The distinct behavior of sedimentary target rocks during the Chicxulub impact event: Observations at proximal and distal ejecta deposits at K-Pg sites El Guayal, La Lajilla, and drill cores UNAM-7 and ODP 207.

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Introduction: Ejecta deposits at the K-Pg boundary reveal that shocked carbonates are a common product of the Chicxulub impact into the carbonate-sulfate target of the Yucatán platform [1-4]. In order to better understand these impact processes, microscopic, EDS and EBSD studies of impactites were carried out.

Results, interpretations: (1) Drilled at the outer rim, 126 km of the Chicxulub crater center, core UNAM-7 contains a sequence of 126.2 m suevite topping a silicate melt-poor breccia with anhydrite megablocks [5]. The microcrystalline breccia matrix is dominated by calcium sulfate (51.8 %), calcium magnesium carbonate (30.6%), calcium carbonate (14.9 %), minor strontium sulfate (0.7 %) and feldspars (1.5 %). Dolomite spheroids with a polygonal to interlobate microstructure document deposition in molten state and slow cooling. A vesicle-bearing crystallization sequence in anhydrite, coated with silicate melt, indicates coherent melting and decomposition.

(2) EBSD studies of spherulitic calcite particles at the K-Pg deposit at El Guayal, Mexico (520 km SW the crater center [5]) reveal a fiber texture of elongated crystals with a preferred orientation distribution. The results indicate the presence of calcium carbonate melt which was ejected from upper target lithologies at T>1240 °C and P>40 bar [6] and crystallized at a high cooling rate of $\Delta T>100$ °C/s [7]. A different microstructure is characterized by equiaxed crystals with a random orientation distribution at calcite particles of El Guayal and the K-Pg deposit at La Lajilla (1000 km W the crater center). This documents recrystallization by thermal stress at T>550 °C at a moderate cooling rate of $\Delta T\sim100$ °C/s during atmospheric transport. At the polymict breccia of El Guayal, spherulitic calcite particles display a progression of microstructures from recrystallized to larger elongated grains towards the rim indicative for a formation at a low cooling rate of $\Delta T\sim10<100$ °C/s [7]. Aggregates of recrystallized calcite with altered silicate melt indicate aggregation of viscous silicate melt with carbonate. Hence, the presence of pseudomorph pore space in altered silicate melt suggests CO_2 degassing at temperatures of ~660≥900 °C. The lack of anhydrite and rare presence of dolomite only in the lower subunits of El Guayal indicate that these minerals were strongly affected by decomposition.

(3) At the 2-cm-thin K-Pg ejecta deposit of ODP 207 in the Western Atlantic (4000 km SE from Chicxulub), the uppermost 1 mm contains shocked quartz and shocked carbonates [1,3]. Shocked carbonates consist predominantly of fine-grained, recrystallized calcite with minor, larger dolomite grains. They are associated with sodium halide and submicron-sized prismatic copper oxy halides. These observations point to a decarbonation of dolomite and calcite at T>778 °C with interaction of seawater.

Conclusions: UNAM-7 provides the first evidence for melting and dissociation of sulfates at the Chicxulub crater, and melting of dolomite. The abundant presence of shocked sulfates in core UNAM-7, and their absence at distal deposits may indicate that high-T processes for sulfates are restricted to a region close to the crater. It can be explained that the melting point for anhydrite at 1465 °C is very close to the temperature of the decomposition reaction [8]. Shocked carbonates from distal ejecta deposits are a clear proof for melting and dissociation. The rareness of dolomite and lack of anhydrite at distal ejecta deposits can be explained by a distinct response of these minerals:

(1) $CaSO_4 \Rightarrow CaO + SO_3$

(2) $CaMg[CO_3]_2 \Rightarrow CaCO_3 + MgO + CO_2$

(3) $CaCO_3 \Leftrightarrow CaO + CO_2$ $\Delta H° = 178$ kJ / mol

Compared to MgO, CaO is highly reactive in the interval of 300-700 °C if CO_2 is present [9]. Reformation of calcite during the fast back-reaction of CaO with CO_2 (and water) would cause a prolonged release of thermal energy that may have initiated a delayed vapor release in the ejecta plume evolution. In turn, this process could force the gas driven ejecta transport.

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