Developing an Isoscape for Human Provenance: Pilot Study Results on the Effect of Formaldehyde on Strontium Isotope Values

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1 INTRODUCTION

- Stable isotopes have shown considerable promise as a tool to aid in human identification through estimating the geographical origin, or provenance, of biological material [1].
- Provenancing of biological materials requires a base-map of the isotope values for that region, known as an isoscape [2,3].
- Strontium, namely $^{87}Sr/^{86}Sr$ has shown considerable promise in provenance research.
- Strontium isoscapes are typically based on the underlying geology of an area. Strontium occurs in rocks and soils but is taken up by plants, animals and humans from the environment[4].
- Isoscapes from human tissues have been developed, but more research is required on extant populations and biological materials, especially in Africa.

2 OBJECTIVES

Study Goal

To establish an $^{87}Sr/^{86}Sr$ isoscape from human tooth enamel as a reference archive to estimate provenance in the Gauteng Province of South Africa

Pilot Study Goals

1. To establish the methodology for strontium istotope analysis from human teeth, using the NuSapprire MC-SF-ICMPS
2. To determine the effect of formaldehyde on strontium isotope values from donated bodies

3 METHODS

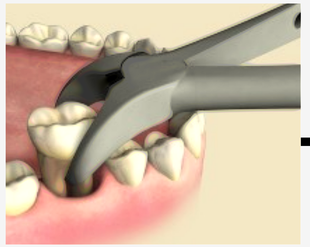

Fig 1. First molar extraction

Fig 2. Enamel drilling with 0.8mm tungsten carbide drill bit

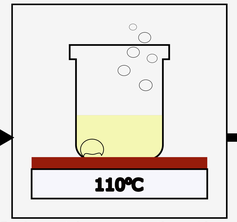

Fig 3. Leaching and digestion of powder sample

Table 1. Ion exchange protocol for Sr separation

Step	Acid	Volume
Wash	0.5 M HNO_3	4 mL
Condition	3 M HNO_3	2.5 mL
Load Sample	3 M HNO_3	1 mL
Matrix Elution	3 M HNO_3	2.5 mL
Sr Elution	0.5 M HNO_3	16 mL

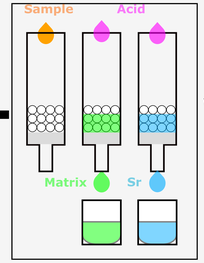

Fig 4. SrSpec resin ion exchange columns

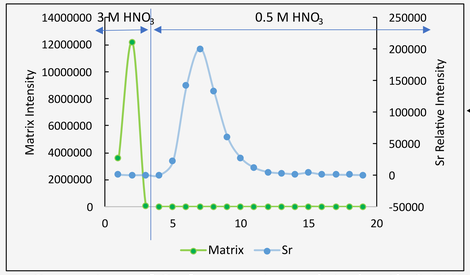

Fig 5. Separation of Sr from matrix, eluted with 0.5HNO_3

Table 2. $\delta^{88}Sr$ and $^{87}Sr/^{86}Sr$ literature values compared to the current study's standard results

Standard	Reference	$\delta^{88}Sr$, ‰	$^{87}Sr/^{86}Sr$
SRM1400	Brazier et al., 2019	-0.327	0.71308
	Zimmermann et al., 2019	-0.32	0.713089
	Romaniello et al., 2015	-0.32	0.713129
	Current Study A	-0.39416	0.714891
	Current Study B	-0.47355	0.714766
SRM1486	Brazier et al., 2019	-0.373	0.70931
	Current Study A	0.221423	0.711774
	Current Study B	-0.06891	0.711502

Fig 6. Analyses were perforemed using a NuSappire MC-SF-ICPMS in the School of Geosciences at Wits University

4 RESULTS

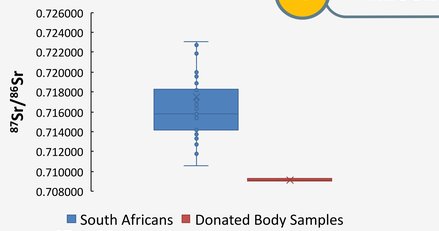

Fig 7. $^{87}Sr/^{86}Sr$ of local residents and donated bodies

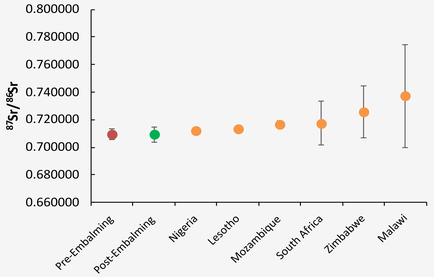

Fig 8. $^{87}Sr/^{86}Sr$ ratios of dental enamel for six countries and embalmed samples. Error bars are 2SD calculated from repeated measures

- $^{87}Sr/^{86}Sr$ ratios from first molar enamel of donated body samples fell outside the $^{87}Sr/^{86}Sr$ range of local South Africans
- No significant differences were found between Pre vs Post embalmed $^{87}Sr/^{86}Sr$ ratios (p=0.931)
- The results of the $\delta^{88}Sr$ values show some differences between the pre and post emalming values

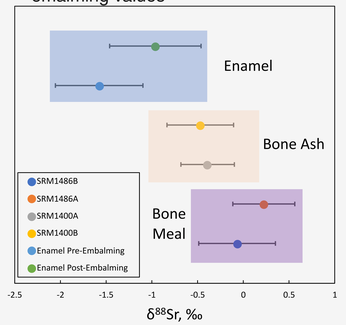

Fig 9. $\delta^{88}Sr$ values for enamel, bone ash and bone meal. Error bars are 2SD calculated on repeated measures of the same sample.

5 CONCLUSION

- The methodology and chemical calibrations show good yields of strontium but further refinement of the methodology would improve internal reliability.
- The results of this study suggest a negligible impact of formaldehyde but more research is needed
- The donated body samples strontium ratio match those of individuals from the UK - further investigation confirmed that the place of birth was the UK

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