Preserving high $^3He/^4He$ ratios in a convective mantle

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Many Ocean Islands Basalts (OIBs), such as at Hawaii and Iceland, have $^3He/^4He$ ratios that are a factor of 4-6 higher than in Mid Ocean Ridge Basalts (MORBs). The high $^3He/^4He$ ratios in OIBs are usually viewed as evidence for the existence of a ^3He-rich primitive mantle reservoir. In contrast to Hawaii and Iceland, some OIB have $^3He/^4He$ ratios lower than MORBs (HIMU OIBs such as the Cook-Austral Islands). Our high-precision neon and helium isotopic measurements indicate that even in HIMU OIBs, ^3He and the primordial isotopes of neon originate from the same ^3He-rich and high $^3He/^4He$ reservoir sampled at Hawaii, Iceland, and Samoa.

Helium is a highly incompatible element. During mantle melting helium strongly partitions into the melt phase leaving the residue severely depleted in helium. Thus, the simplest explanation for preserving high ^3He concentrations and high $^3He/^4He$ is to convectively isolate the reservoir over Earth history. However, geophysical and geochemical observations suggest whole mantle convection and imply that most, if not all, of the Earth's mantle has been processed through melting. Consequently, preserving a primitive mantle reservoir over Earth history is challenging.

We propose a new explanation for preserving high concentrations of primordial volatiles (and high $^3He/^4He$) in the Earth's mantle. We will show that convective mixing inhibits mantle degassing and a mantle reservoir can undergo extensive melting over Earth history but still retain significant primordial volatiles. The degree to which volatiles can be preserved is a function of how efficiently subducted slabs, devoid of ^3He, are mixed back into the mantle reservoir. For example, if mixing is efficient, ~40% of the original budget of primordial volatiles can be retained in the mantle reservoir even after the whole mass of reservoir has been processed through the melting column once. We find no need to invoke the presence of a convectively isolated mantle reservoir for preserving high $^3He/^4He$ ratios. Neither is U and Th depletion, relative to ^3He, required to explain the high $^3He/^4He$ ratios in OIBs. The differences in $^3He/^4He$ ratios between MORBs and OIBs can be explained within the framework of plate tectonics and mantle convection.

Study of processes involving selenite immobilization in a soil-plant-microorganisms system

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Radioactive selenium (Se) is produced in fission reactors in the form of several isotopes including ^{79}Se, which is a long-lived fission product with a half-live of about 1×10^6 years. Over time, the long-term radioactive waste disposal sites may represent sources of long-lived radioactive contamination of the environment. Indeed, Se migration can occur via groundwater and reach the soil, thus affecting the rooting zone of vegetation. In most of soils, the species selenite SeO_3^{2-} and selenate SeO_4^{2-} are the most frequent. These anionic forms are very soluble, mobile, bioavailable and potentially toxic.

This study aims at determining quantitatively the processes involved in radioactive ^{75}Se (selenite) transfer in rye grass grown in two soils located on the surface of two eventual sites studied for radioactive waste geological disposal. The role of microorganism was studied by sterilizing the soils with a gamma source and rye grass seeds with H_2O_2. Volatilization of selenium was studied using activated carbon cartridges in a closed system. The results will be presented in term of chemical budget of selenium and transfer factors to the plant.