Use of Sn, Ni, Cu, Fe, Ag and Pb isotope analyses by MC-ICP-MS to track Potosi silver

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The motivation of this study is to assess silver fluxes from the New World to the Old World and their impact on European inflation over the 16th century. During Antiquity and Middle Age, silver production was dominated by a relatively small number of mining areas, in particular the Greek Laurium up to the beginning of Christian era, then Spain up to High Middle Ages and finally Bohemia up to the discovery of America. The effect of the arrival of precious metals from America on European coinage is one of the main issues that fascinated historians. Common examples are the gold and silver imports from Mexico and silver imports from Peru. Here we focus on silver from Potosi, which massive role as an inflation factor and in the 'price revolution' during 16th century in Europe has been emphasized by some historians. To assess the impact of Potosi silver on the evolution of European monetary mass, we try to track this silver in the coinage. This study is undertaken by developing new fingerprinting methods using the stable isotope compositions of Pb, Zn, Cu, Ag, Cu, Fe and Sn as measured on MC-ICP-MS. To begin with, in order to evaluate the isotopic variations of these elements, ores coming from the potentially most important silver ore deposits and from Potosi, as well as Mexican and pre-Colombian silver coins have been studied. To analyse these samples, we have to carry out a analytical development in two steps: a chromatographic separation of the various elements with a yield close to 100%, followed by their analysis on MC-ICP-MS instruments at ENS Lyon (Nu HR 500 and 1700). The first results showed that Cu and Pb isotopic ratios are very different from one sample to another and can mark distinct sources. The analyses of other elements are in progress but the preliminary results seem encouraging.

The survival of reservoirs of dense material at in the lower mantle and the source of OIB

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The Oceanic Island Basalts (OIB) have specific geochemical signatures (large scattering in the $^4He/^3He$ ratio, large $^{40}Ar/^{36}Ar$ ratio), which suggest that they originate from several reservoirs, one of which should be undegassed. It was long assumed that this undegassed reservoir is hidden in the lower mantle, but the discovery of slabs penetrating in the deep mantle invalidated this hypothesis. Recently, we carried out series of numerical experiments of thermo-chemical convection (in which we prescribed an initial layer of dense material at the bottom of the system) to determine the parameters can maintain large thermo-chemical structures in the lower mantle [1, 2]. Two major results of these experiments are that: (1) a strong thermal viscosity contrast ($R\mu_T \geq 10^4$) create and maintain large pools of dense material at the bottom of the system; and (2) an endothermic phase transition at 660-km depth prevents the dense material to massively flow into the upper part of the system. Thermal plumes dramatically thin at the 660 km and entrain only a very small amount of dense material upwards. Our models globally support the hypothesis that OIB partially sample a reservoir of dense material located in the lower mantle. This reservoir may result from early differentiation [3], and our calculations show that it can survive mantle convection. The next step is to quantify the fraction of dense material that is transported by the thinned plumes, and constrain the balance between primitive and recycled material in the plumes. A preliminary estimate is given by the ratio between the upwards flux of dense material and the total upwards mass flux. For a model with $R\mu_T = 10^6$ and Γ = -2.5 MPa/K, and averaged over the upper mantle, this ratio is low, around 3.0×10^{-3}. More accurate models and estimates should include self-generated plate tectonics at the top of the system and their recycling, and a careful measure of thermal plumes extent.

[1] Deschamps & Tackley (2008) *Phys. Earth Planet. Inter*. **171**, 357-373. [2] Deschamps &. Tackley (2009) P*hys. Earth Planet. Inter*., (submitted). [3] Labrosse, Hernlund & Coltice, (2007) *Nature* **450**, 866-869.