Supplementary Methods

***Specimen treatment***

Handling of wet specimens

Fossils preserved at ZR were typically saturated with ground water and thus required efforts to mitigate the damaging effects of rapid desiccation. Large elements were jacketed and moved to DMNS facilities, where they could be cleaned and slowly dried. Smaller elements were removed from sediment and wrapped in plastic or placed in sealed plastic bags, after which they were washed and photographed and then returned to plastic bags to begin a slow process of controlled drying that continued at DMNS.

3D models

3D models of the Clay Mammoth assemblage and of one mastodon tusk were derived photogrammetrically (using Autodesk 123D Catch!) from digital photographs taken at numerous angles. 3D models of smaller specimens (cheek teeth and mandibular tusks) were generated using a Creaform HandyScan 3D [*REVscan*] laser scanning digitizer and the Creaform application *VXelements*. This produced models with sub-millimeter precision and accuracy. Models from both sources were texture-mapped in 3DSOM Pro, version 3, producing models viewable in internet browser software, and some were converted to 3D pdfs.

***Analysis of stable isotope profiles***

Sample milling

When we sample isotope profiles from premaxillary tusks, we usually mill samples by following second-order increments on polished transverse sections (often on a slab 5 mm thick). The angle at the apex of dentin cones in premaxillary tusks is so small that a bit penetrating perpendicular to a transverse surface produces little unintended time-averaging. In mastodon mandibular tusks, the angle at the apex of dentin cones is much greater (ca. 60°). In this case, time-averaging is minimized by sampling from longitudinal surfaces.

Dentin carbonate pretreatment and analysis

In unpublished tests, prior to this work, one of the authors (ANR) observed changes in oxygen isotope values of pretreated dentin powders that sat for extended periods of time. We therefore scheduled sampling to limit time between pretreatment and analysis to no more than two days.

For dentin carbonate pretreatment, we soaked powder samples in 30% H2O2 (for dentin, we used 0.08 ml per mg of sample; for enamel we followed UCSC stable isotope lab protocol (http://es.ucsc.edu/~silab/di.apatite\_SOP.php last accessed 07/10/2014) and used 0.1 ml per mg) for 24 hours at room temperature to remove organics. Next, we rinsed samples in ultrapure water and treated them with 1M acetic acid-calcium acetate buffer solution (0.08 ml per mg of sample for both dentin and enamel) at room temperature for an additional 24 hours to remove secondarily deposited carbonate. Following another rinsing and subsequent lyophilization, we weighed 800 to 1000 µg aliquots into stainless steel boats for analysis of δ18O and δ13C on a MAT Kiel IV preparation device coupled to a Finnigan MAT 253 mass spectrometer in UMSIL. Prior to analysis, samples were roasted at 200 °C for 1 hour under vacuum.

Dentin collagen pretreatment and analysis

Collagen analyses were performed on blocks of dentin (ranging from 7 to 15 mg) that were demineralized in 10 ml 0.5 N HCl at 4 °C until translucent and flexible (approximately 2-3 days; procedure documented by Rountrey et al., 2007). We then thoroughly rinsed the samples and treated them with a 2:1 chloroform-methanol mixture (10 ml) at room temperature in a sonicator for 30 minutes to remove any oils introduced during the sampling process. After final rinsing and lyophilization, we wrapped subsamples of 583 to 600 µg (adjusted to match sample and standard peak voltages to the degree possible within individual runs) in tin capsules for analysis of δ15N and δ13C on a Costech Elemental Analyzer attached to a Finnigan Delta V+ mass spectrometer in UMSIL.