Experimental Report

Proposal: **1-03-28** **Council:** 10/2012

Title: Gland detection in glyptodont bones

This proposal is a new proposal

Researh Area: Biology

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Samples: (Ca10(PO4)6(OH)2)

Instrument	Req. Days	All. Days	From	To
IN1	3	3	07/06/2013	10/06/2013

Abstract:

The glyptodont belongs to the group of placental mammals. Very few specimens were found in Argentina and Uruguay exhibiting a protrusion, as an inverted spherical cap over the shell. It is not clear yet, if this protrusion corresponds to some injury made by some aggressor or if it is a cavity for accommodating some gland. The last assumption would give rise to a new species of glyptodont. Scanning electron microscopy and computed tomography have been performed on samples taken both from the “normal” part of the shell and from the protrusion. These results show cavities on the protrusion part of the shell that could belong to gland channels, that could be the pipes for the transport of the production of the gland allocated into this protrusion. It is critical to explore if these cavities are really the channels of a gland and Neutron Vibrational Spectroscopy could give information about their functionality. So in order to analyze in detail the mineral and organic content (mainly hemoglobine, with a principal band at 3500 cm-1) of these normal and protrusion parts, an Inelastic neutron scattering experiment on LAGRANGE is proposed. For this study we ask for 3 days of beamtime.

Gland detection in glyptodont bones

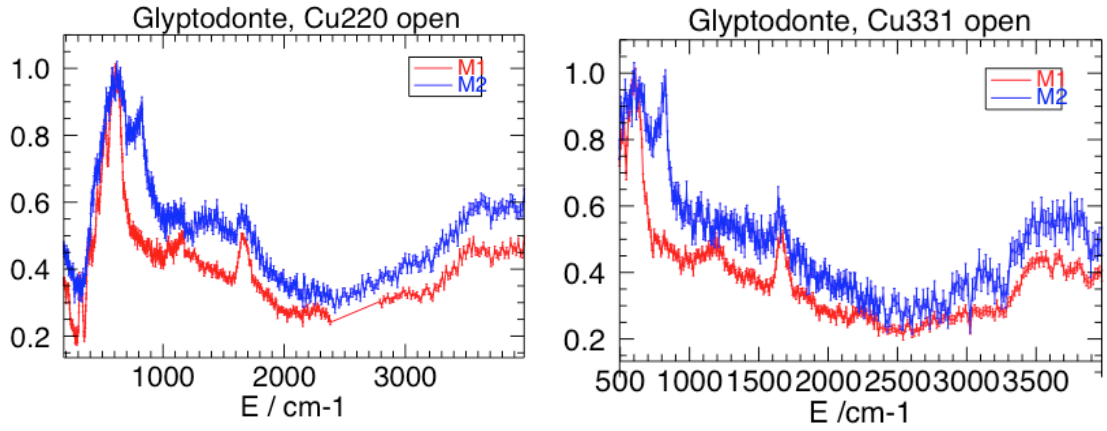
The glyptodont belongs to the group of placental mammals known as Xenarthra and lived in Argentina, Uruguay and Brazil until they migrated to the north. The average glyptodont had a length around 3 m and a weight around 3 tons. However, a few specimens found in Argentina and Uruguay exhibits a protrusion as an inverted spherical cap over the shell. It is not clear yet, if this protrusion corresponds to some injury made by some aggressor or if it is a cavity for accommodating some gland. The last assumption would give rise to a new species of glyptodont. Indeed, if this protrusion protects a gland, this fossil could correspond to a new older species of glyptodont or simply to a different species than the more common ones [1]. Consequently, the aim of these measurements was to gather key information for revealing whether a new species of glyptodont existed prior its extinction. Hemoglobine (Hb) is a protein type of the blood, which has between other function, the transport of the oxygen [2]. In this way the detection of hemoglobin on the channels could reveal its functionality as a gland. In order to analyze in detail the mineral and organic content of these normal and protrusion parts, Neutron Vibrational Spectroscopy by means of inelastic neutron scattering experiments (Lagrange) has been performed.

For these measurements, two pieces of glyptodont bone (labeled M1 and M2 on Fig. 1) were ground to a fine powder. M1 corresponds to the normal shell and M2 to the protrusion with masses 282 and 453 mg respectively.

Figure 1: Glyptodont shell: M1 area corresponds to the normal shell and M2 to the protrusion.

Neutron vibrational spectra were recorded at T=5K on the recently commissioned IN1-Lagrange hot neutron spectrometer (Lagrange). The incident energy on this spectrometer is varied stepwise, and it is selected by Bragg scattering from different monochromators (two Cu and one Si). In this work, the incident frequency range 216-3500 cm^{-1} was covered with the double-focused Cu(220) reflexion, giving a high flux but a moderate instrumental resolution of ~ 3 % ($\Delta E_i/E_i$). The neutrons scattered by the sample are focused on a single counter of He^3 by a reflecting surface built around the vertical sample-detector axis from pyrolitic graphite crystals set to reflect neutrons at a final energy of 4.5 meV. The cooled Be filter is installed after the sample to remove higher-order harmonics in the analyzer reflections. In such experimental conditions, the accessible energy-transfer range was 180-3500 cm^{-1}.

The spectra were recorded at 5 K, to decrease the mean-square amplitude of the atoms, $\langle u^2 \rangle$, and thus to sharpen the bands.



INS spectra measured with the high energy resolution configuration by using the Cu220 (left) and Cu331 (right) monochromator.

The main band at ~600 cm-1 corresponds to the OH libration of the apatite. The band at ~3500 cm-2 corresponds to the OH stretch of the apatite that is much more intense on the IR data. The main difference between samples correspond to the band that appears at ~800 cm-1 and another one (broad, so probably more than one band) at 1400 cm-1 on the M2 sample.

[1] Principles of Paleontology, Michael Foote, Arnold I. Miller, Pub. W. H. Freeman, 2006, San Francisco.

[2] S. Wraya, M. Copeb, D. T. Delpyb, J. S. Wyattc, E. Osmund, R. Reynoldsc, Biochim. et Biophys. Acta (BBA) – Bioenergetics. 933 (1988) 184.