Use of LA-ICP-MS and MC-ICP-MS in a biomedical context

FRANK VANHAECKE[1]*, MAITE ARAMENDÍA[2], ANDREI IZMER[1], MARTÍN RESANO[2] AND LANA VAN HEGHE[1]

[1]Ghent University, Krijgslaan 281 - S12, Ghent, Belgium (*correspondence: frank.vanhaecke@ugent.be, andrei.izmer@ugent.be, lana.vanhege@ugent.be)

[2]University of Zaragoza, Pedro Cerbuna 12, Zaragoza, Spain (maiteam@unizar.es, mresano@unizar.es)

Solution nebulization ICP-MS was exploited since its commercial introduction in the 1980s for the analysis of body fluids. Also elemental speciation using a combination of a chromatographic or electrophoretic separation technique and ICP-MS as a very sensitive and element-specific detector was rapidly deployed in a biomedical context. However, for a long while, both direct analysis of solid materials using laser ablation LA-ICP-MS and isotopic analysis of metallic and metalloid elements using MC-ICP-MS largely remained the domain of geochemical applications. More recently however, also the capabilities of these approaches in a biomedical context are being discovered as will be illustrated in this presentation using applications from the UGent lab.

As a result of the laser beam dimensions (typically from < 5 to > 100 μm diameter) and the sub-μm penetration depth per shot, LA-ICP-MS is also suited for spatially resolved analysis of thin sections of entire small animals and/or selected body parts. By scanning such a section line per line, the distribution of a target element can be visualized in a map. It will be shown how this approach can be used for documenting the distribution of a Br-containing anti-tuberculosis drug across the body compartments of rat or the penetration of a Pt-containing chemotherapeutic drug in cancer tissue after intraperitoneal treatment.

MC-ICP-MS was relied on for isotopic analysis of the essential transition metals Fe, Cu and Zn in human whole blood and/or serum. The isotope ratio results obtained for a reference population were evaluated with the aim of revealing the influence of factors such as gender and feeding habits. A link between the Fe isotope ratio results and the parameters used to describe Fe status (among other, ferritin and transferrin levels) was established. Isotope ratio results obtained for blood from patient groups (e.g., hemochromatosis, anemia of chronic disease ACD, Wilson's disease) were compared to those of the reference population with the aim of investigating the potential of isotopic analysis as a diagnostic tool, capable of revealing diseases that otherwise can only be diagnosed at a later stage or via more invasive methods.

Novel particle method for modelling melt generated heterogeneity in spherical mantle convection models

HEIN VAN HECK AND J. HUW DAVIES

Cardiff University, School of Earth and Ocean Sciences, Cardiff, United Kingdom (vanheckhj@cardiff.ac.uk)

Today there are extensive geochemical databases of surface observations but they lack satisfying geodynamical explanations. Working towards this goal we implement a new way to track chemistry in the well developed mantle convection code TERRA.

The bulk composition and trace element abundance (all isotope of He, Ar, U, Th, Pb, K) are tracked via particles. One value on each particle represents bulk composition, which represents the basalt component. Chemical alteration of bulk composition and trace elements happens at self-consistent, evolving, melting zones. We use a composition dependent solidus, therefore the amount of melt generated depends on pressure, temperature and bulk composition. A novel aspect is that we do not move particles that undergo melting; instead the chemical information carried by a particle is transferred to other particles. Melt is instantaneously transported to the surface, thereby increasing the basalt component carried by the near surface particles and decreasing the basalt component in the residue. As melt arrives at the surface, a fraction of its content of trace elements is moved into separate continent/atmosphere reservoirs. For trace elements in the continent, delayed return to the top of the mantle, simulates erosion and recycling back into the mantle.

Results of our implementation will show the evolution of: 1: bulk composition. 2: melt amount. 3: concentration and abundance of trace elements in the atmosphere, continent, melt and surface layer.

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