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A multiproxy record of Late Maastrichtian and Danian environmental change and Chicxulub impact ejecta from ODP Leg 207, tropical western North Atlantic

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The ODP Leg 207 from the Demerara Rise, tropical western North Atlantic, has recovered an expanded and stratigraphically complete Cretaceous-Paleogene (K-P) sedimentary record that also includes a well-developed Chicxulub ejecta deposit. Therefore, ODP Leg 207 occupies not only a central position for understanding the Maastrichtian-Danian deepwater record from low latitudes but also provides insights into ejecta deposition to the South of the Chicxulub impact, that are otherwise rarely reported. We have conducted a high-resolution mineralogical, isotope geochemical, and rock magnetic study to reveal environmental changes and transient climate shifts from the K-P transition up to the Danian-Selandian boundary and to characterize the Chicxulub ejecta deposit.

A quantitative study of the mineralogical composition by X-ray diffraction and subsequent Rietveld refinement reveals a quite stable Late Maastrichtian environment and strong fluctuations during the Danian following the K-P impact. No evidence was found for any additional impacto-clastic layers during the 300 ky preceding the K-P boundary. The Maastrichtian Biozone CF1 is characterized by a stable high calcite content $>$70 wt%, few wt% of feldspars and quartz, and a diverse clay mineral assemblage. The clay fraction comprises smectite, illite-smectite, kaolinite; in addition some zeolites are present. Across the K-P boundary, the calcite content drops to $<$20 wt% with a concomitant increase of the siliciclastic fraction and a shift in the relative abundance of clay minerals towards kaolinite and illite. Throughout the Danian, the carbonate generally increases, stabilizes during Biozone Pα, followed by strong

fluctuations beginning with the Pα/P1a zonal boundary – which also corresponds to the lower boundary of a reddish interval in the cored material. Late Maastrichtian carbonate contents are, however, not reached until Biozone P1c (i.e., more than 2.5 Ma after the K-P boundary). Isotope studies are currently conducted to show if these fluctuations are associated with perturbations in the carbon cycle.

The single 1.5-2 cm Chicxulub ejecta horizon is composed of a normally graded layer of spherules that decrease in diameter from $\sim$2 mm to $\sim$0.25 mm. In the upper third of the spherule layer, detrital calcite and dolomite clasts as well as quartz grains are present. The morphology and internal structure of spherules is similar to spherules found in the K-P boundary clay layer worldwide: the spherules are massive, hollow, or vesicle-rich, and some show in situ collapse structures. Spherules are altered to two different types of well-crystallized smectite indicating different precursor materials: type one has Si, Al, Mg, and Fe as well as some Ti, whereas, type two consists predominantly of Si and Al. Besides late diagenetic, pervasive chalcopyrite and sphalerite crystals, spherules frequently include Fe-Ti-rich schlieren. The graded nature, the complex composition of the ejecta, and the, in part, good preservation of the delicate spherules suggests an origin as primary air-fall deposit.