

# ***EFFECTS OF SURFACE DETERMINATION AND THRESHOLDING IN ASSESSING TRABECULAR BONE PROPERTIES IN THE PALAEOSCIENCES***

Kimberleigh Tommy <sup>\*1,2</sup>, Amelie Beaudet <sup>†3</sup>, Julia Galway-Witham<sup>4</sup>, and Kudakwashe Jakata <sup>‡1</sup>

<sup>1</sup>Evolutionary Studies Institute, University of the Witwatersrand, South Africa

<sup>2</sup>School of Anatomical Sciences, University of the Witwatersrand, South Africa

<sup>3</sup>School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand

<sup>4</sup>Natural History Museum, London

**Keywords:** x-ray tomography, thresholding, palaeontology, trabecular bone

**Summary:** We have studied the morphometric indices obtained from trabecular bone whilst adjusting the surface determination and thresholding on the histogram. This has been done using VGStudio and the results will be compared with scanning electron microscopy (SEM) experiments.

## **1. INTRODUCTION**

In laboratory based computed tomography (CT), a polychromatic beam of X-rays is incident on a sample placed on a rotating stage. The different materials making up the sample absorb different intensities from the incident beam based on their mass and electronic densities. From this, we obtain radiographic projections from which we can obtain a histogram, figure 1a, showing how the materials making up the sample interact with the X-ray beam.

The CT technique has found use in the reconstruction of the locomotor behaviour of extinct species which represents a major challenge in the palaeosciences. In particular, in the absence of complete skeletons and soft tissues, biomechanical interpretations of fossil specimens primarily relies on isolated and/or incomplete postcranial remains. Imaging techniques significantly improve the quality of data delivered by the fossil record and allow non-invasive access to a bones inner structure. One such application involves the characterization of the trabecular network in key-regions of the skeletons which have been demonstrated to offer insight on the locomotion behaviour in extant and extinct primates [1,2,3]. The following variables are commonly assessed for site-specific textural characterization of the volumes of interest extracted from the trabecular bone: the trabecular thickness (TbTh), spacing (TbSp), the bone volume fraction (BV/TV), and the degree of anisotropy (DA) [3]. These parameters can be influenced by surface determination and thresholding and makes this assessment of great importance [4].

We have investigated the effect of varying the thresholding limits on the morphometric indices obtained from using the software VGStudio. These results will be compared with measurements obtained using scanning electron microscopy (SEM) which are currently underway.

## **2. EXPERIMENTAL METHOD AND RESULTS**

A small piece of bone with dimensions of  $18\text{mm} \times 11\text{mm} \times 1\text{mm}$  with both cortical and trabecular bone was cut and then CT scanned at 70 kV and  $120 \mu\text{A}$ , see figure 1b below. The volume used for the analysis excluded the cortical bone. A Nikon XTH 225/320 LC dual source industrial CT scanner was used. 2000 projections were acquired and reconstruction was carried out using CT Pro 3D. A volume was selected for analysis using VGStudio max in order to determine the morphometric indices such as trabecular bone thickness, and spacing. Surface determination was then carried out using the same parameters for all thresholding limit selections.

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\*e-mail: Kimberleigh.Tommy@wits.ac.za

†e-mail: Amelie.Beaudet@wits.ac.za

‡e-mail: Kudakwashe.Jakata@wits.ac.za

Some of the results obtained using VGStudio are shown in table 1 below. The percentage change in the surface determination from the material peak and the effect on the measured trabecular bone spacing (TbSp), trabecular bone thickness (TbTh), and the ratio of bone volume to total volume (BV/TV) are tabulated. It has been observed that there are significant changes in these results with variations in surface determination.

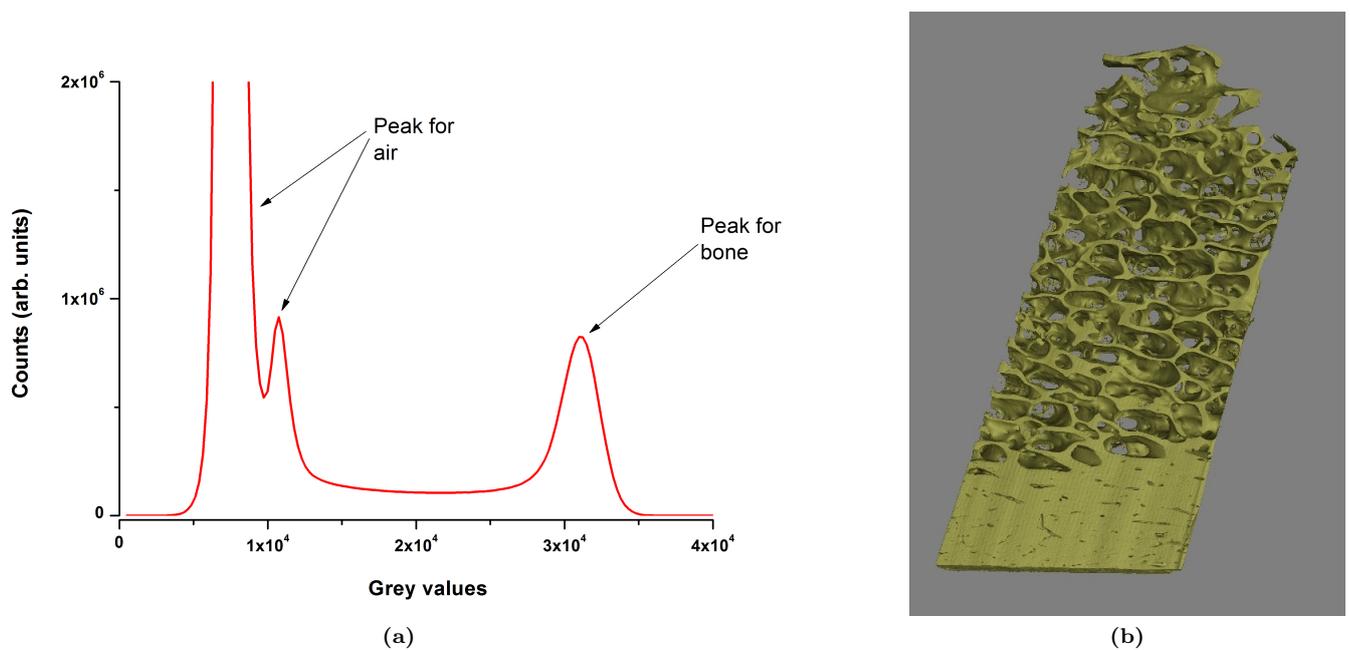
In our paper, we will discuss these results obtained using VGStudio and compare them to the ones obtained using Avizo and also ImageJ. We will also look at the results obtained from SEM experiments on the same sample.

Surface determination	TbSp (mm)	TbTh (mm)	BV/TV
15%	173	8.0	0.04
30%	154	8.3	0.05
50 %	133	8.8	0.06

**Table 1:** Table of trabecular bone spacing (TbSp), thickness (TbTh) and ratio of bone volume to total volume (BV/TV).

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**Figure 1:** (a) Histogram of the projections showing the absorption characteristics of the different materials of the sample. (b) Cow bone sample used for thresholding analysis.