The Chicxulub impact, shocked carbonates, and correlation to the Cretaceous-Paleogene (K-Pg) boundary: New data from ejecta deposits in the Gulf of Mexico area

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Current issues related to the Chicxulub impact event are centered on the release of climatically-sensitive gases and dust during this impact and on the relation of this event to the clay layer and mass extinction at the Cretaceous-Paleogene (K-Pg) boundary. New data from Mexico, Texas and Alabama as well as from various ODP sites (e.g., Leg 171, 174, and 207) show not only the variable composition of silicic Chicxulub ejecta spherules – documenting contribution from basic to acidic target rocks – but also the ubiquitous presence of carbonate clasts (e.g., Schulte and Kontny, 2005; Yancey and Guillemette, 2008; Schulte et al., 2009). Four types of carbonate clasts with specific impact-related textures have been observed: (i) calcite globules with feathery crystallites, indicative of a former molten state and rapid cooling; (ii) carbonates and dolomites rimmed and intersected by ribbons of phyllosilicates that are interpreted as altered melt lithologies and may indicate intimate mixing of silicic and carbonate melt; (iii) accretionary carbonates consisting of loosely-bound, µm-sized calcite crystals within a silicic (smectite) matrix. The internal aggregate microfabric of these calcite clasts indicates that they formed by accretion of small calcite particles within the vapor plume of the Chicxulub impact (Yancey and Guillemette, 2008; Schulte et al., 2009). The small calcite particles may have originated in carbonate back-reactions – this is subject of our ongoing investigations; (iv) carbonate clasts with a specific porous texture that strongly resembles textures produced in carbonate degassing experiments (Agrinier et al., 2001) and therefore, may be interpreted as material from the Yucatán carbonate platform that has experienced various degrees of shock metamorphism, followed in part by thermal overprint in the ejecta plume. These observations suggest that on one hand, carbonate back-reactions may have limited the release of CO_2 during the impact event. The common presence carbonate-silicic melt interaction associated with dissociation and degassing, on the other hand, may have provided an additional source of climatically sensitive gases.

The presence of a compositionally complex, up to 1 m thick Chicxulub ejecta layer at the K-Pg boundary in diverse depositional systems covering an area ranging from Mexico to Alabama to Texas to the Western Atlantic margin (e.g., ODP Leg 171, 174, and 207) strongly suggests that the Chicxulub impact exactly concurs with the K-Pg boundary. Large scale contemporaneous reworking of ejecta into one distinct layer up to several hundred kyrs. after the impact event seems sedimentologically impossible as such event deposits are rapidly dispersed and diluted after deposition. Moreover, detailed tectonic, sedimentological, and petrographic investigations of K-Pg outcrops in NE Mexico and Texas reveal that either slumping and sliding and/or syn-sedimentary faulting are responsible for the generation of local, lense-like ejecta deposits within latest Maastrichtian marls (Schulte & Kontny, 2005). The cm-thick clay layer found below the ejecta spherule layer in Brazos, Texas, was clearly identified as volcanic ash layer and showed no evidence for distinct ejecta phases (spherules, carbonates, shocked quartz, etc.) otherwise present in the Chicxulub ejecta deposits. In conclusion, combining petrographical characteristics of the ejecta deposits with sedimentological outcrop investigations in the Gulf of Mexico K-Pg sections provides no evidence for a “Chicxulub preceding the K-Pg boundary scenario” (e.g., Keller et al., 2007). Moreover, the excellent correlation of ejecta from these K-Pg sites with ejecta found in distal K-Pg sections, for instance in the western North and South Atlantic, further confirms Chicxulub as the K-Pg boundary impact.

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