Micromilled Ca isotope ($\delta^{44/40}$Ca) profiles in human tooth enamel – assessment of physiological controls?

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Ca isotopic compositions have been widely used in geochemical, archaeological and human health studies [1-3]. However, there is no comprehensive understanding of the physiological vs. environmental controls on Ca isotope fractionation in different vertebrate tissues.

We report Ca isotopic measurements using an IsotopX PhoeniX-62 TIMS, equipped with a $10^{10}\Omega$ resistor for ^{40}Ca. Loading Ca using a Ta-emitter with Parafilm dams on single Re filaments minimizes sample spread to <1 mm, and reduces the in-run fractionation on ^{40}Ca/^{44}Ca (measured) to 0.7%. The loading blank is < 1ng. Approximately 20 V (2 nA) of ^{40}Ca can be obtained with 2 µg Ca, and an internal 2se of 0.04‰ on ^{40}Ca/^{44}Ca (normalized) achieved. The internally normalized ^{40}Ca/^{44}Ca ratio (to ^{42}Ca/^{44}Ca = 0.31221) of carbonate standards 915b and HPS has an average of 47.159 ± 0.01 (n = 40), comparable to the analytical error of the most recently published Ca isotopic data by TIMS [4]. A ^{42}Ca-^{48}Ca double spike (DS) is used to correct the measured ratios.

Our enamel microsamples are micromilled along the enamel-dentine-junction (EDJ) from a 150 × 150 µm square in 200 µm thick sections of modern and archaeological human teeth. This allows ~5 µg of apatite (~2 µg Ca) to be reliably extracted. Micromilling was performed within a drop of de-ionized H_2O, confined to a 4 mm^2 hole by parafilm covering the sample surface during milling. The sample slurry is transferred to microtubes, dissolved in 2% HNO_3 and analyzed for its Ca-isotope composition without further ion exchange chromatography. Profiles of $\delta^{44/40}$Ca along the EDJ of modern and fossil teeth will be presented. Variations in $\delta^{44/40}$Ca of modern individuals with known dietary history, together with trace element ratios, will refine our understanding of the physiological effects on Ca isotope fractionation, such as Ca metabolism, Ca utilization efficiency, or dietary stress, which will then help us reliably interpret the environmental signals from $\delta^{44/40}$Ca profiles in fossil teeth.

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