Geophysical Research Abstracts
Vol. 13, EGU2011-13982, 2011
EGU General Assembly 2011

MC-ICPMS U-Th isotope measurements for precise speleothem chronologies in Quaternary climate research

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High precision mass spectrometry is an important technique in palaeoclimate research. For example, isotope measurements of elements such as U, Th and Pb are essential for U-series dating of palaeoclimate archives such as speleothems. There is an increasing demand for higher precisions, smaller detection limits and thus smaller sample sizes that can be analysed.

I will present some recent developments in multi collector (MC) inductively coupled plasma mass spectrometry (ICPMS) U-Th dating. Technical advances in MC-ICPMS lead to higher precisions and enable U-Th dating at per mill precision. Additionally, very small samples sizes that can now be used for MC-ICPMS U-series measurements open up the possibility of very high spatial resolution U-Th dating. I present and discuss a 'conventional' setup for high resolution MC-ICPMS U-Th dating as well as the application of novel techniques in the field of mass spectrometry applied to environmental research including multi ion counter (MIC) arrays available for the ThermoFinnigan Neptune MC-ICPMS and micro sampling techniques such as laser ablation (LA) or micromilling. MIC, for example, increase the efficiency of low level ion beam collection by allowing simultaneous collection of all ion beams which also circumvents problems associated with unstable, transient beams often associated with laser ablation. In situ LA MC-ICPMS is an ideal tool for U-Th measurements at very high spatial resolution without prior chemical separation procedures. However, small beam intensities and matrix effects especially for mass and elemental fractionation pose significant analytical challenges for accurate determinations of U-Th ratios.

I will discuss precision and accuracy as well as potential and limitations of MC-ICPMS U-Th dating methods specifically in the light of instrumental biases. I will also address sample related limitations for high precision dating, such as detrital components and associated corrections. Furthermore, the important topic of generating a distance-age model based on U-series ages for speleothems will be addressed and examples for applications of speleothem high resolution U-Th chronologies for palaeoclimate research will be presented