

**MODERN DEVELOPMENTS IN LIGHT STABLE ISOTOPE ANALYSES.** Pier A. de Groot, Economic Geology Research Unit, Department of Geology, University of the Witwatersrand, Private Bag 3, 2050 Johannesburg, South Africa. E-mail: 065pier@cosmos.wits.ac.za.

Light stable isotope analytical methods were developed in the 50's and 60's as complicated and laborious methods. The sample size needed for a single analysis, in the order of several to tens of milligrams, was relatively large for most methods. In specific fields, such as: meteorite studies, study of single mineral grains rather than a collection of grains, stepped heating methods on rock materials, or for low volume organic matter containing solutions or soils, there was a growing need for methods to analyze smaller samples.

Different ways to reduce sample size were introduced: 1) using static, single inlet mass spectrometers instead of dynamic, dual inlet machines, or 2) systems for micro-scale measuring, such as laser probes (O, S, C isotopes and fluid inclusions) and ion probes (H, Li, B, O, S isotopes)[1, 2]. The former method decreased the gas volume needed to be measured in a mass spectrometer, and the later method decreased the sample size for a single analysis.

New on-line analytical methods were developed for organic materials. A sample is combusted or pyrolysed, eventually in combination with an element analyzer, and the resulting gases are separated either by cryogenic separation or by gas chromatography. Gases are transported by a continuous, inert gas flow (normally He) into the inlet system of a mass spectrometer. This improvement allows a samples size in the order of micro- to nanograms. These systems have now also been introduced for other than pure organic materials (e.g. water pyrolysis, sulfur components in water or soils). These systems are used for measuring C, S, N, O, and H isotopes.

Automation of the analytical process is another development, mostly in those areas where large numbers of samples need to be analyzed. Automated systems are developed for carbonates, including fossils, based on phosphoric acid digestion, and are available from commercial companies. Reliable and rapid measurement of large numbers of water samples from different sources (e.g. natural water or brines, water from hydrated minerals, fluid inclusion water, water from combustion of organic materials) for O and H isotope

composition demanded automation, too. Automates for CO<sub>2</sub> (O-isotope) or H<sub>2</sub> (H-isotope) equilibration with water are available from commercial companies. Automates for H-isotope analysis on water samples, based on reduction in U or Cr containing furnaces, have been developed and published in the last years.

Development of ICP-MS (inductively coupled plasma - mass spectrometry), in line with a gas chromatograph, made compound specific C-isotope measurement in mixtures of organic matter (e.g. oils) possible in a simple and rapid way. The introduction of the MC-ICP-MS (multiple collector ICP-MS) extends the range of stable isotopes (e.g. Cu, Zn, Ge, Se) which can be analyzed without need of extensive preparation procedures [3].

Newly developed methods for stable isotope measurement are: microprobe-AMS (C, S, O isotopes); tunable laser techniques (used in the Mars lander operation for isotopic measurement); glow discharge mass spectrometry (GDMS - basically isotopes of all elements - [4]).

To conclude, a tendency towards smaller samples, measured with high precision, and an increasing automation and simplification of analytical systems is seen at the present. This certainly will develop further in future, eventually also including new methods or tools for stable isotope measurement.

#### References:

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