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Target-rock fluidization during peak-ring formation of the Chicxulub crater inferred from Expedition 364 drill core

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The floors of large impact structures are largely flat and contain one or more morphological rings. The formation of the innermost topographic ring, the so-called peak ring, and the causes of target rock weakening leading to observed flat crater floors are not well understood. Constraining these mechanisms is the prime structural geological objective of Expedition 364 “Drilling the K-Pg Impact Crater”, using the Chicxulub impact structure, Mexico, as a terrestrial analogue for the formation of planetary impact basins. A total of 829 meters of core was recovered from borehole M0077A drilled into the peak ring of the Chicxulub crater. From bottom to top, the core is crudely composed of: (1) pervasively shocked granitoid target rock hosting meter- to decameter-thick impact melt rock and suevite dike-like bodies, (2) a 130 m thick impact melt rock and suevite unit overlying the target rocks, and (3) a 112 m thick section of post-impact pelagic carbonate rocks. Based on visual appraisal of the drill core, we determined prominent impact-induced deformation structures in target rock pertaining to rock fluidization during cratering.

In addition to microscopic planar structures formed by shock metamorphism, the target rocks are replete with impact-induced, mesoscopic planar deformation structures. These structures include: (1) cataclastic deformation zones, (2) striated shear faults, (3) crenulated mineral folia-tions, and (4) ductile shear band structures. Structural overprinting criteria point to a relative age for these structures. Zones of cataclasite are consistently displaced or utilized by shear faults. Cataclasite bands in target rock fragments included in suevite are cut by the latter and a striated target rock fragment was found in impact melt rock. Suevite and impact melt were emplaced in zones of dilation, often localized by shear faults. Collectively, these observations suggest that cataclastic deformation was followed by shear faulting, followed in turn by emplacement of sue-vite and melt into dilation zones. This succession of deformation mechanisms is corroborated by the observation that suevite and impact melt bodies are devoid of cataclasite and shear faults. These lithologies were still viscous when they were deformed by ductile band structures. Thus, the shear band structures formed after the shear faults. Based on the structural overprinting rela-tionships, we attempt to relate the mesoscopic planar structures to cratering stages known from impact mechanics.