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MONASH BIOMEDICINE DISCOVERY INSTITUTE

1 May 2017

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Clarification of export permit Case ID 9890:
Sampling of hominin dentition (*Australopithecus africanus, Paranthropus robustus* & early *Homo*) from the Ditsong collection for stable isotope, trace element analysis and electron-spin resonance

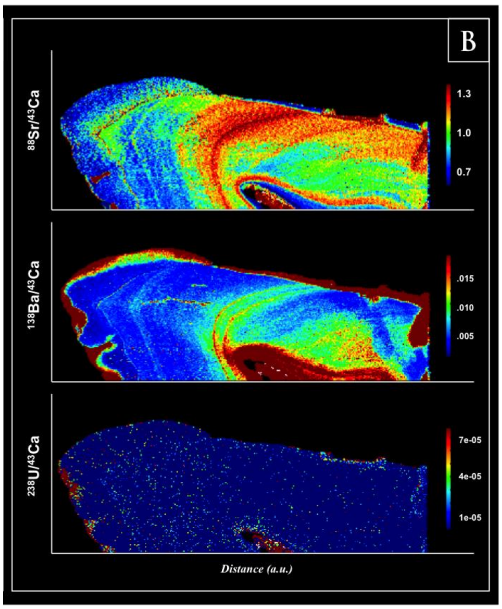
We appreciate the questions raised of our original application for permission to export fossil hominin teeth for sampling. We are happy to provide the following additional information and hope that if any further clarification is required that we can provide it for a positive support of the application. We apologise for the delays in our response but both university holidays and research travel have prevented an earlier response.

1. Photographs of each specimens with indication of how they would be affected and details of any previous destructive analysis;

See the attached document following our written response with detailed pictures with descriptions of previous damage that we have been able to observe and information about which parts of these specimens will be affected with the new analyses.

2. A detailed description of the methods and sample preparation related to the trace element analysis. The reference provided indicates that the tooth will be sectioned, i.e. cut vertically in half.

In order to successful map the tooth for trace element and isotopic distribution, we need to obtain a flat surface of the enamel and dentine. The analyses on itself is virtually non-destructive. The laser ablation tracks are shallow lines not deeper than 10microns (i.e. 15 times smaller than the width of a human hair). We will use a LA-MC-ICPMS Thermo Neptune Plus to measure the Sr isotopic ratio and LA-ICPMS Agilent 8900 for trace element mapping. Maps are created by parallel shallow ablation tracks of 100microns wide and 10 microns deep that once put together represent the distribution of each trace element.



Example of fossil ape tooth mapped for trace element distribution using LA-ICPMS Agilent 8800, (100width x10 deep microns).

For all specimens that were already cut in half (*KB5223*, *SK24605*, *SK96*, *SKX268* and *SKX334*, see picture below) with exposing dentine and enamel, no further preparation will be conducted, therefore no visible damages will be done to the teeth, only non-visible shallow laser ablation tracks.

For the remaining 5 samples *SKW14*, *SKX257*, *SKX258*, *STS28* and *STS51*, each tooth will be cut vertically in half (see picture below) using a diamond wire saw of 80 microns (i.e. about half the width of a human hair), to minimise the loss of material, leaving a smooth flat surface ready for analysis. After, mapping is completed, the tooth can easily be glued back together leaving minimal to no visible damages to the specimen.

3. Clarification is required with regard to ESR-dating and U-series work.

The initial research study was intended to answer one main gap of knowledge, early life history of South African hominins, in particular the development and weaning process in the difference species, as well as a secondary question refining the timing of hominins occurrence of 39 specimens by accurate direct US-ESR dating. With only 10 specimens available, we must reprioritise our study to answer the most important aspect of our intended research, the trace element and isotopic mapping for early life history reconstruction, and exclude completely the U-series and ESR dating of the specimens.

4. Clarification is required with regard to the proposed stable isotope work and how it will contribute to our understanding of South African hominins.

The initial research study was intended to answer one main gap of knowledge, early life history of South African hominins, in particular the development and weaning process in the difference species, as well as secondarily fine tuning the timing of hominins occurrence with 39 specimens accurately directly dated. With only 10 specimens available, we must reprioritise our research to answer the most important aspect of our intended research, the trace element and isotopic mapping, and exclude the U-series and ESR dating of the specimen.

Because first molar eruption is not correlated with weaning age in living great apes, the timing of dental development is not going to be an ideal indicator of hominin breastfeeding patterns. Breastfeeding is an important life history trait critical to developmental and reproductive rates (Austin et al., 2013), not accessible by any other means than geochemical analyses of the enamel.

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Our recent work was the first to accurately describe breastfeeding patterns of a Neanderthal child (Austin et al., 2013), giving important information of the species development pattern and social interaction. To access this hidden information, we have demonstrated that by mapping the distributions of strontium (Sr) and barium (Br) in teeth, we are able to highlight important features of the early life history such as birthmark (timing of Molar development), breastfeeding patterns, weaning period as well as stress related bands. The same methodology will be applied for the **first time** to Plio-Pleistocene hominins from South Africa, giving an incredible insight into the discrepancy or similarities of the different species.

Elemental maps will provide insights into incorporation and potential diffusion patterns of each element, and help us to account for diagenetic processes using rare earth elements. We will use barium (Ba) and strontium (Sr) to describe hominins' dietary pattern and to reconstruct the breastfeeding sequence (Austin et al., 2013). Finally, the strontium isotope ratios will allow us to better understand the diet variations, potential migration pattern, and the trophic level of each specimen.

In order to do so, we have selected 10 teeth out of the 39 specimens that should offer the best chance to give insight of each species early life history.

Specimen	**Taxon**	**Locality**	**Tooth**	**Status**
STS 28	*Australopithecus africanus*	Sterkfontein	upper LM1?	almost intact
STS 51	*Australopithecus africanus*	Sterkfontein	lower RP3	almost intact
SK 96	*Paranthropus robustus*	Swartkrans	lower roots Ldm1	fragments
SK 24605	*Paranthropus robustus*	Swartkrans	lower M1	fragment
SKW 14	*Paranthropus robustus*	Swartkrans	Indet.	almost intact
SKX 257	*Homo sp.*	Swartkrans	lower M1	almost intact
SKX 258	*Homo sp.*	Swartkrans	M1	almost intact
SKX 268	*Paranthropus robustus*	Swartkrans	upper RM1	various fragments
SKX 334	*Homo sp.*	Swartkrans	upper RM1	fragment
KB 5223	*Paranthropus robustus*	Kromdraai	lower RM1	half crown

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Again, we hope that we have sufficiently addressed the questions raised in our original application. Please feel free to contact us directly should any further questions arise. We would note that we are hopeful that this response can be acted on prior to the onset of our next South African fieldseason (commencing in 5 weeks) to allow for the export of the nominated specimens, particularly given this application has been in process for nearly a year at this point.

Sincerely,

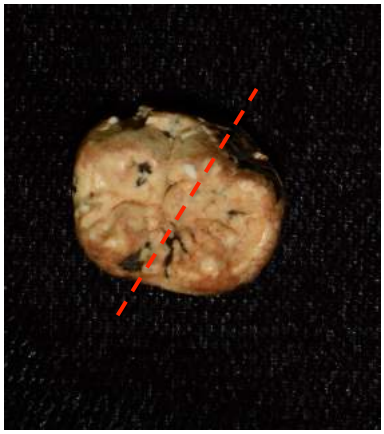
Justin W. Adams
Deputy Director
Senior Lecturer
Centre for Human Anatomy Education
Department of Anatomy and Developmental Biology

KB5223
Sample already cut in half exposing enamel and dentine. No further damages

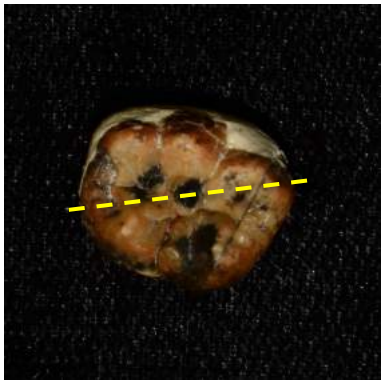
SK96
Sample already cut in the middle exposing enamel and dentine. No further damages.

SK24605
Sample already cur in half exposing enamel and dentine. No further damages.

SKW14
Sample broken, missing one fragment. Sample will be resectioned (red line) to expose the dentine and enamel.



SKX257
Sample is intact and will be sectioned (red line) to expose the dentine and enamel.

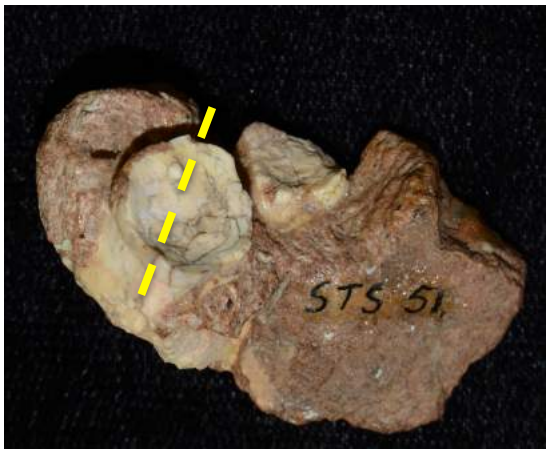


SKX258
Sample is intact and will be sectioned (yellow line) to expose the dentine and enamel.

SKX268
Sample already fragmented and cut in half exposing enamel and dentine. No further damages.

SKX334
Sample already cut in half exposing enamel and dentine. No further damages.

STS28
Sample is intact and will be sectioned (yellow line) to expose the dentine and enamel.



STS51
Sample is intact, and will be sectioned (yellow line) to expose the dentine and enamel.