Effects of Large Impacts on Crustal Structure and Basin Evolution: Example of the 65.5 Ma Chicxulub Impact

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Large terrestrial impacts permanently modify local hydrology, mineral content, basin evolution and crustal structure. Modeling shows target material in a large impact, such as the Chicxulub impact 65.5 Ma, behaves as a fluid for 10-100s due to the 10-20 km/s impact velocity. Initially a transient crater forms 100 km in diameter by 35 km deep; rebound causes the center of the crater to uplift above the Earth's surface and then collapse forming a large basin containing a ring of elevated topography known as a peak ring. 3D seismic refraction data show that the Moho is upwarped ~1.5-2 km and the granitic basement remains uplifted by ~10 km within the center of the crater. Overlying this central uplift, and merging with the topographic peak ring, is an impact melt sheet that is imaged on seismic reflection data. As gravity becomes the dominant force, the transient crater walls collapse inward widening toward a final crater diameter that includes ring faults mapped at radial distances >125 km from the crater center. Interior listric normal faults move 5-10 km wide, intact blocks into the crater center; the blocks arrive prior to the final outward collapse of the central uplift and are emplaced partly beneath the peak ring. Above the slump blocks, the central basin of the crater is overlain with breccia from airfall and groundsurge that was dominated ocean re-entry into the crater. This effect was enhanced at Chicxulub due to the impact being on a continental slope where the deep-water part of the crater never formed a topographic barrier to entry by tsunami. The final crater floor remains topographically lower than the surrounding region forming a basin dominating the depositional setting for 10s of Myr. Remnant heat of the impact likely generated a vigorous hydrothermal system for up to 1-2 Myr into the Paleogene while the reformed crustal structure and high-porosity impactites continue to drive local hydrology today. The hydrothermal system and interaction of the impact melt sheet with the peak ring breccias may result rich mineral deposits, such as those that found in other terrestrial impacts; this same environment likely fed a subsurface chemosynthetic biosphere. Consensus is that the pristine peak ring and melt sheet within Chicxulub are excellent targets for drilling to understand impacts as a geologic process.