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Impact spherules from K-Pg-boundary at Beloc (Haiti): Geochemistry and Mineralogy

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Six spherules from the Chicxulub ejecta layer in Beloc, Haiti were analyzed using optical and electron optical microscopy, microprobe, laser ablation-inductively coupled-mass spectrometry (LA-ICP-MS), Raman spectroscopy and X-ray diffraction (Institut für Mineralogie, WWU Münster). These mm-sized spherules consist of glass ("black glass", Jéhanno et al. 1992) that is partly or totally altered to clay minerals (smectites, [saponite, nontronite] and montmorillonite) but original textural features are still visible. The geochemical composition of the black glass is similar to the average Upper Continental Crust; we did not detect any hint for the presence of a "meteoritic component" (Ni/Cr <0.5). The main chemical difference between the black glass and the alteration products is a general depletion in trace elements, except for Th, Ba, Ti, Co, Ni, Cr, Ga, Ge, V, Sc, and Li. In more detail, the Zr/Hf ratio is similar in the glass and the clay (∼39.4) but Nb/Ta is decreasing from a value of 17 over 10 to 5. The REE distribution patterns and concentrations in the glass match those of the Upper Continental Crust with just a minor Eu anomaly. In contrast, REE in the clays have sub-chondritic abundances, a LREE depleted distribution pattern, significant negative Ce anomalies, and a minor positive Eu anomaly. According to X-ray diffraction the clay minerals show a low degree of crystallinity, and have very small grain sizes. The high spatial resolution of the LA-ICP-MS (spot size 90 μm) allows reconstruction of the alteration process in a single sphere: The first step yields a total depletion of the REE, followed by a loss of Ta, Hf, Zr, Cr, and, in part Ti. This later stage obviously caused a fraction between Nb and Ta. We conclude that the glass has undergone alteration by sea water suggesting an open water-rock-system. Similar alteration with strong depletion in REE has been reported from several K-Pg boundary layers that, however, have been deposited in quite different environments ranging from shore (Shell Creek; AL) to deep water (ODP 207). To better understand the complex processes of alteration, we suggest to study other K-Pg ejecta beds (Schulte et al. 2010) using a multi-element investigation in combination with a throughout mineralogical characterization.

Jéhanno C. et al. 1992, EPSL 109
Schulte P. et al. 2010, Science 327