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Micro-Raman and other spectral studies on dinosaur fossils

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Keywords: dinosaurs, Raman identification, elemental and chemical group mappings

Introduction

Dinosaurs had been once living beasts which played very distinguished role inside whole animal world before they became extinct 65 Ma ago. Paleontologists find recently many remains joined to dinosaurs. The fragments of bones and teeth prevail in the material due to much greater resistivity of hard tissues in comparison with soft tissues. However, it is strong controversy whether the hard tissues are more or less original apatite sample or not the geological cast. The significant diagenesis changes were noticed in discovered material. Still another problem is preservation of soft tissues. Some announcements inform that such matter was found in special conditions.

Figure 1. Fragment of the bone under scrutiny. It is a top part of 6.5 kg weight, cut off from the whole preserved bone of weight of 820 kg.

Our sample is the fragment of hip of unidentified dinosaur, most probably sauropod, found in Jurassic Morrison Formation, Colarado and Utah states. It is dated on Upper Jurassic, but not later than 147 Ma. The formation is famous of the dinosaur discoveries which occurs even contemporarely. The whole fossil involves the fragments which can be initially described as the fossilized remains or casts of the bone, muscles, fat and skin. The aim of the paper was the determination of different phases and potential coupling them to the anatomical parts mentioned and looking for potential organic material preserved. We cut off some strips of the sample and they were one-sided polished with corundum .

Devices

- Dispersive Raman Microscope InVia manufactured by Renishaw with exciting laser 785 nm.
- X-RAY FLUORESCENCE XDV-SDD manufactured by Fischerscope.

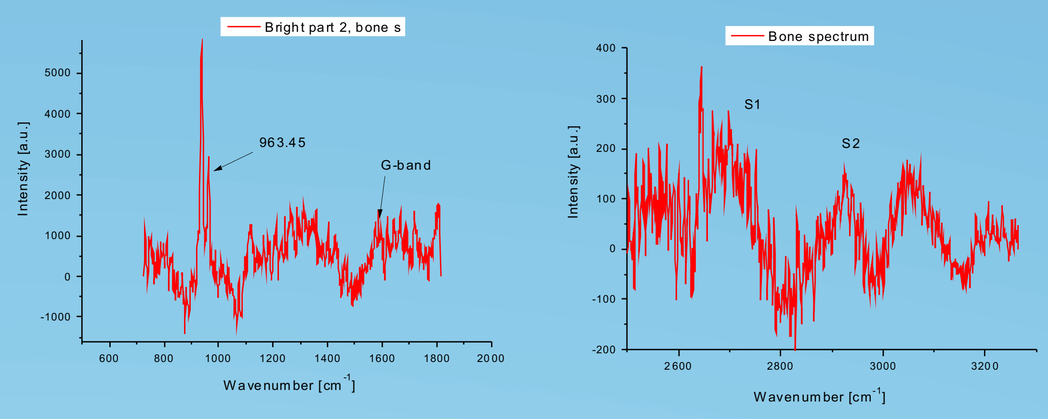

Figure 3. Raman spectra of the dinosaur bone. One can see the bands corresponding to transformed organic matter, tones G and S_1 and S_2 (acc. Beyssac *et al.*). The signal of apatite is clearly visible.

Raman measurements were interesting. Due to the presence of many compounds the spectra were very complicated. The fragment over 2500 cm-1 was most informative. S1 and S2 tones were signed, according to Brissac to some forms of graphite or another transformed organic matter.

Conclusions

The fragment of well-preserved bone was investigated with X-ray Fluorescence Spectroscopy. Mappings indicated that we have two distinct materials - one enriched in apatites, second one with hematite and silica, they differ also in porosity. The fragments once existing organic matter were detected with Raman microscopy. It is difficult to decide at this stage of studies whether the organic matter is original one or metamorfized one (most probable version according to spectra) or microbially transformed one.

Results

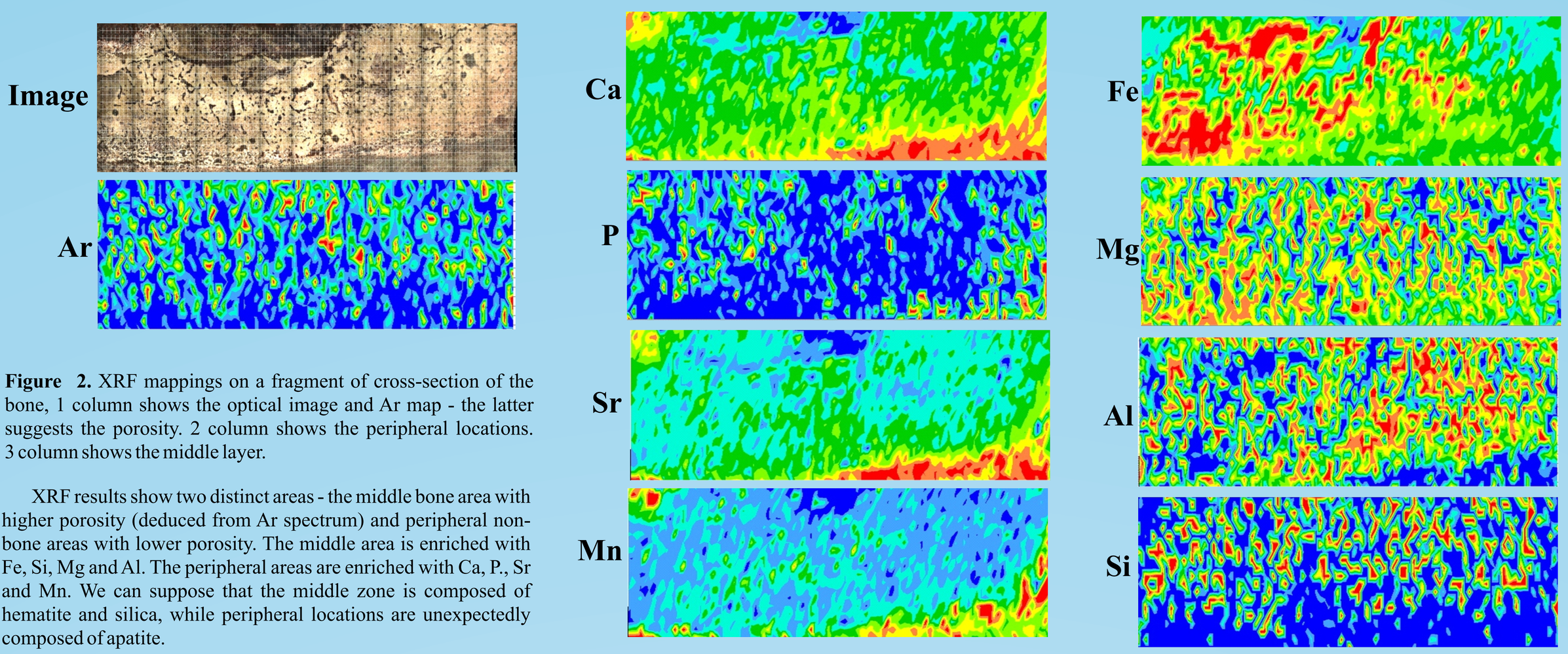

Figure 2. XRF mappings on a fragment of cross-section of the bone, 1 column shows the optical image and Ar map - the latter suggests the porosity. 2 column shows the peripheral locations. 3 column shows the middle layer.

XRF results show two distinct areas - the middle bone area with higher porosity (deduced from Ar spectrum) and peripheral non-bone areas with lower porosity. The middle area is enriched with Fe, Si, Mg and Al. The peripheral areas are enriched with Ca, P., Sr and Mn. We can suppose that the middle zone is composed of hematite and silica, while peripheral locations are unexpectedly composed of apatite.

References

[1] G. Piga, A. Santos-Cubedo, A. Brunetti, M. Piccinini, A. Malgosa, E. Napolitano, S. Enzo. Palaeogeogr. Palaeoclim. Palaeoecology 2011, 310, 92.
[2] M.H. Schweitzer, W. Zheng, C.L. Organ, R. Avci, Z. Suo, L.M. Freimark, V.S. Lebleu, M.B. Duncan, M.G. Vander Heiden, J.M. Neveu, W.S. Lane, J.S. Cottrell, J.R. Horner, R.C. Cantley, R. Kalluri, J.M. Asara. Science 2009, 324, 626.
[3] J.M. Asara, M.H. Schweitzer, L.M. Freimark, M. Phillips, L.C. Cantley. Science 2007, 316, 280.
[4] J.D. Harris, P. Dodson. Acta Palaeontol. Polonica 2004, 49, 197.
[5] O. Beyssac, J.-N. Rouzaud, B. Goffe, F. Brunet, Ch. Chopin. Contr. Mineral. Petrology 2002, 143, 19.

This work was also partly supported by EU-PL project (No. POPW.01.03.00-18-016/12-00) in the frame of the Operating Programme ("Development of Eastern Poland" 2007-2013) co-financed by the European Regional Development Fund.