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FRACTAL FRAGMENTATION TRIGGERED BY METEOR IMPACT: THE RIES CRATER (GERMANY)

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The No¨rdlinger Ries is a large circular depression in western Bavaria, Germany. The depression was caused by a meteor impact, which occurred about 14.3 million–14.5 million years ago. The original crater rim had an estimated diameter of 24 kilometers. Computer modeling of the impact event indicates that the impact or probably had diameters of about 1.5 kilometers and impacted the target area at an angle around 30 to 50 degrees from the surface in a west- southwest to east-northeast direction. The impact velocity is thought to have been about 20 km/s.

The meteor impact generated extensive fragmentation of preexisting rocks. In addition, melting of these rocks also occurred. The impact melt was ejected at high speed provoking its extensive fragmentation. Quenched melt fragments are ubiquitous in the outcrops.

Here we study melt fragment size distributions with the aim of understanding the style of melt fragmentation during ejection and to constrain the rheological properties of such melts.

Digital images of suevite (i.e. the rock generated after deposition and diagenesis of ash and fragments produced by the meteor impact) were obtained using a high-resolution optical scanner. Successively, melt fragments were traced by image analysis and the images segmented in order to obtain binary images on which impact melt fragments are in black color, embedded on a white background. Hence, the size of fragments was determined by image analysis.

Fractal fragmentation theory has been applied to fragment size distributions of melt fragments in the Ries crater. Results indicate that melt fragments follow fractal distributions indicating that fragmentation of melt generated by the meteor impact occurred as a scale- invariant process. We hypothesize that fractal fragmentation of impact melts occurred shortly after melt generation, as a consequence of the high strain rate suffered by the melts upon radial ejection from the point of the impact. In particular, the high strain rate may have induced the melt to cross the glass transition domain. The result is that the melt does not deform viscously as a high-Schmidt number fluid, but undergoes fragile fragmentation. This hypothesis might explain a series of feature observed on outcrop, such as cuspate terminations of melt fragments (a typical feature of fragile rheology).