Synchrotron XRF Determination of Element Distribution in Fossilized Sauropod Bones

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Introduction

Sauropod dinosaurs were typically one order of magnitude larger than any other living or extinct terrestrial animal. The gigantism lead to scale effects in their biology and physiology, which still are only inadequately understood and subject to study in the DFG Research Unit “Sauropod Biology” (this is report no.21). Virtually the only remnants of the sauropods are their fossilized bones, which have sustained burial for 65 million years and thus experienced significant diagenetic changes due to interactions with the burial environment, which often do not affect bone preservation on the histological level, but, may result in significant alterations of the fossil bone microstructure.

In order to determine both qualitatively and even quantitatively the diagenetic effects on sauropod bones we employed different techniques such as SEM-EDX, PIXE, and synchrotron µ-fluorescence analyses (SR-µ-XRF).

Methods and Materials

Samples: Our investigation focused sauropod long bones from the Tendaguru sauropod fauna from the Upper Jurassic of Africa.

Samples of longbones of *Barosaurus africanus* and were taken by a core-drilling technique. The specimens are half cylinders that cover the whole bone cortex from the cancellous structure in the center to the primary fibrolamellar structure at the outside of the bone.

SR-µ-XRF: Synchrotron radiation induced micro-X-ray fluorescence analysis (SR-µ-XRF) in confocal geometry were carried out at the micro focus end-station Fluo-topo at the SR facility ANKA, Karlsruhe, Germany.

Results and Discussion

SR-µ-XRF measurements performed on the sample shown in fig. 1 revealed -beside those elements expected in the hydroxyapatite remains- also Mn, Fe, Cu, Zn, As, Pb, U, Sr and Y. The spatial distribution of these elements shows maxima of Ca, Mn, Fe and Cu concentrations within the vascular canals. A very high Ca concentration also occurs at the surface of the bone. X-ray and neutron diffractograms of bones from the same fossil bed showed that Ca mainly is incorporated as calcite into the bone and is observed as a deposit within the vascular canals.

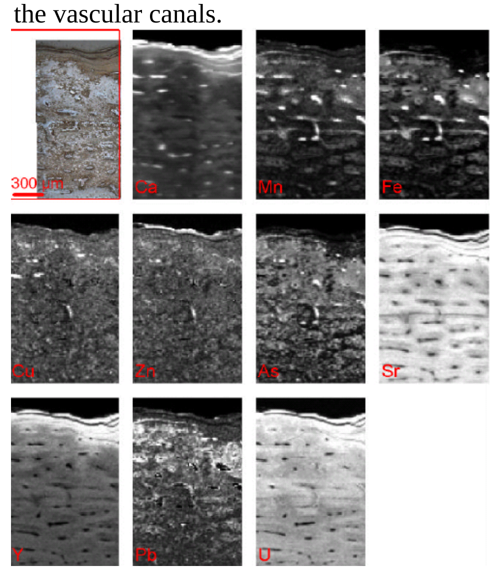

Fig. 1.: SR-µ-XRF element maps of the outer part of the Barosaurus africanus longbone cross-section

Fe and Mn are typical elements incorporated into the bone by diagenetic exchange with the environment. They are incorporated in oxides at the boundary of the calcite filled vascular canals and the smaller lacunae.

Sr and U are known as bone seeking elements. Sr substitutes Ca in the former hydroxyapatite, U is incorporated into the bone as complex of the Uranyl ion by diffusion and subsequent adsorption. Pb enters the fossilized bone both by ion exchange of the former hydroxyapatite with the environement and as a decay product of U. Y also appears to be incorporated into the apatite by ion exchange.

A comparison of the distribution of the bone seeking elements Sr, Y, U and Ca (fig.1) shows that at the periosteal surface of the bone, calcite fills voids between layers of the lamellar bone.

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