Spectral Insights: Multi-dimensional approach to evaluate the diagenetic status of skeletal remains with respect to strontium isotope ratio measurements

Anika Retzmann[1], Magdalena Blanz[2], Johanna Irrgeher[3], Andreas Zitek[1], Jörg Feldmann[2], Thomas Prohaska[1]

[1] University of Natural Resources and Life Sciences, Vienna, Department of Chemistry, Division of Analytical Chemistry, VIRIS Laboratory, Konrad-Lorenz-Str. 24, 3430 Tulln, Austria
[2] University of Aberdeen, College of Physical Sciences, Department of Chemistry, Trace Element Speciation Laboratory Aberdeen (TESLA), Meston Walk, Aberdeen AB24 3UE, Scotland, UK
[3] Helmholtz-Centre Geesthacht, Institute of Coastal Research, Marine Bioanalytical Chemistry, Max-Planck Str. 1, 21502 Geesthacht, Germany

Strontium isotopic analyses by either TIMS or MC ICP-MS of in vivo incorporated environmental signatures (aka 'biosphere fingerprint') in human and animal skeletal remains have been widely used in anthropology and archaeology to trace residential changes, mobility or living conditions. Often the in vivo isotopic signature in bone and teeth is distorted by cumulative physical, chemical and biological alteration during burial which leads to exchange and/or addition of strontium from the burial environment (soil, water) – referred to as diagenesis. A well-preserved biogenic Sr signal is crucial for a reliable evaluation of historic migration (paths) using $^{87}Sr/^{86}Sr$-analysis. Thus, localizing biogenic areas and the spatial extent of diagenetic alteration is essential. So far there is no sufficiently satisfactory method to differentiate between diagenetically changed and biogenic regions in bones or teeth.
Herein we present the first results of the comparison between solubility profiling and bioimaging of archaeological bone to assess in vivo $^{87}Sr/^{86}Sr$ ratios of the biogenic material. Bioimaging was performed to spatially resolve the extent of diagenesis on bone cross-sections by simultaneous mapping diffusion profiles of $^{87}Sr/^{86}Sr$ ratios and the concentrations of Sr and elements of non biogenic origin (Ba, Pb, U) using laser ablation split stream ICP-QMS and MC ICP-MS [1].
In order to generate accurate $^{87}Sr/^{86}Sr$ ratios LA MC ICP-MS data need to be corrected for matrix-based polyatomic interferences such as Ca dimers and $CaPO^+/ArPO^+$-clusters in addition to Rb and correction for instrumental isotopic fractionation.
Preliminary results show diffusion gradients of trace elements originating from the repository material along with a change in the Sr isotopic composition which can be related to diagenetic processes. Subsequent imaging by ArcGIS allows the selection of areas of minor diagenetic alteration by using selected thresholds.

Within a pilot study initial measurements of the diagenetically altered bones were performed by near infrared hyperspectral imaging (NIR HSI). The preliminary results of the Principle Components Analysis of the HSI pictures already indicates differences correlated with the diagenetic changes identified by the biomapping, which shows the potential of NIR HSI in the context of monitoring diagenesis.

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[1] T. Prohaska, J. Irrgeher and A. Zitek, "Simultaneous multi-element and isotope ratio imaging of fish otoliths by laser ablation split stream ICP-MS/MC ICP-MS", J. Anal. At. Spectrom., 2016, Advance Article, DOI: 10.1039/c6ja00087h.