Application of Trace Element and Sr Isotope Analyses to Anthropological and Groundwater Research

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Historically, Sr isotope analysis of biological and geological samples have been conducted by TIMS (thermal ionization mass spectrometry); although, the latter technique produces extremely accurate and precise data, it is in fact a labor-intensive and time-consuming technique. Sr isotopic measurement by solution mode MC-ICP-MS greatly increases sample volume throughput with little (if any) detriment to the quality of individual analyses (compared to TIMS). Recent studies have also reported reliable Sr isotope measurements and elemental concentrations within geologic and biologic samples at high spatial resolution using various LA-(MC)-ICP-MS instrument configurations. The relatively rapid nature of an individual laser ablation Sr isotope analysis (i.e. minutes) could possibly revolutionize (if successful) the manner in which migration studies of ancient civilizations are conducted.

Sr isotope analysis of human tissue has proven to be an important tool for examining ancient human migration patterns. The development and activities of ancient polities are the subjects of much anthropological inquiry. Exploring population dynamics during significant sociopolitical changes allows for a more thorough understanding of those involved in the power relationships of these ancient interactions. In areas where the geological variability is sufficient, strontium isotope ($^{87}Sr/^{86}Sr$) analysis has proven to be a successful technique to address questions of archaeological significance regarding the interactions of societies such as Roman period mobility in Britain and Europe and the movements of the Wari, Inca, and Tiwanaku in South in addition to numerous other past cultures. Dental enamel from faunal remains is used to examine variability in strontium sources in seven regional sites; human enamel samples are analyzed from eight Nile Valley sites in order to trace human movements. The faunal samples show a wide range of $^{87}Sr/^{86}Sr$ values demonstrating that some animals were raised in a variety of locales. The results of the human samples reveal overlap in $^{87}Sr/^{86}Sr$ values between Egyptian and Nubian sites; however, Egyptian $^{87}Sr/^{86}Sr$ values (mean/median [0.70777 ±0.00027]) are statistically higher than the Nubian $^{87}Sr/^{86}Sr$ values (mean [0 .70762], median [0.70757 ±0.00036], suggesting that it is possible to identify if immigrant Egyptians were present at Nubian sites. Samples examined from the site of Tombos provide important information regarding the sociopolitical activities during the New Kingdom and Napatan periods. Based on a newly established local $^{87}Sr/^{86}Sr$ range, human values, and bioarchaeological evidence, this study confirms the preliminary idea that immigrants, likely from Egypt, were present during the Egyptian New Kingdom occupation of Nubia.

The second case study involves reporting high precision Sr isotope determinations and trace element analyses for water samples retrieved from the coastal region of Benin in order to help delineate the interaction between groundwater and surface water. Understanding the incursion of saltwater within the Godomey Well Field is critical since the Well Field supplies drinking water for the city of Cotonou.