecta flow already at a distance of ~1 km past the crater rim.

Contact Suevite-Bunte Breccia. This contact is marked by a ~decimeter to cm thick, poorly consolidated transition zone [2]. This transition zone is characterized by fine grained debris and sometimes shows rounding and comminution of clasts. Also, clast size reduction occurs in this zone. It contains a larger content of sedimentary rock clasts compared to the suevites and towards the Bunte Breccia, silty layering is sometimes developed. Microscopic analyses of this transitional layer revealed that it is composed of variable amounts of impact melt particles, some of which indicate welding, while towards the overlying suevites vesicular melt shards occur that are indicative of airborne transport. It grades into a polymict breccia, which becomes size-sorted towards the Bunte Breccia. Diaplectic quartz glass with coesite is frequently preserved in this transition zone, which suggests very rapid quenching from post-shock temperatures. At the contact zone of the Bunte Breccia with Suevite, vertical vent pipes formed locally that transect the suevite (Fig. 2) [3]. At their inside, the pipes are matrix deficient and some show hydrothermal precipitates. These pipes likely vented steam from water saturated Bunte Breccia that was covered with hot suevite.

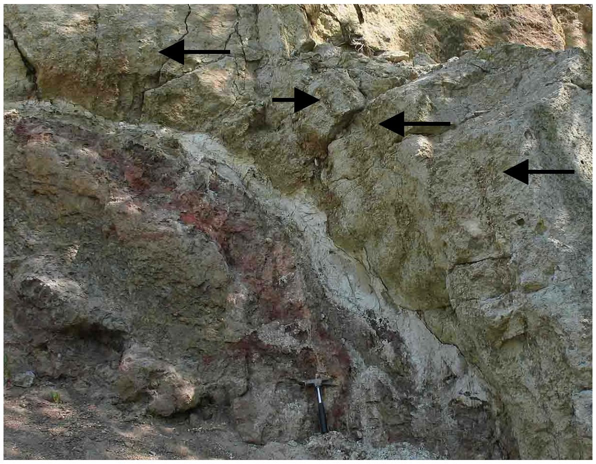

Fig. 2 Bunte Breccia contact with Suevite in Aumühle quarry. Arrows indicate vertical venting pipes in Suevite that originate at contact with Bunte Breccia.

Model: Previous interpretations of the emplacement of the Bunte Breccia assumed analogies to the Moon: (I) as a ballistic emplacement that triggered a ground hugging debris surge [4], or (II) as a rolling and gliding emplacement under high localized confining pressures [5]. These models did not regard the potential role of water saturation in the target sequence. This was previously suggested by [6] from analyses of displacements in the bedrock below the Bunte Breccia. These authors suggested that the Ries may more likely have formed analogous to Martian rampart craters. Some sedimentological evidence from the ejecta blanket was found in support of this hypothesis. A variably thick cover of poorly consolidated Tertiary sediments and underlying sedimentary rocks have to be considered for the formation of a fluidized ejecta blanket. The apparent lack of surficial water in the target area at the time of impact may be comparable to conditions on Mars, where liberated volatiles from near surface sources in the ground supposedly led to the formation of fluidized ejecta blankets [7]. Upon loading with ejecta, the surficial sediments assumed a thixotropic character above a critical yield stress, which accomodated the gliding surge of the Bunte Breccia. Upon loss of momentum, confining pressures dropped and basal portions of the fluidized ejecta blanket froze. This led to the formation of sub-horizontal glideplanes. The glideplanes might have accomodated stacking of ejecta layers within the Bunte Breccia, which was observed by [6] as a possible mechanism in the ejecta blanket of the Chicxulub crater. However, such glideplanes were only found close to the crater rim of the Ries crater and no such features could be found in greater distance.

A complex transition zone between the Bunte Breccia and overlying suevites likely formed during the touchdown of the collapsing fireball. Indications for scouring and turbulence were recorded with the interface between Bunte Breccia and Suevite. These sedimentological features of the poorly consolidated quench zone, and formation of venting pipes support the presence of water at the Bunte Breccia's surface during the emplacement of Suevites.

Outlook: For the emplacement of the Bunte Breccia, a combination of ballistic sedimentation, rolling and gliding, and low viscous flowing has to be regarded. A quantification of Tertiary sediments in the vicinity of the Ries crater at the time of impact is required to provide estimates for their potential contribution to a fluidized ejecta blanket. This could resolve whether fluidization has merely been a localized phenomenon of the ejecta blanket.

Was the suevite predominantly formed from the crystalline basement or did sedimentary rock components decompose due to porosity and water content? The apparent separation of hot, highly shocked crystalline basement dominated ejecta from cool ejecta formed from sedimentary target components of low shock degrees may be testable with a detailed analysis of the Bunte Breccia-Suevite transition zone.

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