"BLOCK SIZE" IN A COMPLEX IMPACT CRATER INFERRED FROM THE UPHEAVAL DOME STRUCTURE, UTAH. T. Kenkmann , A. Jahn, K. Wünnemann, Institut für Mineralogie, Museum für Naturkunde, Humboldt-Universität Berlin, Germany, Thomas.kenkmann@museum.hu-berlin.de

Introduction: The gravity-driven collapse of large impact craters implies a temporarily strong reduction in strength properties of target rocks. The currently best explanation for the strength degradation provides the model of acoustic fluidization [1] or block oscillation [2] which is implemented in modern numerical models of impact crater collapse [e.g. 3, 4]. The basic idea of acoustic fluidization is that seismic vibrations of fragments or blocks within the target result in fluctuations of the overburden pressure, which leads to slip events in periods of low pressures and reduced frictional strength. The time and space-averaged effect of this process is that the rock mass behaves as a viscous fluid (Bingham rheology) with an effective kinematic viscosity [1]: $\nu = c_{af}\, h^2/T$, where T is the period of oscillations, and c_{af} a numerical coefficient in the range from 4-8 (depending on internal model assumptions) [4]. The most critical parameter in this equation is the block size *h*. In recent numerical models the block size remains constant through time and space but varies according to the size of the crater structure depending either on the transient cavity size [2] or the projectile diameter [3]. Variations of block sizes with respect to the distance from the point of impact are neglected so far. The oscillation amplitude varies with time and space and the acoustically fluidized zone is restricted to the damaged target volume [3, 4].

Objective: To better constrain the acoustic fluidization parameters for numerical computations of impact crater formation the average block size distribution at real crater structures needs to be determined. For this purpose we have chosen the well exposed 7 km Upheaval Dome crater, Utah (Fig. 1) which provides detailed insights of the fragmentation state beneath the post-impact surface due to a deep erosion level.

Methods and Results: A detailed mapping campaign was conducted in the inner part of the central uplift of the Upheaval Dome structure, Utah [5] (Figs. 1, 2a). The data were compiled in a GIS-model. A complete map and three-dimensional model of the central uplift can be found in [5]. It was used as a base for discriminating "blocks". The term "block", in strict sense a rigid body all-side deliminated by faults, does not occur in impact craters. "Blocks" as described here are commonly internally deformed from milimeter-decameter scale. Thus, bending, folding and faulting within a block is typical (Fig. 2a). Neighboring blocks can locally be connected with each other along fault bridges. The block size was determined by defining areas that are deliminated by major faults with offsets > 10m (Fig. 2b). However, in the distal portions of the central uplift, the extent of the units is difficult to contrain and we used a minimum area that is given by the exposure. Maximum fault offsets exceed 200 m (Fig. 3b). We discriminated 37 blocks within the central uplift of Upheaval Dome (Fig. 2c). Their areas were measured with ArcGIS. The block volume was determined by multiplying the block area with its square root. The size of a block is expressed by the edge length of a volumetrically equivalent cube. For determination of the mean distance of a block to the crater center we used the barycenter of that particular area. Figure 3a shows the block size, b, as a function of its distance, d, to the crater center. A trend of increasing block size with increasing distance is apparent although the scattering in the data is large. The regression line is: b = 0.39 d + 50.2, with a stability index, R^2 being 0.5096. The average block size is 170 m. The distances displayed in Figure 3a apply to the present surface and are not corrected for erosion. Thus, the horizontal gradient in block size is only valid for a depth of about –1500 m.

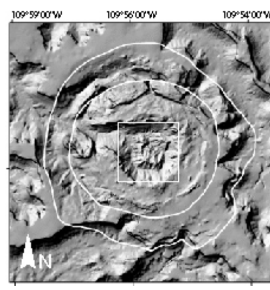

Fig. 1 Upheaval Dome

Discussion: The average "block size" determined within the central uplift of the 7 km Upheaval Dome crater falls in the range of sizes required for acoustic fluidization, e.g. [2]. Block sizes of 100 m on average were determined from the Vorotiv Deep Borehole (5374 m) drilled through the central uplift of the 40 km diameter Puchezh-Katunki impact crater [6]. In accordance to theoretical models the study shows that the block size and, hence, the viscosity of the acoustically fluidized material change as a function of distance to the crater center. Using the spatial dependency of fragment sizes in numerical simulations of crater formation results in structural modifications of the final crater shape (Fig.4). However, to obtain a satisfactory agreement between models and observations further adjustments of acoustic fluidization parameters are required.

References: [1] Melosh, H. J. (1979) *J. Geophys. Res.* 84, 7513-7520. [2] Melosh, H. J. and Ivanov, B. A. (1999) *Annu. Rev. Earth Planet. Sci*., 27, 385-415. [3] Wünnemann, K. and Ivanov, B. A. (2003), *Planet. Space Sci*., 51, 831-845. [4] Ivanov, B. A. and Artemieva, N. A. (2002), *GSA Spec. Pap.*, 356 pp. 619-629. [5] T. Kenkmann, T., Jahn, A., Scherler, D., and Ivanov, B. A. (2005) . *GSA Spec. Pap*. 384 pp. 85-115. [6] Ivanov, B. A., et al. (1996) *LPSC* XXVII, 589-590.

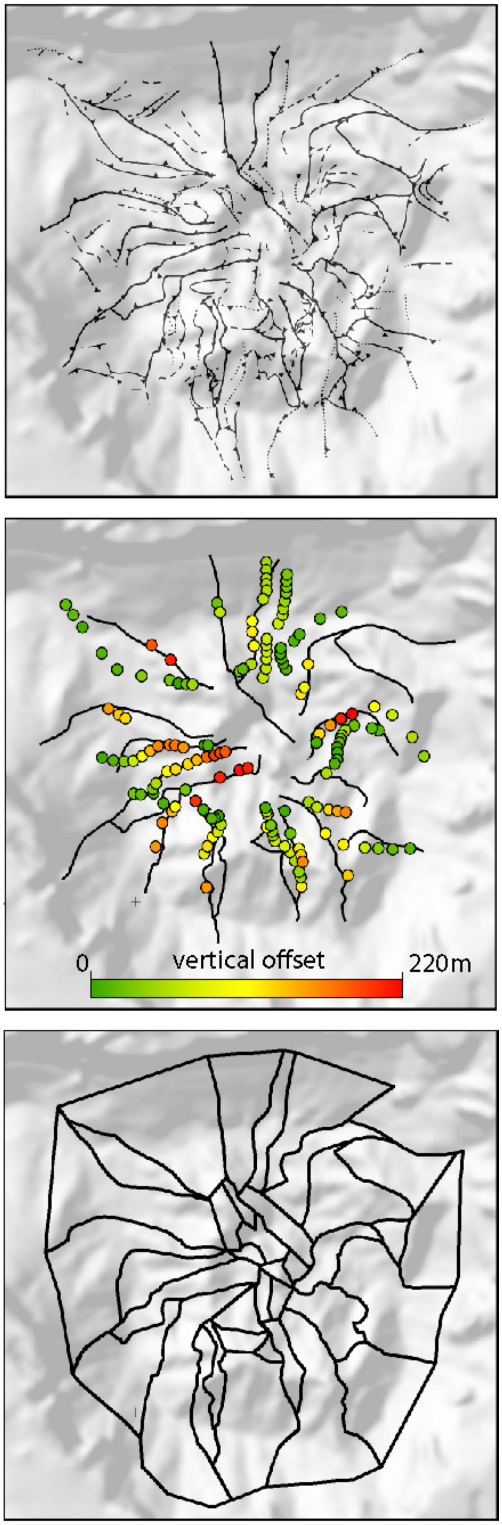

Fig.2 Central uplift with (a) structural inventory, (b) vertical fault offsets along major faults, (c) and discriminated block units

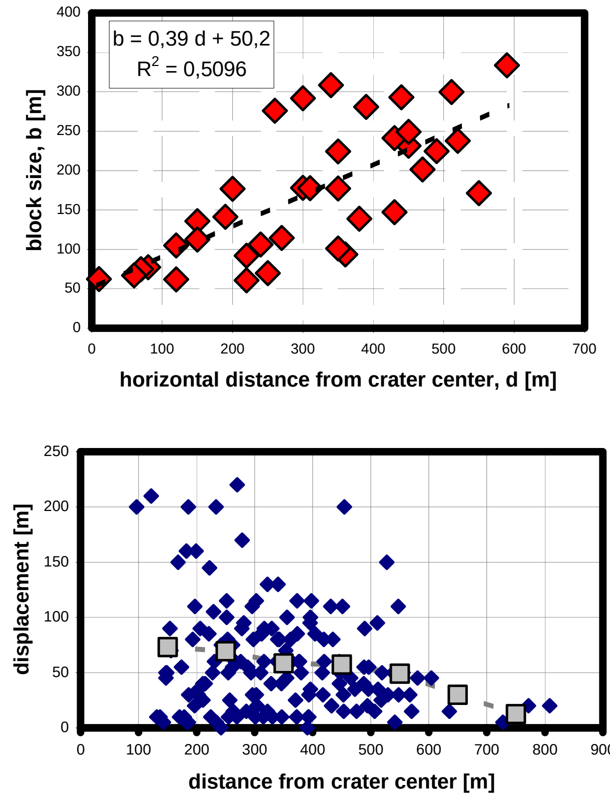

Fig. 3a) hor. distance vs. block size b) hor. distance vs. fault displacement

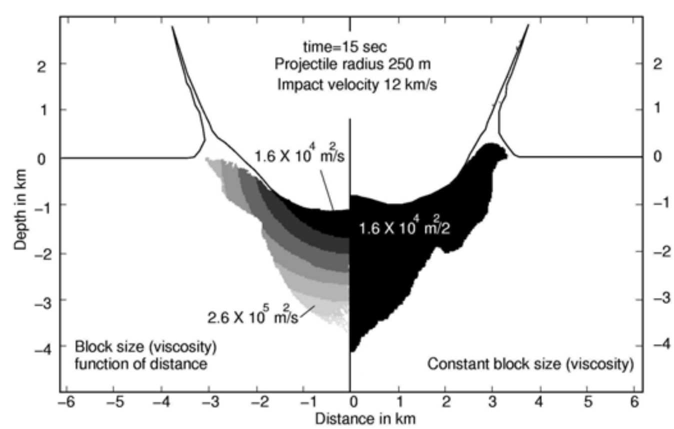

Fig.4 Numerical model with parameters given in [5]. Contours display the viscosity within the acoustically fluidized area with constant block size (constant viscosity)(right), and with block sizes varying with distance from the point of impact according to Fig. 3a (left).