Imperial College London

Natural Environment Research Council

2024_26_ESE_RM: The transition metal isotope signatures of metalloproteins

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Transition metals are present in all organisms at trace quantities, with some essential for life. These metals are acquired by organisms from the environment and maintained under close internal control (homeostasis), to ensure they are available where needed whilst avoiding toxicity. In most organisms, trace metals are primarily present bound in and regulated by metalloproteins. Based on structural genomics, it has been estimated that up to a third of all proteins require metals to carry out their physiological function, with Zn alone present in 10% of all human proteins, amounting to about 3000 Zn metalloproteins.

Despite long-standing efforts, there is a severe lack of understanding about the role of specific proteins for controlling the homeostasis of different metals and the physiological role of metals for the functioning of organisms and their interaction with the environment. However, a number of recent investigations have shown that new constraints on the role of transition metals in organisms can be obtained from high precision isotope analyses of these elements. Such research in isotope metallomics is not only of fundamental interest but also of practical importance, for example (i) in plant sciences, to help breed crops that are fortified with essential metals but exclude toxic elements; (ii) in Earth sciences, as the isotope signatures of past biological activity recoreded in sediments can inform on past environmental conditions and changes; and (iii) in medical research, to develop potential new isotopic biomarkers for diseases such as cancer.

The key aim of this PhD project is to advance understanding about the role of metalloproteins in the handling of metals in organisms. This will be accomplished by laboratory-based studies, which characterise the metal stable isotope fractionations that are induced by metal-protein interactions using state-of-the-art methods that employ MC-ICP-MS (multiple collector inductively coupled plasma mass spectrometry). The studies will focus on the essential transition metals Zn and Fe as well as toxic Cd, as all three elements are of particularly wide-ranging interest. The project is deliberately described in broad terms, so that the research can be targeted to your specific research background and scientific interests in Earth, marine, plant and/or medical sciences. All analytical work will be carried out in the clean room and mass spectrometry facilities of the MAGIC Laboratories at the Department of Earth Science & Engineering, Imperial College London (http://www.imperial.ac.uk/earth-science/research/research-groups/magic/).

Applications from students with degrees in Earth, marine, biological and chemical sciences or equivalent qualifications are welcome. Please don't hesitate to get in touch via email (markrehk@imperial.ac.uk, r.moore13@imperial.ac.uk) if you are interested or have further questions.