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$^{87}Sr/^{86}Sr$ analysis on Late Jurassic fish teeth. Implications for paleosalinity of fossil habitats

Alexander MUDROCH, Detlev THIES & Albrecht BAUMANN

Abstract

The study by SCHMITZ et al. (1991) of $^{87}Sr/^{86}Sr$ ratios in various Phanerozoic fishes led to the idea of testing this method on fish faunas from the Upper Jurassic of Germany and France. These faunas consist of microvertebrate remains. The Sr isotope results for the Kimmeridgian data from northern Germany are consistent with faunistic evidence that implies an environment of lower marine salinity. The high radiogenic content of the material from the Boulonnais, northern France (Kimmeridgian to Tithonian) contradicts the faunistic implications that point more probably to a genuine marine environment for the sampled periods. The possibilities of postmortem alteration of the measured $^{87}Sr/^{86}Sr$ ratios are discussed.

Introduction

Twenty years after the first proposal to take Sr isotopes as indicators of the marine or freshwater origin of some Paleozoic dipnoans and arthrodires (DASCH & CAMPBELL 1970), SCHMITZ et al. (1991) attempted to verify this assumption on various Phanerozoic fish fossils. They showed that, for most of the 38 samples they chose, the presumed habitat salinity could be corroborated by means of $^{87}Sr/^{86}Sr$ analyses. The only one they considered to be of freshwater origin, but which showed a marine signature instead was a sample of *Bothriolepis canadensis* from Escuminac Formation, Québec, Canada. A site which is better interpreted as representing a coastal marine (SCHULTZE 1972, SCHULTZE & ARSENAULT 1985, VÉZINA 1991) or brackish/estuarine environment (CHIDIAC 1989, 1996, HESSE & SAWH 1992). Very recently SCHMITZ et al. (1997) made another attempt to test the application of $^{87}Sr/^{86}Sr$ analyses as palaeosalinity indicators on various skeletal apatites from the early Tertiary of the southern U.S.A. They took material from marine, brackish and freshwater palaeoenvironments and found in comparison with Recent material, that despite a visible diagenetic overprint in some of their samples a certain amount of original Sr isotope signature containing the salinity information is still present.

The reason for using Sr isotopes is that they are not fractionated by the physiology of the organism and Sr is present as a trace element in nearly every biogenic material, because it substitutes Ca. In unaltered bioapatite of aquatic organisms the measured $^{87}Sr/^{86}Sr$ ratio mirrors the situation of the habitat water. The Sr isotopic composition of the diet is a factor mainly in continentally influenced environments. But why is the $^{87}Sr/^{86}Sr$ of freshwater and seawater different? Of the four stable isotopes of Sr-^{84}Sr (0.5 %), ^{86}Sr (9.5 %), ^{87}Sr (~7 %), ^{88}Sr (83 %) – only ^{87}Sr has a partly radiogenic portion gained from long term radioactive decay of ^{87}Rb (half-life: 4.88×10^{10}a, decay constant $\lambda 87_{Rb} = 1.42 \times 10^{-11} a^{-1}$, STEIGER & JÄGER 1977) and is therefore enriched in the upper crust. Continental weathering provides the fluvial systems with Sr which remains in solution until it reaches the sea, where it stays resident for a long time (ca. 10^6 a). Each fluvial system has its own typical $^{87}Sr/^{86}Sr$ ratio, but in general these ratios are above 0.71 (average world riverine ratio: 0.712; McARTHUR 1994). Marine ratios have been slightly variable throughout Phanerozoic time (VEIZER 1989), but lie in a narrow band between 0.7065 and 0.7095 (recent seawater value: 0.70922±4, McARTHUR 1994; Kimmeridgian seawater value: 0.70695±10, JONES et al. 1994), because in ocean waters the $^{87}Sr/^{86}Sr$ is equilibrated with mantle-derived hydrothermal Sr influx with values of around 0.703.

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