

Enamel biomarker for assessing and tracing heavy metal exposure

J.E. ERICSON¹, A. RINDERKNECHT¹, T.J. CHAN¹,
M.T. KLEINMAN² AND G.E. MILLER³

¹Environmental Health, Science, and Policy, UC Irvine,
Irvine, CA, USA (jeericso@uci.edu, arinderk@uci.edu,
tjchan@uci.edu)

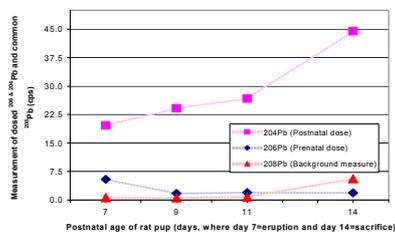
²Community and Environmental Medicine, UC Irvine, Irvine,
CA, USA (mtkleinm@uci.edu)

³Chemistry, University of California, Irvine, Irvine, CA
92697-7070, USA (gemiller@uci.edu)

New Biomarker Method

We report on a new enamel biomarker for assessing and tracing heavy metal exposures with application to forensic geochemistry: The enamel crystals record a longitudinal record of ambient exposure to heavy metals, analogous to growth rate recorded in tree rings. Ion probe mass spectrometry (IMS) and laser ablation inductively coupled mass spectrometry (LAICPMS) have been used to reconstruct Pb and Mn exposures relative to Ca and Fe, respectively.

Pb isotopic tracers were used to demonstrate first principles of deposition and kinetics of Pb absorption in an animal model. Our IMS results are shown in figure below.



Instrumental neutron activation analysis (INAA) was conducted to measure Mn concentrations in target tissues in a controlled inhalation and ingestion experiment. Brain Mn was significantly associated with tooth concentrations ($R^2=0.64$).

We report on strontium isotopic characterization of enamel as a geochemical tracer, having forensic applications.

Environmental isotope forensics of perchlorate

NEIL C. STURCHIO¹, J. K. BÖHLKE², JUSKE HORITA³,
BAOHUA GU³, GILBERT M. BROWN³ AND
PAUL B. HATZINGER⁴

¹University of Illinois at Chicago, Chicago, IL 60607, USA

²U. S. Geological Survey, Reston, VA 20192, USA

³Oak Ridge National Laboratory, Oak Ridge, TN 37381, USA

⁴Shaw Environmental, Lawrenceville NJ 08648, USA

Widespread occurrence of perchlorate in surface water bodies and ground water aquifers has been recognized in recent years. This perchlorate, which may have both anthropogenic and natural sources, can be problematic because the highly soluble perchlorate anion is relatively inert and difficult to remove by conventional water treatment methods. Stable isotope ratios of Cl and O can potentially be used to distinguish the source(s) of perchlorate in a given location, and to evaluate the extent of biodegradation. However, few data yet exist regarding the stable isotopic composition of perchlorate from anthropogenic and natural sources. Before isotopic forensics of perchlorate can be widely applied, further isotopic characterization of perchlorate sources is necessary.

The stable isotope ratios of Cl and O in anthropogenic perchlorate salts can now be readily measured in milligram amounts, but it is difficult to extract and recover isotopically measurable amounts of perchlorate from natural waters in which perchlorate concentrations may be in the ppb range. The recent development of a new class of bifunctional anion exchange resins for efficient sorption and removal of perchlorate, along with a new resin regeneration technique for recovering sorbed perchlorate, provides a means for nearly quantitative recovery of perchlorate from water samples collected in the field for isotopic analysis.

We have begun a systematic characterization of the stable isotope ratios of Cl and O in perchlorate from different sources, starting with anthropogenic perchlorate reagents and natural perchlorate-bearing salt deposits. Preliminary results indicate that there are significant isotopic differences between anthropogenic and natural perchlorate sources, and that microbial perchlorate reduction has a large kinetic isotope effect. When the data set of isotopically characterized perchlorate sources becomes sufficiently representative, stable isotope forensics of perchlorate may become useful for resolving issues of source apportionment, natural attenuation, or monitoring of remediation efforts.