OFFICIAL ABSTRACT and CERTIFICATION

Modeling Uranium Uptake in Fossilized Teeth and Bones: Insight into Potential for Long-Term Uranium Waste Storage in Phosphates

Ethan Sontarp

Commack High School, Commack, NY, USA

Oxidized uranium (U) is soluble in groundwater and can be incorporated in or adsorbed to porous materials it encounters in the environment. In the early stages of fossilization, mammal?teeth and bones provide this environment through bacterial decay and?mineralization of the previously living tissue. The purpose of this study is to?quantitatively model the uptake of uranium in porous biomaterials to 1) predict?age of fossilization for samples whose origin is unknown, and 2) to?understand the systematics of an exponential falloff uranium uptake in?phosphates in order to improve the function of nuclear waste remediation?tactics. Laser Ablation Inductively Coupled Plasma Mass Spectrometry?(LA-ICP-MS) was utilized to determine isotopic ratios and ultimately calculate?the isotopic age for a small elemental map spanning several of the hydroxyapatite-bearing biomaterials.?Uranium concentrations were in the thousands of ppm for sections of dentine?and under 100 ppm for sections of enamel. A model was devised based off the isotopic age?equation to describe the uptake history of uranium in several fossilized?biomaterials. Parameters for the model were described by an exponential fall?off of uranium (U) uptake, with the initial U being zero and lead (Pb) only being produced as a?product of decay. Simulated and measured data assured a?good fit for the model ' s predictive property. Conjugate gradient technique was utilized to?solve for local values of initial uptake, e-folding time, and predicted age, with the e-folding time for the bone sample being 1.3 Ma, and the tooth 0.9 Ma, respectively.?These provide insight into the process of uranium uptake in porous biomaterials to further the knowledge of nuclear waste sequestration, as both porous materials had a rapid uptake history. Porous phosphates are worthy materials for the remediation of high concentrations of uranium waste and are able to hold uranium for millions of years of time, even under destructive geological conditions.

Category
Pick one only—
mark an "X" in box
at right

- Animal Sciences ☐
- Behavioral & Social Sciences ☐
- Biochemistry ☐
- Biomedical & Health Sciences ☐
- Biomedical Engineering ☐
- Cellular & Molecular Biology ☐
- Chemistry ☐
- Computational Biology & Bioinformatics ☐
- Earth & Environmental Sciences ■
- Embedded Systems ☐
- Energy: Chemical ☐
- Energy: Physical ☐
- Engineering Mechanics ☐
- Environmental Engineering ☐
- Materials Science ☐
- Mathematics ☐
- Microbiology ☐
- Physics & Astronomy ☐
- Plant Sciences ☐
- Robotics & Intelligent Machines ☐
- Systems Software ☐
- Translational Medical Sciences ☐

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check ALL that apply):

   ☐ human participants ☐ potentially hazardous biological agents

   ☐ vertebrate animals ☐ microorganisms ☐ rDNA ☐ tissue

2. I/we worked or used equipment in a regulated research institution or industrial setting: ■ Yes ☐ No

3. This project is a continuation of previous research. ■ Yes ☐ No

4. My display board includes non-published photographs/visual depictions of humans (other than myself): ☐ Yes ■ No

5. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only ■ Yes ☐ No

6. I/we hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work. ■ Yes ☐ No

This stamp or embossed seal attests that this project is in compliance with all federal and state laws and regulations and that all appropriate reviews and approvals have been obtained including the final clearance by the Scientific Review Committee.