NEW INSIGHTS INTO THE RELATIVE TIMING AND CONTRIBUTION OF THE CHICXULUB IMPACT AND DECCAN VOLCANISM IN THE CRETACEOUS-PALEOGENE BOUNDARY EXTINCTIONS. M. L. Cousineau[1], F. Therrien[2], T. Maruoka[3], D. Fortin[1] and B. A. Wing[4], [1]University of Ottawa, Department of Earth sciences, Ottawa, Ontario [2]Royal Tyrell Museum of Palaeontology, Drumheller, Alberta [3]University of Tsukuba, Ibaraki, Japan [4]McGill University, Earth and Planetary Sciences, Montréal, Québec

Introduction: The Cretaceous-Paleogene (KPg) boundary marks one of the most significant mass extinctions in Earth history. The leading hypothesis attributes the extinctions to a bolide impact with sulfate-rich rocks—the Chicxulub impact, but a major competing hypothesis suggests a major role for the emplacement of the Deccan continental flood basalts. Absolute age measurements for the largest Deccan eruptions and the KPg boundary suggest the two events were contemporaneous, but measurement uncertainties have so far thwarted attempts at resolving their relative timing. Using sulfur stable isotope measurements at two KPg sedimentary sections, we provide new insights into the relative timing of these two geologic events and their respective contribution to the KPg biotic turnover.

Sulfur isotopes: Both the Chicxulub impact and Deccan volcanism would have released massive amounts of sulfur (S) in the atmosphere. Impact-released S would have primarily been derived from late Maastrichtian seawater and the ≈3-km-thick sequence of Cretaceous evaporite- and carbonate-bearing target rocks at the impact site, whereas S released by Deccan volcanism would have an igneous origin. Maastrichtian seawater, Upper Cretaceous evaporites, and Chicxulub target evaporites have δ^{34}S values centered around ≈18‰[1], while sulfate aerosols collected at basaltic vents have much lower δ^{34}S values (≈8‰)[2].

KPg sedimentary sections: We measured whole-rock sulfur content and isotopic composition (δ^{34}S) at high resolution across the KPg boundary at two sections (Knudsen's Coulee Section, KCS; Knudsen's Farm Section) in Alberta, Canada. We focus our discussion on the extremely well-preserved KCS, which features lithological, paleontological, and geochemical markers indicative of the terrestrial KPg boundary, including a three-part boundary claystone layer representing the initial ballistic melt ejecta, an early-formed 'fireball' layer of condensed vapor from the impactor and target rocks, and a later-formed layer of fine Ir-rich particles and sulfate aerosols.

Results: Sulfur contents and δ^{34}S values show similar behavior at both sections (Fig. 1A, 1B: KCS shown), with, below the boundary claystone, extremely low (<0.2 wt%) S contents and mildly varying δ^{34}S values (≈6.5‰±2‰). This provides a favorable backdrop for monitoring the addition of ^{34}S-rich sulfur to the system (δ^{34}S×[S], Fig. 1C). Mixing curves (not shown) show the ^{34}S-enriched sulfur is derived from two distinct sources, with measurements associated with the brief and intense pulse falling on a high (≈18‰) δ^{34}S curve, comparable to Chicxulub target rocks, and those associated with the broader pulses falling on a lower (≈8‰) δ^{34}S curve, comparable to sulfate aerosols from oxidized volcanogenic SO_2.

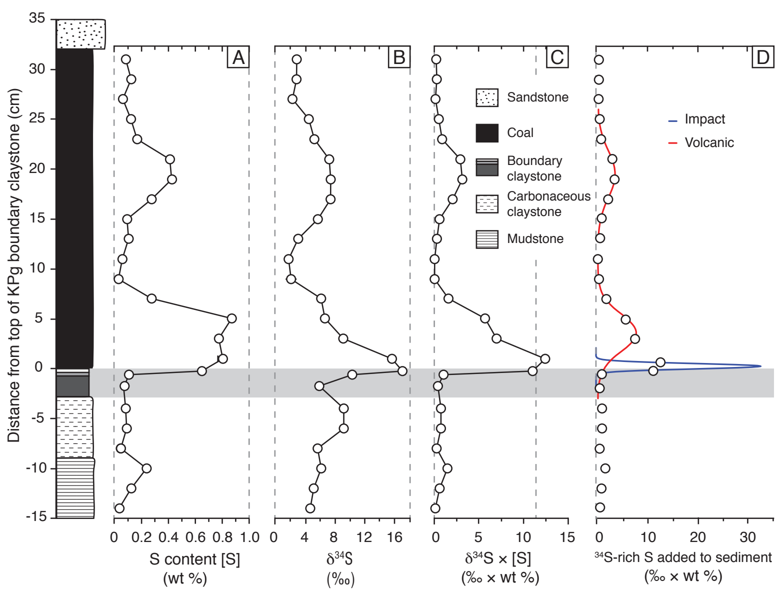

Fig. 1 Whole-rock S content [S] (A) and δ^{34}S values (B) at the Knudsen's Coulee KPg section. Data points represent 2 cm-thick sample intervals (smaller intervals in boundary claystone). (C) Plot of δ^{34}S×[S] representing the amount of ^{34}S-rich S added to the sediment. (D) Modeled data. The shaded area indicates the boundary claystone, divided into a three-part micro-stratigraphy.

Discussion: The environmental scenario we propose places the onset of a major Deccan eruptive phase, lasting ≈90 kyrs, at the KPg boundary, contemporaneous with the Chicxulub bolide impact (Fig. 1D). A subsequent eruptive phase started ≈120 kyrs post-impact, lasting ≈90 kyrs. Deccan eruptions may have delayed the recovery of marine and terrestrial ecosystems after the impact, but our results highlight the Chicxulub impact as the primary extinction trigger.

References: [1] Paytan et al. (2004) *Science,* 304, 1663-1665; C. Koeberl, (1993) *Geology,* 21, 211-214 [2] Mather et al. (2006) *JGR*, 111.