Isotope reference materials for present and future isotope research

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The variation of isotope abundance ratios is increasingly used to unravell natural and technical questions. In the past the investigation and interpretation of such variations was the field of a limited number of experts. With new upcoming techniques and research topics in the last decades, such as provenance and authenticity of food, the number of published isotope data strongly increased. The development of inductively coupled plasma mass spectrometers (ICPMS) from an instrument for simple quantitative analysis to highly sophisticated isotope abundance ratio machines influenced this process significantly. While in former times only experts in mass spectrometry were able to produce reproducible isotope data, nowadays many laboratories, never been in touch with mass spectrometry before, produce isotope data with an ICPMS. Especially for such user isotope reference materials (IRM) are indispensible to enable a reliable method validation. The fast development and the broad availability of ICPMS also lead to an expansion of the classical research areas and new elements are under investigation. Here all users require IRM to correct for mass fractionation or mass discrimination or at least to enable isotope data related to a common accepted basis. Despite this growing interest suitable IRM are still lacking for a number of isotope systems such as magnesium.

For all isotope abundance ratio applications reference materials are necessary either for correction of mass fractionation/mass discrimination, for method validation or to provide a common accepted basis. The production of these urgently needed IRM, however, has stagnated within the past decades. Reasons might be that the scientific relevance often has not been realized; time and effort seemed not in balance with the scientific gain. Recently the situation has changed slightly, as researcher at NIST resumed their work and BAM and NRC started working on IRM.

The needs for present research on isotope variations are being considered and are compared to the limitations of current isotope reference materials within this presentation. The resulting disagreement between both is being discussed and solutions will be provided.

Geochemical consequences of thermomechanical processes in subduction zones. Implications for crustal making processes

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We have analyzed the dynamics of crustal growth processes at active continental margins based on a 2D coupled petrological-thermomechanical numerical model of an oceanic-continental subduction zone. The model includes spontaneous slab retreat and bending, dehydration of subducted crust, aqueous fluid transport, partial melting, melt extraction and melt emplacement in form of both extrusive volcanics and intrusive plutons.

Our results show that the rate of crust formation and the composition of newly formed crust are strongly depended on the degree of rheological weakening induced by fluids percolating from the subducting slab and upwards propagating melts. Subsequently we could identify the following geodynamic regimes: (i) stable arcs (ii) compressional arcs with plume development and (iii) extensional arcs.

Crust formation in stable arc settings is characterized by flattened intrusions and low crustal growth rates. At first dacitic melts are produced due to partial melting of the slab nose, followed by flux melting of wet peridotite. In compressional arcs the emplacement of hybrid plumes adds additional material to the continantal crust. Partially molten rock melanges composed of basalts and sediments accumulate at asthenospheric depth forming plumes, which rise through the mantle prior to emplacement. We have calculated the isotopic initial ratios of Sr and Nd in the plume during the simulations, showing that the geochemical signature varies strongly with the basalt/(basalt+sediment) fraction in the plume. These signatures are transferred to andesitic magmas and finally confirm the geochemical signatures of the continental crust.

Crustal growth in extensional arc settings is accomplished by decompression melting of dry peridotite, leading to elevated crustal growth rates.