Niche partitioning in early Eocene mammalian faunas: New insights into a C3 ecosystem from tooth morphology, microwear, and stable isotopes

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The stable isotopic composition of biological tissues can provide information about an animal's diet, and as preserved in crystalline tooth enamel can persist unaltered for millions of years. This makes stable isotope techniques very important tools in the study of life history and ecology in extinct animals. In such cases, however, the sources of isotopic variability are often difficult to pinpoint. The present study introduces a novel method for the evaluation of dietary signal in mammalian stable isotope ecology by combining stable isotope analysis with these independent dietary indicators. Phosphate $\delta^{18}O$ and carbonate $\delta^{18}O$ and $\delta^{13}C$ values from the tooth enamel of an early Eocene mammalian fauna exhibit a wide range of values, especially for an ecosystem composed entirely of C3 plants. Comparison with microwear and morphological results show that the ^{18}O variability in these animals stems from differential reliance on ^{18}O-enriched leaf water as a proportion of water intake (high-fiber herbivores= more leaf water, frugivores= more meteoric water), while the ^{13}C variability likely stems from feeding on plants growing in different microhabitats. The dietary information available from microwear and morphology allows the sources of stable isotopic variability to be addressed, providing a powerful tool to the interpretation of isotopic values in both fossil and living systems.

Unravelling sources of ground-level ozone in the intermountain western U.S. through Pb isotopes

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The Western United States (US) is subject to pollution transported across the Pacific from Asia. One component of aerosol pollution is lead (Pb), an element that can be readily traced back to sources using isotopic fingerprints Over the past decade China has emitted ~$7x10^9$ g/yr of Pb to the atmosphere with the principal source being coal combustion. The isotopic composition of aerosol Pb from China is distinct from sources in the Western US. In [1] it was shown, using data from Northern California, that the amount of Pb sourced in Asia/China (termed Trans-Pac Pb, ng/m^3) could be determined from the aerosol Pb isotopic composition. Here we explore the combined use of Pb isotopes and back-trajectory analyses to constrain the sources of ozone and its precursors to remote areas of the intermountain Western US. The EPA is considering lowering the ozone standard from 75 ppbv (MDA8= Maximum Daily 8-hour Average) to 60-70 ppbv. This will result in remote areas of the intermountain west being out of compliance, despite a lack of significant local sources. Sources suggested as culprits for ozone exceedance events in the remote west include long-range transport from Asia, regional transport from the Los Angeles/Las Vegas area, exchange/intrusion of stratospheric air to the surface, and wildfires. We used a combination of Pb isotope fingerprinting and back-trajectory analyses to distinguish sources of ozone to Great Basin National Park located in eastern Nevada. We found that during discrete Chinese Pb events (>1.1 ng/m3) trans-Pacific transported ozone was 4±5 ppbv above 15 year averages for those dates. In contrast, dates charaterized by regional transport from the Los Angeles and Las Vegas areas were 19±3 ppbv above the long-term averages, and those characterized by high-atitude transport were 21±5 ppbv above. The latter is indicative of long range free tropopshere transport, most of these samples had modest concentrations of Trans-Pac Pb (ave. 0.43 ng/m^3). Our data constrain the average background concentration of Asian sourced Pb in air to 0.3±0.2 ng/m^3 in the western US.

[1] Ewing *et al*. (2010) *ES&T* **44,** 8911-8916

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