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Dinosaur "mummification": Clay templating in a fluvial setting preserves three-dimensional integument renderings after carcass desiccation

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Dinosaur "mummies" preserve large areas of three-dimensional, wrinkled, desiccated integument renderings enveloping articulated skeletons. The majority of dinosaur "mummies" are "duck-billed" hadrosaurids in desiccated death poses that were buried in Late Cretaceous fluvial sandstones, such as in the Lance and Hell Creek formations of western North America, and unlike the lacustrine, marshy, or shallow marine sediments of many Konservat-Lagerstätten. Although first described in1912, the structural and chemical nature of these renderings and the steps leading to their formation have only recently begun to be explored in detail. Hypotheses about the mode and mechanism of "mummy" preservation have varied widely, from simple impressions in sediment to near-pristine retention of organic tissues or biomolecules. Two newly described "mummies"of the Late Cretaceous hadrosaurid *Edmontosaurus annectens* were subjected to a wide range of modern structural and chemical analyses. These specimens come from a several-kilometer region in east-central Wyoming, USA, near the top of the Maastrichtian Lance Formation that has produced multiple of the best-preserved "mummy" dinosaurs over the course of the last century. These two "mummies" preserve exceptional integument renderings, including skin/scales, tail spikes, and hooves. We characterized how the three-dimensional form of the integument is preserved and whether any original tissue structure or organic biomolecules remain. We find little evidence for any endogenous organic preservation or internal tissue structure. Instead, these "mummies" likely desiccated sub-aerially for a period of time before rapid burial and infilling of the carcass by fluvial sands. Next, organic decay induced preservation of their outermost integumentary surface largely via microbially induced clay templating (a

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