A high resolution carbonate-clumped terrestrial temperature record from a Cretacous-Paleogene section in North Dakota, USA

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The Cretaceous-Paleogene boundary is a conspicuous sliver in Earth's history as it straddles a mass extinction that has largely been attributed to a catastrophic bolide impact. Leaf margin analyses suggest a warming event that began at 66.0 Ma and continued until 65.6 Ma, with temperatures increasing 6°C over this interval; no sizeable temperature change is noted at the boundary itself [1]. Here we use carbonate clumped isotope paleothermometry (Δ_{47}) to verify this terrestrial climatic change across a 1.21 m.y. section spanning the Hell Creek and Fort Union formations. As the Western Interior Seaway receded, southwestern North Dakota was left with a system of freshwater rivers as evidenced by freshwater mollusc assemblages interspersed in sandstone channels and silty mudstones from flood plains and overbank deposits. Bioapatite scales from *Lepisosteus sp.,* or the gar fish, are numerous throughout this environment, well-preserved, and record mean annual temperatures. Reconstructed temperatures from scales are determined from 82 m below the boundary to 9 m above the boundary at approximately 5 m intervals. Gar scales record a 10 °C increase in temperature from 13 °C to 23 °C at approximately the same stratigraphic interval as found using leaf margin analysis. There is a slight decrease in temperature of 1 to 3°C within the first meter above the boundary, but it rebounds within 52 k.y. or 5 m to pre-warming event levels at approximately 14 °C. There is no visible bimodality in $\delta^{18}O_{water}$, which fluctuates by 1.8‰ around an average value of −8.5 ‰.

[1] Wilf *et al.* (2003) *PNAS* **100**, 599-604