Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12724

What can lead isotopes in human bones tell us about changing exposure?

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Isotope techniques have long been used in the study of human skeletal remains to help determine places of origin, migration patterns, and nutritional status. Lead (Pb) isotopes are particularly well suited to identifying sources of environmental lead exposure because of the large and systematic variations in Pb isotope ratios. Human bones are similar to geological hydroxyapatite; they incorporate trace elements into their crystal lattice structure via substitution for major elements, and they may suffer mechanical weakness because of the crystal lattice defects caused by these substitutions. Yet biological hydroxyapatite is much more dynamic in its formation and dissolution than its geologic counterpart. Bone remodeling (the process of bone formation and resorption) happens throughout an individual's life in order to maintain biologically relevant blood levels of essential elements, but also to mitigate toxicity when the body is exposed to toxic metals, like Pb. As different bone types have different rates of remodeling (25-30 years for cortical bone, <10 years for trabecular bone) , there also exists the potential to determine an individuals exposure over different time scales.

This study utilized 60 femoral head bones resected during hip replacement surgery in Rochester, New York, USA, to determine the sources of lead incorporated into human bone, and potential changes in exposures over time. As all 60 patients lived most of their lives in the Rochester area, local geologic and anthropogenic sources of lead were considered as potential contributors to the overall Pb isotopic composition of the bone. The isotopic signatures of the studied femoral heads appears to be a mixture of anthropogenic sources and soil lead, and differences among patients of different ages, as well as between paired trabecular and cortical bone samples indicates a shift in the sources of Pb exposure over time. Though the exact sources contributing to the change in Pb isotope ratios in bones is difficult to delineate, the observed shift is not consistent with local natural geologic sources of Pb.