



## 29 million years of diverse mammalian enamel proteomes from Turkana in the East African Rift System

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Exploration of the paleobiology of extinct taxa through ancient DNA and proteomics has been largely limited to Plio-Pleistocene fossils due to molecular breakdown over time, a problem exacerbated in tropical settings. Here, we report small proteomes from the interior enamel of fossils deposited at paleontological sites dating between 29–1.5 Ma in the Turkana Basin, Kenya, which has produced the richest record of Cenozoic mammal evolution in eastern Africa. We recovered enamel protein fragments in all sampled fossils, including a ~ 29 Ma *Arsinoitherium* specimen belonging to an extinct mammalian order, Embrithopoda. Identified proteins include the classical structural enamel proteins amelogenin, enamelin, and ameloblastin, but also less abundant enamel proteins including collagens and proteases. Protein fragment counts decline in progressively older fossils, but we observe significant variability in Early Miocene preservation across sites, with ~17 Ma deinotheres and elephantimorph proboscidean fossils from Buluk preserving substantially more proteins than rhinocerotid and anthracotheriid fossils from ~18 Ma Locherangan and hippopotamids from younger localities at Napudet (< 11 Ma). Most specimens yield known clade-specific diagenetiforms that support morphology-based taxonomic

identifications. Matches to clade-specific proteins suggest the future potential of paleoproteomics to contribute to the systematic placement of extinct taxa, but should be approached with caution due to sometimes sparse fragment identification and the possibility of sequence diagenesis. We identify likely modifications that support the ancient age of these proteins, and the oldest examples of advanced glycation end-products and carbamylation yet known. The discovery of protein sequences within dense enamel tissues in one of the persistently warmest regions on Earth promises the discovery of far older proteomes that will aid in the study of the biology and evolutionary relationships of extinct taxa.