

ISOTOPIC ANALYSIS VIA ICP – MASS SPECTROMETRY: WHAT, HOW AND WHY.

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The course starts with a general introduction and reviews the various origins of natural variations in the isotopic composition of elements. The capabilities and limitations of various types of ICP-MS instrumentation for isotope ratio measurements are discussed. Attention is also devoted to instrumental bias caused by detector dead time and mass discrimination and approaches for correction for these biases are covered.

A next section focuses on applications relying on the quantification of induced changes in isotope ratios and includes elemental assay using isotope dilution and tracer experiments with stable isotopes to obtain a more profound insight into (bio)chemical reactions or physical processes.

Next, attention will be devoted to applications based on the natural variation in the isotopic composition of metallic and metalloid elements as a result of (i) the presence of radiogenic isotopes and (ii) isotope fractionation effects.

Isotopic analysis of elements with one (e.g., Sr) or more (e.g., Pb) radiogenic isotopes can be relied on for dating purposes (geochronology) as the parent radionuclide decays into the corresponding daughter nuclide with a characteristic half-life. The quite pronounced variation in the isotopic composition of the elements containing the radiogenic daughter can also be relied on in the context of provenancing – *i.e.* the determination of the geographical origin of, e.g., agricultural products, human remains or the raw products used in the manufacturing of objects of art.

It is now accepted that the isotopic composition of *all* elements with two or more isotopes can show natural variation as a result of isotope fractionation effects, *i.e.* the isotopes of an element do not take part with exactly the same efficiency to physical processes or (bio)chemical reactions. Both kinetic and thermodynamic isotope fractionation can occur and this leads to typically very small differences in the isotopic composition of the target elements. One area of application is the provenancing referred to above. As the extent of isotope fractionation is affected by the conditions prevailing when the physicochemical process is occurring, isotope ratios “stored” in historical archives (e.g., sediments, speleothems or ice cores) can also be used as paleoproxies, providing insight into the variation of conditions such as temperature, pH or atmospheric CO₂ levels over geological times.

Throughout the course, the basic principles and theoretical background of isotope ratio applications will be discussed and real-life examples will be used to illustrate their capabilities and limitations.