Thank F for Ca: Novel methods for measuring Ca isotopes in biomedical samples with collision cell MC-ICPMS

J. LEWIS[1]*, C.D. COATH[1], A. HEUSER[2], A. EISENHAUER[2], J.B. SCHWIETERS[3] AND T. ELLIOTT[1]

[1]Bristol Isotope Group, School of Earth Sciences, University of Bristol, Bristol, UK, (*jamie.lewis@bristol.ac.uk)

[2] GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel Germany

[3] Thermo-Fisher Scientific (Bremen), Bremen, Germany

In recent years, and with the maturity of MC-ICPMS, non-traditional isotope geochemistry has expanded into several new areas with developing sub-disciplines. One of these emerging disciplines is the application of metal stable isotope analysis to biomedicine. Several exploratory and pilot studies having already identified a handful of elements whose isotopic systematics show potential for the detection and monitoring of disease in the body.

Of these elements, the isotopic composition of Ca in bodily fluids has been shown to be indicative of body Ca homeostasis and particularly sensitive to bone mineral loss e.g. in osteoporosis. However, analysis of Ca isotopes is a challenging endeavour. Bodily fluid samples present a complex, organic-rich, sample matrix where Ca is only present in minor concentrations (~100 µg/mL). This requires careful sample processing, often with multiple stages of chemical purification. Sample preparation, therefore, limits the potential for the high sample throughput needed for clinical studies. Calcium isotope analysis by MC-ICPMS is equally challenging. Typically, the major $^{40}Ca^{+}$ ion cannot be measured by MC-ICPMS due to the intense $^{40}Ar^{+}$ beam. Moreover, a range of isobaric interferences on the minor Ca isotopes must be mass-resolved or corrected for to make accurate and precise $\delta^{44/40}$Ca measurements.

We report on recent biomedically-focused Ca isotope work using Proteus, a prototype collision cell MC-ICPMS with mass prefiltering. We take a twin approach making use of calcium's strong chemical affinity for fluorine. First, we present a novel method for efficient chemical purification of Ca from complex sample matrixes. Second, we use Proteus' mass prefilter combined with SF_6 gas in the collision cell to mass-shift Ca^{+} to CaF^{+}, avoiding K^{+} and Sr^{++} interferences to make precise and accurate $\delta^{44/40}$Ca measurements on CaF^{+} ions. Combining these approaches produces a robust, high-throughput and scaleable workflow for Ca isotope analysis on biomedical samples to both detect the onset and monitor the treatment of diseases such as osteoporosis.