Time resolution of laser ablation MC ICP-MS Sr isotope composition measurements in dental enamel: Implications for the reconstructions of mammals paleo-ecology

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Dental enamel is the most resistant tissue capable of quantitative retention of geochemical and isotopic record after animal's death. Despite the fact that in situ analyes of (bio)apatite appear analytically challenging and that enamel still may undergo some secondary alterations, accurate Sr isotope composition can be recovered by laser ablation MC ICP-MS. In this study, we investigated the influence of post-mortem chemical changes in tooth enamel on accuracy of Sr isotope measurements using teeth of mammoths, elks horses and reindeers. We combined laser ablation Sr isotope measurements with histological studies in order to link spatial resolution with time.

The secondary alterations of tooth enamel appeared fairly common, and expectedly, well correlated with elevated abundance of elements like REE, U, Ba or Fe. Rather surprisingly, we did not observe any detectable differences in Sr isotope record in such zones relatively to that in a well preserved, tissue.

Histological studies of elks' incisors indicated < 2 years period of enamel formation. However, a single plate in wooly mammoth molar formed over 11 years, which makes it perfectly suitable for testing the potential of high resolution isotope record. We obtained a reproducible pattern of cyclic changes in $^{87}Sr/^{86}Sr$ ratios correlating with cyclic varitions in oxygen isotopes which point to a seasonally driven migration. Taking into account the applied analytical parameters and the estimated dental enamel extension rates, we achieved < 1 month time resolution. Sub-seasonal Sr and O isotope record revealed annual migration cycle of mamoths from southern Poland, most likely, between the northern and southern sides of the Western Carpathians.