ESRF	**Experiment title: 3D imaging of bone mineral content using dual energy synchrotron radiation microtomography**	**Experiment number:** LS479
Beamline: ID19	**Date of experiment:** from: 16 nov 96 to: 18 nov 96	**Date of report:** 28 february 97
Shifts: 6	**Local contact(s):** José BARUCHEL	*Received at ESRF:* 04 MAR 1997

Names and affiliations of applicants (* indicates experimentalists):

Francoise PEYRIN* (CREATIS, ESRF)
Peter CLOETFNS* (ESRF, EMAT)
Gerard GIMFNEZ (CREATIS)
Gilles PEIX* (CNDRI)
Murielle SALOME-PATEYRON* (CREATIS, ESRF)
Anne-Marie LAVAL-JEANTET (CREATIS)
Michel AMlEL (CREATIS)

CREATIS, CNRS UMR 5515, affiliated to INSERM, INSA 502, 69621 Villeurbanne Cedex, FRANCE.
CNDRI, INSA 303, 69621 Villeurbanne Cedex, FRANCE.
EMAT, RUCA, Antwerp, BELGIUM

Report:

So far, we only investigated trabecular bone samples from a structural point of view using 3D x-ray absorption computed microtomography (CMT). The purpose of this new experiment was to perform quantitative measurements of bone mineral density, in terms of hydroxyapatite concentration, using CMT.

The microtomography set-up was similar to the one which we used to image human vertebrae samples (proposal LS382), it included a rotation stage to scan the sample in the monochromatic beam and a CCD based 2D detector. The detector consisted of a high resolution Gd_2O_2S:Tb screen converting X-rays to light, light optics performing an optical magnification of 2.86 and the FRELON CCD camera. The pixel size in the image was 6.65 µm.

The first step of the experiment consisted in calibrating the acquisition set-up and the tomographic reconstruction program. The calibration measurements were performed on phantoms with different concentrations in hydroxyapatite (from 50 mg/cc to 1500 mg/cc). The linear attenuation coefficient of the phantoms was first measured at 20keV and 35keV and is plotted as a function of hydroxyapatite concentration in figure 1. Four phantoms (50 mg/cc, 150 mg/cc, 500 mg/cc and 1500 mg/cc) were imaged in three dimensions using CMT. 2D slices of two different samples are presented in figure 2. These phantoms which are conventionally used for the calibration of medical scanners with coarser spatial resolution turned out to be very inhomogeneous at the scale of our imaging system because they contained air bubbles and the dimensions of some hydroxyapatite particles were more than 300 µm. Therefore, an average linear attenuation coefficient was calculated on the whole reconstructed volume to calibrate the tomographic reconstruction program.

A foetus vertebra was then scanned using the same set-up at 20 keV and 35 keV. A 3D image was reconstructed at each energy and we are currently working on deriving the hydroxyapatite concentration within the sample from those images. The same 2D slice of the vertebra at each energy is presented in figure 3.

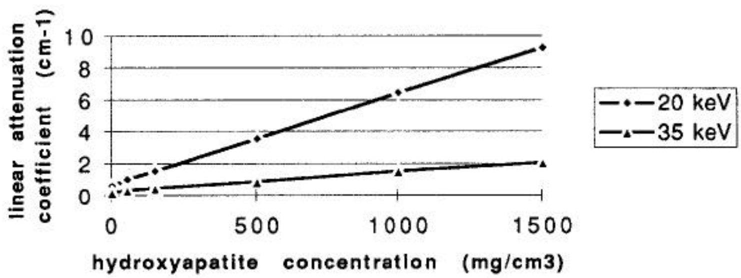
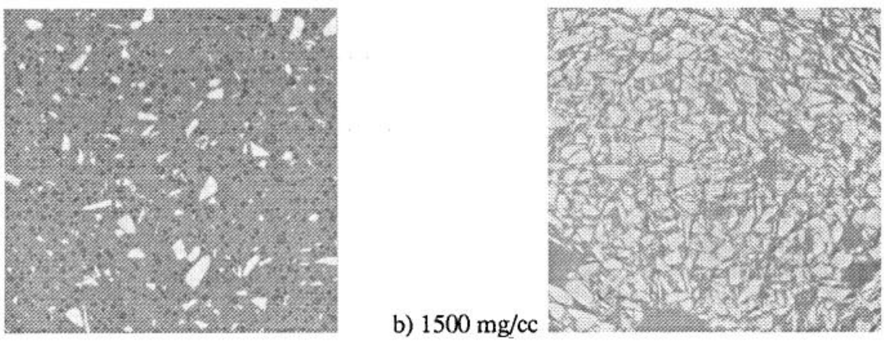
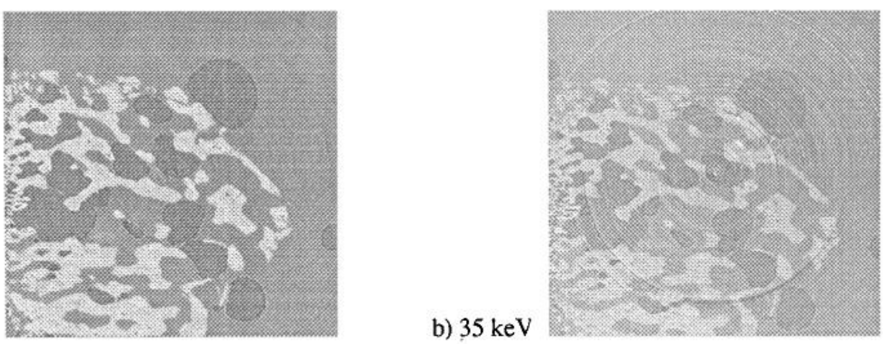


Fig 1 : Linear attenuation coefficient of the phantoms plotted as a function of hydroxyapatite concentration.



a) 500 mg/cc b) 1500 mg/cc

Fig 2 : 2D tomographic reconstructions (3.4 mm x 3.4 mm) of calibration phantoms with different hydroxyapatite concentrations at 20keV



a) 20 keV b) 35 keV

Fig 3 : 2D tomographic reconstructions (3.4 mm x 3.4 mm) of a foetus vertebra at 20 keV and 35 keV.