Application to sample and permanently export non-biological material from human remains.

April 2022

**RE: application for permanent export of material for strontium isotope analysis**

Dear committee members,

I would like to thank you for the careful consideration of the application to sample and permanently export strontium from dental elements for isotope analysis at the University College Dublin. To address your comments:

* After coming to the conclusion that the Lancaster Mine (UP series) individuals would not generate enough data for publication, we decided to expand the project and sample material from the Koffiefontein Mine (K series; 6-25) to shed light on South Africa’s migrant labour system and industrialisation.
* The samples will be destroyed in the process of isolating the strontium using strong acids. Ultimately the strontium will be transported in 5mL vials in aqueous solution. The vials will be wrapped in parafilm to prevent any unlikely leakage. The samples will no longer be biological material.
* Please find the list of requirements below.

Sincerely,

Linda Mbeki

**Applicant (name and affiliation): this is usually the museum curator!**

Prof Ericka L’abbé/Okuhle Sapo

University of Pretoria

Department of Biological Anthropology/

Forensic Anthropology Research Centre

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**Applied for (principal researcher):**

Linda Mbeki

**Participants with affiliations, email addresses, phone numbers (& their role):**

1) Dr Grant Hall, University of Pretoria, grant.hall@up.ac.za, 073 173 1196.

Role: Stable isotope laboratory, oversee collagen extraction and C, N, and O analyses.

2) Dr Petrus le Roux, University of Cape Town, petrus.leroux@uct.ac.za, Department of Geological Sciences, 021 650 4139 (office)/4806 (lab), oversee isolation of strontium.

3) Dr David van Acken, University College Dublin,

Role: Senior Technical Officer, Earth sciences, oversee strontium analysis david.vanacken@ucd.ie, +353 1 716 2326.

4) Dr Robin Feeney, University College Dublin,Anatomy Department.

UCD School of Medicine, Robyn.Feeney@ucd.ie +353 1 716 6620

Role: Host, collaborator.

5) Professor Ericka L’Abbé, ericka.labbe@up.ac.za 012 420 3111

Department of Biological Anthropogy.

Role: Project supervisor/advisor/facilitator

6) Dr Wendy Black, wblack@iziko.org.za 021 481 3883

Role: Project supervisor/advisor/facilitator

The material will be \_\_\_\_**Couriered**\_\_\_\_\_\_\_(hand-carried or couriered) to \_\_\_**University College Dublin**\_\_\_\_\_ (facility/institution) in \_\_\_**June 2022**\_\_ (month, year) by \_\_ **Linda Mbeki**\_\_\_\_\_ (name of a**nalysed as very small amounts will be used**\_\_\_\_\_\_\_\_ (leave blank if same person as above).

\_\_\_\_\_\_**Linda Mbeki**\_\_\_\_\_\_\_\_\_\_\_ (name) will be involved with the \_\_\_sampling, laboratory work, and analysis\_\_\_\_ (e.g., transport/scanning) of objects and \_\_ **preparation of samples for strontium analysis will be performed at the University of Cape Town. Strontium isotope analysis will be carried out at the University College Dublin. Nitrogen/carbon, and carbon/oxygen isotope analyses will be performed at the University of Pretoria** \_\_\_**The strontium will be in aqueous solution in 5mL centrifuge tubes**\_(whatever else)

**Institution incl. address that currently hosts the object:**

University of Pretoria

Forensic Anthropology Research Centre

Prinshof 349-Jr

Pretoria,

0084

**Facility incl. address at which the experiment will be done:**

University of Pretoria

Stable Isotope Laboratory

Lynnwood Rd,

Hatfield,

Pretoria,

0002

University of Cape Town

Department of Geological Sciences

Rondebosch

Cape Town

7700

UCD School of Earth Sciences,

Science Centre West

University College Dublin

Belfield, Dublin 4, Ireland.

**Table of samples to be analysed:**

|  |
| --- |
| **Koffiefontein Mine (1895/6) (excavated 1996) individuals and elements for which sampling authorisation is requested** |
|  |  |  |  |  |  |
|

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Individual** | **Element** | **Quadrant** | **Dentine** | **Enamel** | **Rib bone** |
| **K1** | M1 | UR | Y | Y | Y  |
|  | M2 | UR |   | Y |   |
| **K2** | M1 | UL | Y | Y | Y  |
|  | M3 | UR |   | Y |   |
| **K6** | M1 | UR | Y | Y | Y  |
|  | M3 | UL |   | Y |   |
| **K7** | M2 | UL |   | Y | Y  |
|  | M3 | UL |   | Y |   |
| **K8** | M1 | UL | Y | Y | Y  |
|  | M3 | UL |   | Y |   |
| **K9** | M2 | UR |   | Y | Y  |
|  | M3 | UR |   | Y |   |
| **K10** | M2 | UR |   | Y | Y  |
|  | M3 | UR |   | Y |   |
| **K11** | M1 | LL | Y | Y | Y  |
|  | M3 | UR |   | Y |   |
| **K12** | M1 | UR | Y | Y | Y  |
|  | M3 | UR |   | Y |   |
| **K13** | M1 | LL | Y | Y | Y  |
|  | M3 | LL |   | Y |   |
| **K15** | M1 | LL | Y | Y | Y  |
|  | M3 | LL |   | Y |   |

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|  |  |  |  |  |  |

**Lancaster Mine (Krugersdorp) individuals and elements sampled (1895-1914)**

**(excavated 2002)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Individual | Lab code | Mass (Sr) | Mass (C/O) | Rack position | Element  |
| UP 52 | UP 1 | 8mg | 5mg | A1 | UL |
|   | UP 2 | 8mg | 5mg | A2 | UR |
|   | UP 3 | 8mg | 5mg | A3 | UR |
| UP 54 | UP 7 | 8mg | 5mg | A7 | LL |
|   | UP 8 | 8mg | 5mg | A8 | LL |
|   | UP 9 | 8mg | 5mg | A9 | LL |
| UP 55 | UP 10 | 8mg | 5mg | A10 | LL |
|   | UP 11 | 8mg | 5mg | B1 | LL |
|   | UP 12 | 8mg | 5mg | B2 | LL |
|  UP 59 | UP 20 | 8mg | 5mg | B10 | UL |
|   | UP 21 | 8mg | 5mg | C1 | UL  |
| UP 60 | UP 22 | 8mg | 5mg | C2 | LL |
| UP 61 | UP 25 | 8mg | 5mg | C5 | LL |
|   | UP 26 | 8mg | 5mg | C6 | LR |
|   | UP 27 | 8mg | 5mg | C7 | LL |
| UP 63 | UP 31 | 8mg | 5mg | D1 | UR |
|   | UP 32 | 8mg | 5mg | D2 |  |
| UP 64 | UP 34 | 8mg | 5mg | D4 | LL |
|   | UP 35 | 8mg | 5mg | D5 | LL |
|   | UP 36 | 8mg | 5mg | D6 | LL |

**Time frame:**

# Transport to \_\_Dublin: National Centre for Isotope Geochemistry

\_\_\_\_\_\_\_\_\_\_\_\_\_ (facility): \_\_\_\_**8/6/2022**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(date)

Return date: \_\_\_\_\_\_**8/9/2022**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (date)

**Aim/rationale:**

This academic study will be the first to simultaneously utilise the strontium, oxygen, carbon, and nitrogen isotope systems to elucidate the individual and group migration and dietary histories of labourers on the gold and diamond mines, thus gauging the effect of colonial contact and the migrant labour system on African communities. Moreover, labourers from other parts of the country will be subjected to the same analyses to assess the impact the labour demands of the mines had on other communities in South Africa. The determination of the extent to which labourers from African polities migrated (strontium and oxygen isotopes) prior to contributing to South Africa’s industrialisation in the late 19th century is important as the structure of South Africa’s economy has not changed significantly since. As the name states, the economy relied heavily on the movement of (cheap) labour. In the Witwatersrand, deep-level mining required a large workforce. The mine owners, the Rand Lords, worked together with the British administration to keep costs down and profits high. The different forms of labour — enslaved, indentured and migrant—are part of a 350-year continuum which saw colonial administrations exploiting local and foreign migrant workers.

Movement between areas with different underlying geologies can be determined by strontium and oxygen isotope analyses applied to different dental elements. Dietary histories (carbon and nitrogen isotope systems) will give an indication of changes in nutrition and food resource exploitation before and after migrating (Lancaster individuals, Gladstone individuals, and the Koffiefontein Individuals).

My research in the National Archives suggests a diet of maize meal, sorghum, maize, and red meat. The lack of mention of fresh fruit and vegetables for workers is conspicuous. Comparing isotope data with pathology studies published by other bioanthropologists, and archival research will enrich our understanding of mine labourers’ lives as individuals, and as a group.

We wish to apply strontium and oxygen isotope analysis to the enamel of individuals’ three molars that develop at discrete times in one’s life. A timeline of migration can be recorded from before birth till early adulthood. Dietary histories determined from dental enamel, bone, and dentine will complement these migration histories as they too are an indication of how lives changed when labourers arrived on the Rand.

**Methodology (short):**

Dietary histories can be determined from carbon and nitrogen isotope analyses of dentine and ribs. The former reflects diet in the years prior to death, and the former, diet in early life. The root fragment is removed with a cutting disc attached to a mini rotary tool. Demineralisation of bone and teeth with dilute acid followed by isolation of collagen and analysis to give an indication of the protein portion of diet.

Enamel (5mg) is pretreated with dilute bleach (optional), dilute acetic acid, agitated, then centrifuged. The sample is then replaced with ultrapure and this “washing” is repeated until neutrality. The pretreated sample is dried and subjected to carbon and oxygen isotope analyses. The carbon isotope data will give an overview of the consumption of all macronutrients – protein, lipids, and carbohydrates. Oxygen isotope data can yield information about the environment in which individuals lived such as altitude and distance from the ocean. This information complements strontium isotope data when plotted together.

Inorganic strontium is isolated after passing the enamel through an ion exchange resin and nitration. Once dry, the sample is loaded onto a filament and loaded into the thermal ionisation mass spectrometre which gives high resolution isotope ratio data that can reflect the underlying geology of the place of residence at the time of development of a dental element.

**Confirmation/permit by museum**:

UP: Authorisation to sample secured

**Damage/destructive analysis? (if yes, explain in detail)**

The sampling procedure is indeed destructive, however less than 15mg of dental enamel is required from a sampled tooth. Using a HCl/Ultrapure water cleaned diamond tipped burr (1mm) attached to a mini rotary tool, a tooth is abraded until a dull white surface is revealed. Pure enamel is then collected on clean weighing paper and transferred to a 1.5mL mini centrifuge tube for further processing and analysis. With this small amount of sample, important data can be collected, especially about migration which characterised the South African (slave/indentured/migrant) economy for more than 300 years.

The removal of a root fragment and processing, along with a rib fragment, is also destructive, however, once again the information derived from carbon/nitrogen data is invaluable, providing us with dietary histories which can be compared to written sources. It is certain that workers’ food culture changed once they moved to the mining camps. This change represents a significantly different way of life of the workers.

**Statement why this study cannot be done in South Africa:**

Most parts of this study will be carried out in South Africa, such as the collagen and bioapatite preparation and analyses of carbon, nitrogen, and oxygen. The preparation of the enamel samples for strontium isotope analysis will also be carried out in South Africa. The strontium isotope analysis will be carried out at UCD because the university has a Thermal Ionisation Mass Spectrometre. Data from this machine allows us to report values to 10-5. This is the order of magnitude that is standard when publishing in bioarchaeological journals. The precision that is possible with this spectrometre is high which makes analyses on this machine desirable.

Moreover, I have managed to secure funding from UCD to carry out the analyses. Working with individuals in South Africa and Ireland is mutually beneficial because as collaborators with different expertise and contributions we can publish our data in renown journals.