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Geo-neutrinos in monitoring geochemical and geodynamic models of mantle circulation

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Measurements of terrestrial antineutrinos provide a direct insights on the main sources of Earth's flow. In turn, this implies that information on mantle composition and mechanisms of mantle circulation can be derived from antineutrino flux after subtracting the crust composition, with obvious implications for geochemical and geodynamics models. In this contribution we address three major points: i) the sensitivity of geo-neutrino fluxes to uncertainties about the mechanisms of mantle circulation; ii) the possibility of using neutrinos to test the Bulk Silicate Earth (BSE) model; and iii) the accuracy required for local/regional prediction and geo-neutrino detection.

A wide class of models, including the extreme geochemical and geophysical models, is built in terms of the depth *h* marking the border between the uppermost (depleted) mantle and its lowermost part that must fit mass-balance requirements for the whole Earth. All these models have the same amount of heat/neutrino sources and only the geometrical distribution is varied. Major results of our modelling can be summarised as it follows:

1) Uncertainties on the geometrical distribution of trace elements in the mantle can change the prediction of the reference model for the geo-neutrino flux from the mantle by at most ±6%, the extreme values corresponding to a fully-mixed and to a two layer model, with primordial abundance below about 1600 km.

2) The flux contribution originating from distant sources in the crust and in the mantle can be fixed within ±5% (1σ) with respect to the reference model, by using global mass balance within the BSE framework.

3) The geo-neutrino signal can be measured with ±5% accuracy by a properly installed four-kton detector thus providing a crucial test for BSE. Detailed geological and geochemical investigations of the region within few hundreds km from the detector are required to reduce the flux uncertainty from fluctuations of local abundances.

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New lecture of mantle source heterogeneities reconciling the geochemical and geophysical approaches

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A new approach is proposed for the analysis of mantle source heterogeneities based on the distinction of large-scale mantle domains, combining the use of isotopic and incompatible trace element ratios. This approach leads to the distinction between two types of domains, and provides evidence for relationships between these domains and tomographic features within the mantle.

The first type of domain contains MORBs associated with OIBs. Comprised by the Atlantic-East Pacific (AEP) and Indian Ocean (IO) domains it can be related to upper mantle layers. The second type of domains only contains OIB and plateau basalts, and comprises the South Central Pacific (SCP), and Kerguelen-South Atlantic (KSA) domains. The relationship noted between the areas recovered by these domains and tomographic anomalies associated to the D" layer [Masters et al.] allows us to attribute the second group (SCP and KSA) to sources located within this layer and/or to the large upwelling plumes associated with these D" anomalies.

The nature and composition of the sources of the distinguished domains can be inferred through the use of the incompatible trace element ratio (Nb/La vs. Th/La) diagram, highly appropriate for constraining the source compositions and magmatic processes. The sources of the AEP and IO domains are interpreted as mainly formed by a residual mantle peridotite/ recycled oceanic crust (ROC) association although the sources of the SCP and KSA mantle domains are interpreted as variably enriched in ROC and RCC

Various mantle structure models, including the two major debated ones (layered and un layered), both involving a D" layer at the CMB can be put forward. The reliability of these structures is assessed through the development of mantle budgets allowed by the incompatible trace element approach adopted. Mantle budgets show that in the whole convective structure case, the D" layer composition is found to overlap the composition of upper parts of recycled slabs comprising ROC associated with RCC materials.

Associated with numerous geophysical observations these geochemical deductions favor a whole convective mantle structure convecting upon a D" layer, with a mantle divided in two large convective cells.