From conodonts and ancient oceans to fish bones and metal contaminant stabilization

J. WRIGHT

PIMS NW, Inc., 403 West Riverside Drive, Carlsbad, NM 88220, USA (judith@pimsnw.com)

Fish bone are the modern analogs of fossil apatite. The desire to find simple and inexpensive ways to effect environmental remediation of metal contaminants has led to the development of the patented use of fish bones (Apatite II™) for metal stabilization. Metal contaminants are pervasive in the modern environment, particularly Pb, Cd, Zn, Ni, Cu, Al, Sr, U and anthropogenic Pu. Processing of the wastes generated from production of fish for human and animal food provides Apatite II™, the unique nano-crystalline apatite of fish bones, which can then be used to stabilize metals leaching from soils at firing ranges, manufacturing facilities, battery sites, old pesticide practices as well as mine tailings wastes and depleted uranium from its production and use in war.

The application of fish bone for toxic metal stabilization originated in a detailed knowledge of conodont geochemistry. The apatite remains of conodonts hold the secrets of oceanic, tectonic, and environmental changes locked within the calcium phosphate crystal lattice. The information about trace element and isotopic signatures is 1) very useful for detailed interpretation and understanding of paleoecology, paleoceanography, paleogeography, radiometric dating of carbonate sequences, diagenetic history, economic resource exploration, and stratigraphy of Paleozoic sections, and 2) enables the imaginative extrapolation and successful application of conodont geochemistry to fish bones for the purpose of environmental remediation.

Conodont microfossil elements (left) and Apatite II™ from processed fish bones (right)

Preliminary study of fish bone using Raman spectroscopy

CHAOXIAN ZHOU[1] AND JILL PASTERIS[2]

Department of Earth and Planetary Sciences, Washington University, CB 1169, St. Louis, MO 63130 USA ([1]cxz@levee.wustl.edu, [2]pasteris@levee.wustl.edu)

Carbonated apatite is the major component of bone. Using Raman microprobe spectroscopy, we analyzed the biomineral characteristics of fish (salmon, halibut) bones, including spinal vertebrae and ribs, which we compared to analyses on mammal bone (bison jaw). From the Raman band positions, areas, and widths, we can identify components (e.g., phosphate, hydroxyl, collagen) in the whole bone and determine their relative concentrations, as well as evaluate the degree of atomic disorder in the solids. Carbonated apatite and collagen are the only compounds detected in the bone samples. OH was not detected in any bone (although this band is strong in enamel samples). For a given fish species, no differences were recorded in the components or their relative concentrations (see figure). However, there are interspecies difference (see figure): Halibut bone apatite has a higher carbonate concentration than salmon (inferred from area ratio of 1072 to 960 Δcm^{-1} bands) and shows a greater degree of atomic disorder (inferred from full width at half height of 960 Δcm^{-1} band). The salmon bones, especially the vertebrae, are spectroscopically very similar to the bison jaw bone. Among all of these samples, there is a positive correlation between carbonate concentration and degree of atomic disorder in the apatite. The measured collagen to apatite ratio varies up to 3-fold within an individual bone sample, but the collagen concentrations are indistinguishable among all the bones.