Assessment of the porosity and density structure of complex impact structures based on their strain distribution

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Data from three impact structures in crystalline rocks were collected for the study:

- The complex *Ries* impact structure in south-west Germany with data from a 1.2 km deep drill hole in the mega breccia ring basin and its crystalline basement compiled in Pohl et al. (1977).

- The *Puchezh Katunki* complex impact structure in western Russia with data from an over 5 km deep drill hole in crystalline rocks in its central uplift published in Masaitis and Pevzner (1999).

- The *numerically modelled complex crater* in Collins et al. (2004) where the strain distribution is presented as accumulated strain, or bulk strain. The strain model was calculated for a homogenous target with granite properties. Three strain regimes can be seen – A far reaching belt of dispersed low strain (A), a concentric low strain belt (B), an upper high-strain hyperbolic contained volume (C) and a deep hemispheric contained volume (D) of outward and downward decreasing strain.

The strain distribution with depth is in a subsequent step combined with the porosity – depth distribution as measured in the deep drill holes of the Ries and Puchezh Katunki impact structures. The strain distribution of the model crater can then, via the porosity distribution, be translated to the density distribution related to the impact structure. For comparison of data from different sized impact structures, depth values are normalised by division with the respective transient crater diameter. This in turn has to be estimated from presently measurable parameters that can be related to a common surface: The pre-impact surface of the model crater providing the strain distribution and the reconstruction of the pre-impact surface of the two complex impact structures that are the data source for porosity.

The obtained density distribution differs considerably from conventional thinking as it was found that an upper common density region is characteristic for the whole collapsed crater interior, including the mega breccia ring basin and the central uplift. The high strain region contributes 90 % of the gravity anomaly of –12 mGal in the Dellen impact structure, for which the new approach was tested. At 80 s after impact the formed melt is still liquid; in a final crater the melt and the fall back suevite have to be modelled separately (grey shaded top part of the strain model). The concept of accumulated strain in a hemispherical volume can be applied for simple craters, where the high strain region of the collapse phase not occurs, to account for a radially downward and outward decreasing remaining porosity and the associated density contrast.

References

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