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Sr and Pb Isotopes for Tracking Human Historical and Ancient Migrations

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The identification of 'foreigners' in ancient burials is crucial to many archaeological theories of migration and colonisation. Traditionally this is done by analysing such things as skeletal traits, skull shape and burial goods, however, there is such a diversity of these factors within a population that they do not discriminate reliably between populations. The Sr and Pb content and isotope composition of human tooth enamel reflects the environment in which an individual developed. Teeth are composed of calcium phosphate, a carbonated hydroxyapatite mineral, often termed biological apatite, and renowned for its non-stoichiometry. There are two main tissues in a tooth: the hard, highly mineralised outer enamel and the softer, relatively organic-rich inner dentine. Once enamel is fully formed in the gums, the tissue-forming cells die, the blood supply is cut off and it looses the ability to regenerate. As a result, its composition is effectively fixed, locked into place in its tough crystal structure. Studies on archaeological teeth show that the enamel is resistant to alteration and it preserves Sr concentrations, within the range of life values (50-100 ppm), and $^{87}Sr/^{86}Sr$ values that reflect the diet of the person at the time when the tooth mineralised (in vitro for deciduous teeth and early childhood for permanent teeth). Dentine, however is clearly affected by burial and usually shows enriched Sr contents (200-600 ppm) and $^{87}Sr/^{86}Sr$ values close to, or within error of the burial environment. Lead behaves in a similar manner to strontium in terms of its ingestion and up-take in pre-metallurgical societies. With the advent of metal mining and smelting, however, new routes of lead ingestion were opened up and these reflected cultural habits and artefact use rather than the local geological sources. Pb was used in pipes, tableware, cooking pots and as a food and drink additive. Wine was sweetened either by being prepared in Pb-lined pans or later by addition of Pb acetate (sugar of lead). Lead compounds were used by women to whiten their faces and in modern times the lead in car exhaust and paint is the latest manifestation of anthropogenic pollutants. The resistant nature of enamel means that it withstands the effects of burial and diagenesis better than any other tissue type and preserves 'life' values of the isotopic composition. Used with archaeological data on lifestyle and diet, the data preserved in teeth provide valuable information about the different types of people in a burial site and their possible origin. For example, a tooth from a woman buried in a Neolithic site on the chalk gives a Sr isotope value of 0.710. The chalk has a value of c. 0.7075. The radiogenic nature of the Sr in this tooth demonstrates that this woman spent her childhood in an area with significantly more radiogenic soil that the chalk in which she was finally entombed. Pb data from the same tooth suggest an area near the Mendips is a likely site.

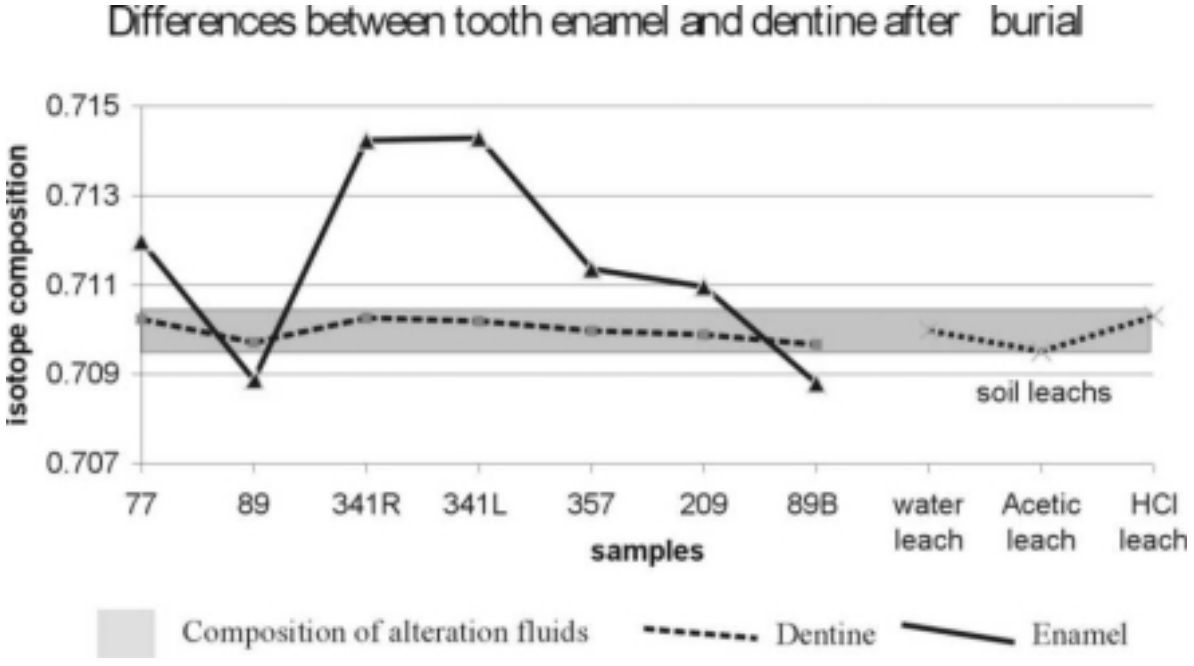

Figure 1: Differences in $^{87}Sr/^{86}Sr$ compositions of human tooth enamel and dentine after burial.