Hydrogen in tooth enamel, and δ^2H for paleodiet

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Hydrogen isotopes in tooth enamel have not been previously explored for paleodietary applications. Of modern elephants, hippos, and giraffids, expected dietary niches are not observed (by δ2H vSMOW). Yet the δ^2H distribution of Kenyan enamels have similar range (~40‰) and are ~100‰ more negative than Kenyan waters.

Material complexity of enamel's H prevents straightforward dietary analysis such as in the case of $\delta^{13}C$, $\delta^{15}N$, and $\delta^{18}O$. Inter-species comparisons by TGA display a diversity dehydration temperatures and magnitudes of normalized weight loss. Fluorination (HAP→FAP) remains incomplete after millions of years in fossil enamel, and gives large intra-tooth variation (O- and F-EMPA, 25 keV, 1-10 μm spatial resolution).

Exchangeable H fractions >30% are observed after 2 years in enriched (+180‰) deionized water for modern tooth enamel by TC-EA-IRMS. Protein (enamelin) is apparently not removed by peroxide treatment (3%; 15 minutes). Therefore much of the observed isotope exchange may be attributed to residual protein rather than hydrated Ca-phosphates. A successful approach to paleodietary study of enamel H must account for intra- and inter- tooth variation by multi-phase mass balance, and dynamic phase relationships.

NanoSIP: Combining stable isotope probing and high resolution secondary ion mass spectrometry to identify diazotrophs in stratified marine microbial communities

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Cyanobacterial mats are stratified microbial communities often found in coastal marine environments. Previous studies have indicated that N_2 fixation occurs at high levels in these mats and constitutes a significant portion of the nitrogen flux. The application of stable isotope probing (SIP) with $^{15}N_2$ and nanometer-scale secondary ion mass spectrometry (NanoSIMS), which we term NanoSIP, has allowed us to observe N_2 fixation at the single cell level. We have collected cyanobacterial mats throughout the year from Elkhorn Slough at Moss Landing, CA and incubated them with $^{15}N_2$. Using acetylene reduction assays and IRMS analyses, we determined that N_2 fixation occurs in the upper 2 mm of these mats, where cyanobacteria predominate. NanoSIMS analysis of the upper layer of these mats has indicated that the dominant cyanobacterial species, *Microcoleus*, does not fix N_2. However, these measurements demonstrate that populations of small filamentous cyanobacteria and single cell bacteria are primarily responsible for fixing N_2. We are currently using a combination of *nifH* expression, enrichment cultures and phylogenetic labeling to identify the diazotrophic communities in the mats.