Geochronology and timescales in the evolution of mammalian tooth shape: the Paleogene of Patagonia

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The South American fossil record provides a unique and rich record of the evolution of mammalian tooth shape, especially structural features that serve to resist abrasive wear. For the evolution of mammalian tooth shape, our understanding of geochronology points increasingly to a convergence between rates of morphological change and the intensity of earth surface processes (climate-driven erosion of pyroclastic sediment accumulations). Using single zircon U-Pb methods to construct high-precision age models for fossil-bearing strata of the Sarmiento Formation, we gain increasing confidence in the remanent magnetic polarity stratigraphy and the measurement of linear sedimentation rates. Where fossil preservation permits, age-calibrated change in the evolution of tooth shape are observed but imprecision suggests we may be approaching the limits of resolution for continental sequences. The earth surface processes that drive natural selection and the evolution of tooth shape operate over many timescales. The surface processes that contribute to variation in tooth wear and dental senescence (and through these reproductive longevity) operate at seasonal, inter-annual and decadal timescales, beyond the limits of precision of geochronology in most Paleogene terrestrial mammal sequences. However, these same earth surface processes vary at orbital and evolutionary timescales. Coupled continental and marine records reveal a temporal correlation between evolutionary rates of change in tooth shape and surface erosion represented by the accumulation of mineral particles transported by wind and exported to the sea-floor. Such records illuminate the mechanism and illustrate the role of environmental causation in the evolution of tooth shape. For the Sarmiento Formation of Patagonia, a similar correlation may await discovery in southern South Atlantic deep sea cores.

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