Geoneutrino observations and the Earth energy budget

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The total energy loss of the Earth has been calculated to be 46+/-2TW. The heat loss is balanced by the radio-activity of the Earth's crust and mantle, the core heat flow and the mantle secular cooling. The crustal radioactivity is relatively well constrained (6.5+/1TW), but the uncertainty on all the other components is very large. Estimates of core heat flow vary between 5 and 14TW. Mantle cooling could provide between 6 and 18TW. Bulk silicate earth models predict about 13TW for the heat generation in the mantle, but proposed values of mantle heat production vary between 9 and 20TW.

Underground neutrino observatories now have the capability of detecting geo-neutrinos, anti-neutrinos produced by β decay in radio-elements U and Th series.

It is thus hoped that geoneutrino observations will put constraints on the abundance and distribution of U and Th in the mantle and their contribution to the earth's energy budget.

A small error on the crustal heat generation has a large impact on the estimates of the abundance of U and Th in the mantle, because the contribution of the crust to the geoneutrino flux is 4 to 5 times larger than that of the mantle,. Combining heat flux and heat production data is the most robust method to determine with high precision the crustal radio-activity and to predict the crustal geo-neutrino's contribition.

Rare earth element (REE) quantification in geochemical samples: Can we trust commercially available ICP-MS calibration solutions?

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The ICP-MS technique allows the analyses of individual REE concentrations in a wide range of matrices relevant for geochemists. However, the quantification of concentrations via in the mass spectrum still faces complications due to the vast potential chemical and spectral interferences, arising from complex sample matrices, when quantification is needed. To overcome these interferences, a number of measures including internal standardization, matrix separation, isotope-dilution, the standard addition method, algebraic correction, among others, are employed.

In this work we report the results from the isotopic analysis of fourteen REE in geological materials by ICP-MS. Three different analytical approaches were studied: 1) ICP-MS using matrix matched reference materials (RM) for calibration and 2) HPLC-ICP-MS after Tm addition 3) Isotope Dilution ICP-MS with and without chemical separation. All approaches involve sample dissolution by sodium peroxide sintering to assure complete dissolutions of refractory minerals. The first analytical procedure for determination by ICP-MS uses external calibration curves generated from certified and well characterized, matrix matched geological RM (CRM, provided and certified by the International Association of Geoanalysts, IAG) which were prepared in the same way as the studied samples. The determination by HPLC-ICP-MS comprises spiking with Tm before sample dissolution and a straightforward chromatographic matrix separation procedure. Oxalic and diglycolic acid were used as complexing agents on a Dionex Ionpac CS5A analytical column. Synthetic standard solutions obtained from Inorganic ventures, High Purity Standards and Spex were used for calibration of the HPLC-ICP-MS.

The findings of this study, and the advantages and disadvantages of all methodologies used are discussed. Significant differences between the three calibration strategies were observed for some of the ICP-MS solutions. Thus the traceability of the so called certified ICP-MS standard solutions is questioned and the reliability of the new CRM is highlighted.