Novel Applications of Trace Metal Stable Isotopes in Medical Research

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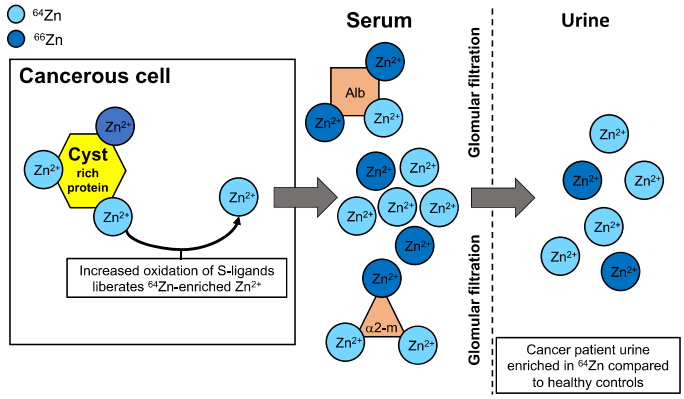
The application of multiple-collector inductively coupled plasma mass spectrometry (MC-ICP-MS) for trace metal stable isotope analyses is well established within the geochemical community, since inception of the technique about 25 years ago. The use of such instruments for high-precision isotope measurements in medical research has only just begun, however, and the scope of applications is vast.

In the human body, the concentrations of essential metals, such as iron, copper and zinc, are kept within the narrow range compatible with life. When a pathological disorder, such as cancer, disturbs this metal balance (homeostasis), this can trigger significant changes (fractionations) in the mass-dependent isotope compositions of the metals in affected tissues, as well as in blood and urine. The premise of research in isotope metallomics is that such changes can be harnessed to understand the role of metals in disease pathologies, as well as for disease characterisation, early detection and/or treatment monitoring.

This current project will specifically explore such applications and investigate Fe, Cu and Zn isotope variations that are associated with breast cancer and Alzheimer's disease.



Release of isotopically light Zn from cancerous cells, and subsequent transfer into the blood system. This ultimately leads to urine associated with lower δ^{66}Zn values for cancers of some secretory organs. Such changes in Zn isotope composition may be useful for non-invasive cancer detection (see Schilling et al., 2021).

The analytical work will be carried out in the clean room and mass spectrometry laboratories of the MAGIC Research Center at the Department of Earth Science & Engineering, Imperial College London (http://www.imperial.ac.uk/earth-science/research/research-groups/magic/). This encompasses sample preparation in the clean room facilities and high-precision isotope analyses with our three isotope ratio mass spectrometers.

The inter-disciplinary nature of the project implies that the successful candidate will need to communicate effectively with academic professionals from medicine, biology, and chemistry. Please don't hesitate to get in touch via email (markrehk@imperial.ac.uk and r.moore13@imperial.ac.uk) if you are interested or have further questions.

Selected literature:

Moore, R.E.T., Rehkämper, M., Maret, W., Larner, F., 2019. Assessment of coupled Zn concentration and natural stable isotope analyses of urine as a novel probe of Zn status. Metallomics 11(9), 1506-1517; doi.org/10.1039/C9MT00160C.

Sullivan, K.V., Moore, R.E.T., Capper, M.S., Schilling, K., Goddard, K., Ion, C., Layton-Matthews, D., Leybourne, M.I., Coles, B., Kreissig, K., Antsygina, O., Coombes, R.C., Larner, F., Rehkämper, M., 2021. Zinc stable isotope analysis reveals Zn dyshomeostasis in benign tumours, breast cancer, and adjacent histologically normal tissue. Metallomics 13, mfab027; doi.org/10.1093/mtomcs/mfab027.

Schilling, K., Moore, R.E.T., Sullivan, K.V., Capper, M.S., Rehkämper, M., Goddard, K., Ion, C., Coombes, R.C., Vesty-Edwards, L., Lamb, A.D., Halliday, A.N., Larner, F., 2021. Zinc stable isotopes in urine as diagnostic for cancer of secretory organs. Metallomics 13, mfab020; doi.org/10.1093/mtomcs/mfab020.