Assessment of Stable Isotopic Reference and Inter-Comparison Materials

While many school text books still consider the terrestrial abundances of the stable isotopes of the elements as constants and characteristic for the planet or for the solar system, this is not really true and needs to be refined. Some of the elements contain radiogenic isotopes, and the respective abundance changes can, for instance, be used for dating the age of stones or sediments. In particular, the light life-science elements carbon, nitrogen, oxygen, and hydrogen exhibit variations originating from fractionation processes:

- Upon evaporation, the water isotope $^2$H is depleted in the gas phase, similarly $^{18}$O. Conversely, during condensation, $^2$H and $^{18}$O preferentially accumulate in the liquid. Repeating this process, as is permanently happening in precipitation, can leave a larger trace in form of significant isotope abundance alterations, which form the basis for paleo-climatic investigations using ice cores from Antarctica or Greenland ice sheets.

- During photosynthesis, the light isotope $^{12}$C in CO$_2$ is preferred, hence the resulting organic material is depleted in the heavier $^{13}$C isotope. Generation of all living matter starts with CO$_2$ from air (or in the oceans). The $^{13}$C/$^{12}$C ratio of CO$_2$ in air has varied very little over billions of years, hence all fossil organic carbon has a lower $^{13}$C/$^{12}$C ratio (roughly 0.0110 instead of 0.0112).

The stable isotope ratio changes due to fractionation processes such as the ones above (there are many more in nature, in particular in living matter, where the reactions mostly are catalyzed and proceed close to the threshold) appear small; yet, they are both, significant and robust. They also can be analyzed reliably with specialized technology that was developed in the early 1950s. We now have more than 2000 stable isotope ratio laboratories world wide, and one of the major challenges is to have any two laboratories produce identical results from the same materials. Fractionation processes in general also happen during sample preparation (all carbon bearing material has to be converted to CO$_2$ for stable isotope measurement). Therefore, best results are obtained from identical chemical compounds or classes of compounds. This contrasts with the fact that international standards often are carbonates, water samples, or a few other compounds. There is a need for a larger chemical variety in stable isotope reference materials. Solving this problem entails accurate calibration of these materials.

Accurate calibration often is a major challenge, in particular for materials that are chemically very different or that have a large deviation in isotopic composition. Therefore, a number of calibration studies are always under way somewhere; the results of which are then published and the results made available (e.g., through NIST or the IAEA in Vienna). What we are missing is an authority that audits the respective analytical results and is capable of separating “the wheat from the chaff.”

The project is aimed at producing an authoritative, citable reference table for Stable Isotope Ratio Reference Materials, with a biennial update cycle.

For more information contact Task Group Chair Willi A. Brand <wbrand@bgc-jena.mpg.de>.

Terminology and Definition of Quantities Related to the Isotope Distribution in Elements with More than Two Stable Isotopes

This new project, coordinated by the Inorganic Chemistry Division, will seek to define terminology and to identify the most suitable definitions of quantities that characterize the isotope distribution in elements with more than two stable isotopes, including so-called mass-independent fractionation, nonmass dependent fractionation, isotope anomaly, $^{17}$O excess, and other terms.

Most atmospheric oxygen-bearing species show deviations in their triple oxygen isotope ratios from mass-dependent fractionation (MDF) relationships predicted by the theories of Urey, Bigeleisen, and Mayer. Similar deviations have also been found in sulfur and other elements with more than two stable isotopes (e.g., Hg, Cd, Zn), often preserved in non-atmospheric reservoirs, including rocks, minerals, soils, ice, and waters. Despite the ubiquity of this type of isotope anomaly, there has never been an attempt to clearly define the terminology and physical quantities used to measure these anomalies and the processes...
that lead to their formation. Terms like mass-independent fractionation, nonmass dependent fractionation, isotope anomaly, and isotope excess, have been used in the historic and recent literature, but are often not carefully distinguished.

The realization that MDF comprises a range of possible relationships between the isotopes of one element led to further complications because it meant that apparent isotope anomalies could be created by a combination of different MDF processes. At the moment, at least four different definitions to quantify isotope anomalies are being used. Furthermore, coefficients used in these definitions vary, which makes the comparison of data from different sources very difficult. A consistent set of recommendations on how to express and quantify the isotope distribution in elements with more than two stable isotopes is highly warranted. From our experience as academic teachers, we are woefully aware how impenetrable the field is for young researchers at the moment because of the lack of consistency and the lack of understanding between different groups. This project seeks to alleviate this situation.

For more information contact the task group chair Jan Kaiser <j.kaiser@uea.ac.uk>.


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**Postgraduate Course in Polymer Science**

The Institute of Macromolecular Chemistry of the Academy of Sciences of the Czech Republic in Prague, Czech Republic, with its more than 100 scientists and a total staff of about 250, is among the largest laboratories devoted to basic research in polymer science worldwide. For 50 years, the Institute has offered postgraduate studies. In the mid-1990s, the Institute launched the Postgraduate Course in Polymer Science with the mission to enable young university graduates and Ph.D.s from countries with limited research facilities to acquire knowledge on recent advances in polymer science and professional skills needed for promotion of polymer science in their home countries. The course was granted UNESCO sponsorship from the beginning, with IUPAC adding its sponsorship soon afterwards. The course has gained international recognition as a most commendable educational activity in the IUPAC Polymer Division and was awarded the IUPAC-Samsung Education Prize for 2005 (see www.iupac.org/publications/ci/2005/2706/iw1_samsung.html).

So far, 13 iterations of the course have been completed, with the 14th in progress and the 15th starting in October 2010. Each course lasts 10 months and comprises about 50 hours of lectures in modern polymer science and experimental work on research projects under the supervision of senior scientists of the Institute. The results of the research are published in international technical journals and presented at meetings. As of 1 January 2010, the cumulative results of the Course held so far are as follows: 116 graduates, 152 papers published in international journals, and 201 communications at international meetings. The papers co-authored by the course graduates have been cited more than 2000 times. For a list of papers, see <www.imc.cas.cz/unesco/papersUI.html>.

The graduates of the 13 completed courses, students in the current course, and those admitted to the 15th course have been from the following 22 countries: Algeria, Bangladesh, Brazil, Bulgaria, China, Hungary, India, Iran, Kazakhstan, Macedonia, Mexico, Poland, Romania, Russia, Serbia, South Africa, Spain, Ukraine, Uruguay, Uzbekistan, Venezuela, and Vietnam.

Follow-up with graduates has shown that the Course has been very helpful for professional promotion of the graduates in their home countries. Cooperation with a number of alumni continues through joint projects with their home laboratories.

The 15th Postgraduate Course in Polymer Science will be one of the contributions of the Czech Republic to the International Year of Chemistry 2011.

For more information contact the task group chair Pavel Kratochvíl <krat@imc.cas.cz>

www.iupac.org/web/ins/2010-015-1-400

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**Toward Higher Quality of Chemistry Teacher In-Service Training in Croatia**

The primary objective of this project is to organize the first Croatian Workshop on Chemical Education (1stC-WCE), scheduled for 10–14 November 2010 in Split, Croatia. The workshops is intended to improve the process of in-service training of chemistry teachers in Croatia and the region and catalyze the dissemination process of in-service experiences between neighboring countries.