

## **Experiment Report Form**

**The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.**

Once completed, the report should be submitted electronically to the User Office via the User Portal:

<https://www.esrf.fr/misapps/SMISWebClient/protected/welcome.do>

### ***Reports supporting requests for additional beam time***

Reports can be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

### ***Reports on experiments relating to long term projects***

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

### ***Published papers***

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

### **Deadlines for submission of Experimental Reports**

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

### **Instructions for preparing your Report**

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.



	<b>Experiment title:</b> Investigation of development and locomotor performance in the Malapa hominin postcranium: a new South African Plio-Pleistocene site.	<b>Experiment number:</b> EC 522
<b>Beamline:</b> ID19	<b>Date of experiment:</b> from: 24/2/2010 to: 27/2/2010	<b>Date of report:</b>
<b>Shifts:</b> 9	<b>Local contact(s):</b> Dr. Paul Tafforeau	<i>Received at ESRF:</i>
<b>Names and affiliations of applicants</b> (* indicates experimentalists):		
<b>Prof. Lee Berger</b>		
<b>Dr. Paul Tafforeau *</b>		
<b>Dr. Kristian Carlson</b>		
<b>Dr. Tea Jashashvili</b>		

## Report:

### 1. Aim of the proposal

In August 2009, my colleagues and I submitted a proposal to image postcranial remains of a new hominin recently discovered from the site of Malapa in the Cradle of Humankind. At the time, material from the site was still being analyzed and studied. It was clearly Plio-Pleistocene based on associated fauna, but little else was known of its geochronological age. It was unclear upon initial discovery whether the hominin fossils should be attributed to *Australopithecus africanus*, *Homo (habilis)*, or whether the material belonged to a new taxon. The primary aim of the experiment was to assess bone histomorphometric variables of long bone diaphyses in the individual represented by the partial skull (MH 1). The secondary aim was to digitally extract postcranial elements from remaining surrounding matrix, restore fragmentary specimens, and aid in further study of its postcranial (e.g., locomotor) adaptations.

### 2. Current status of the project

In February 2010, we successfully scanned long bone material that was attributed to the juvenile male (MH 1). Subsequently, additional material has been recovered and attributed to this individual, while some material previously attributed to this individual (e.g., the distal

half of a well-preserved tibia) is no longer attributed to MH 1. Results of the imaging conducted at the ESRF led to much better visualization of external and internal anatomy than results obtained from previous acquisitions using medical computed tomography.

### *2.1 Reconstruction of locomotor behavior*

The relatively intact tibia that was originally assigned to MH 1 has been reassigned to a different (adult) individual subsequent to acquisition of the synchrotron image data. Nonetheless, attempts to quantify/visualize its internal bone microstructure, as proposed, were largely unsuccessful. While a few areas of its diaphysis retained some intact histomorphometric structure, most of the internal structure of this particularly promising specimen, as well as others from the site of Malapa that have been investigated thus far, showed disorganized osteonal structure. It appears that subsequent to deposition organisms (likely bacterial in nature) disrupted osteonal organization through taphonomic processes while accessing the organic components of long bone shafts. However, a metacarpal shaft from a non-adult individual was found to preserve pristine osteonal organization. It is presently unclear whether this specimen should be attributed to MH 1, or to another non-adult individual. These results have contributed to a better understanding of the taphonomic history of the Malapa fossil assemblage.

In a second research thrust aimed at reconstructing locomotor behaviour of *A. sediba*, cross-sectional geometric properties of MH 1 humeral and femoral shafts have been calculated using synchrotron image data (Carlson et al. in prep). The images acquired using synchrotron technology were of much greater quality than previous ones obtained using medical computed tomography, which was necessary to accurately visualize and quantify internal cortical boundaries in MH 1 femoral specimens. Initial indications are that the forelimb to hind limb strength ratios of MH 1 were more similar to later *Homo* (e.g., *H. erectus*) than even *H. habilis* (see Carlson et al., 2010). The forelimb to hindlimb strength ratio of MH 1 also appears more similar to that estimated for Lucy (*A. afarensis*) and those of modern humans compared to those of chimpanzees.

### *2.2 Post-cranial developmental patterns in A. sediba*

Synchrotron-based imaging of the postcranial remains of MH 1 has contributed to a better understanding of patterns of growth in *A. sediba* (e.g., epiphyseal fusion sequences). The acquired synchrotron image data have proven useful when assessing relevant metaphyseal surfaces of fossil long bones. The analysis of MH 1 epiphyseal closure patterns is still ongoing.

### *2.3 Comparison of dental and postcranial development*

This analysis, or set of comparisons, has been delayed by the ongoing analyses of separate dental and postcranial development. Once these are published, the degree of concordance between the two sets of indicators can be investigated further.

## **3. Future work plan**

### *3.1 Additional functional investigations of long bone structure*

Thus far, a metacarpal shaft from a non-adult individual has been shown to retain osteonal organization. This specimen is presently being studied, and results will be published once necessary comparative data have been acquired. Through the investigation of the specimen, we may be able to address loading patterns on the palmar and dorsal sides of the hand of the individual, perhaps giving some indication as to how the upper limb functioned during grasping behaviours (e.g., how frequent was below branch position behaviour).

### **Current list of publications in journals and conferences**

Carlson, K.J., Wrangham, R., Muller, M., Sumner, D.R., Morbeck, M.E., Nishida, T., Yamanaka, A., Boesch, C. (2010) The locomotor repertoire of early *Homo*: insights from chimpanzee variation. American Journal of Physical Anthropology 141 (suppl. 50): 76. Published abstract for a conference presentation given at the American Association of Physical Anthropologists 79<sup>th</sup> annual meeting, Albuquerque, NM, USA.

### **In prep manuscripts**

Carlson, K.J., Churchill, S.E., Berger, L.R. Locomotor adaptations in the limbs of *Australopithecus sediba*. Currently being prepared for a general science journal of high impact.