

Hydrocode Simulations of Chicxulub Crater Collapse and Peak-Ring Formation

Gareth Collins, Jay Melosh, Jo Morgan* and Mike Warner*. Lunar and Planetary Laboratory, University of Arizona; *Dept. of Earth Science and Eng., Imperial College, University of London. Email: gareth@lpl.arizona.edu.

We use hydrocode modeling to investigate dynamic models for the collapse of the Chicxulub impact crater. Our aim is to integrate the results from numerical simulations with kinematic models derived from seismic reflection and wide-angle velocity data to further our understanding of the formation of large impact craters. In our simulations, we model the collapse of a 100-km diameter, bowl-shaped cavity formed in comprehensively fractured crustal material. To facilitate wholesale collapse we require that the strength of the target be significantly weakened. In the present model we achieve this using acoustic fluidization; where strong vibrations produced by the expanding shock-wave cause extreme pressure fluctuations in the target. At times and positions where the overburden pressure is sufficiently counteracted, the frictional resistance is reduced, enabling the rock-debris to flow.

Our simulations produce a collapsed crater that contains most of the features that we observe in the seismic data at Chicxulub. In particular, we observe a topographic peak ring, formed as material that is originally part

of the central uplift collapses outward and is thrust over the inwardly-collapsing transient crater rim. Our model predicts that the peak ring is composed of deeply derived but highly brecciated material, and that the stratigraphy within the peak ring is overturned.

In contrast to previous models for peak-ring formation, this research suggests that peak-ring generation involves significant lateral movement of the target material immediately beneath the crater; a result that leads to a new generic model for the subsurface structure of a peak ring crater (see Figure 1). This new model may reconcile apparently contrasting evidence from terrestrial outcrop patterns for the nature of peak-ring material. For example, erosion of the fresh peak ring crater illustrated in Figure 1 to a level between line A and B, would reveal a broad ring of stratigraphically uplifted rocks, as observed at Popigai crater in Siberia. Deeper erosion, however, would reveal a narrow central uplift, surrounded by overturned younger stratigraphy, similar to the sequence observed at the Vredefort impact structure in South Africa.

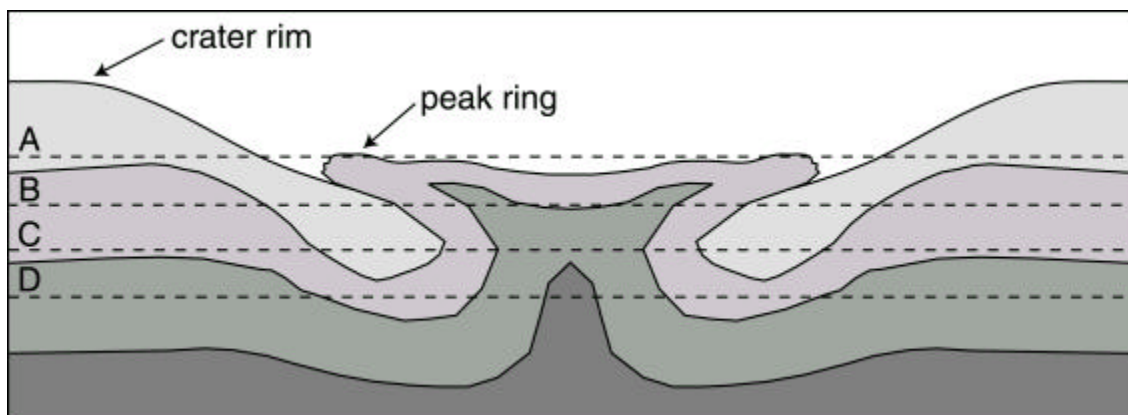


Figure 1: Illustration depicting the subsurface structure of a generic peak ring crater as derived from our simulation results. The solid lines separate originally flat stratigraphic layers that have been deformed by both excavation and collapse. The dashed lines labelled A-D refer to possible stages in the erosion of an initially fresh crater. Note that the illustration has an aspect ratio of 1:2. Thus, the pre-impact thickness of the stratigraphic layers is on the order of $D/20$, where D is the final crater diameter.