He-Ne-Ar isotope systematics of the HIMU reservoir; implications to K and U budget in the mantle

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Noble gas isotopes could have the potential to provide the evidence for recycled origin of some mantle reservoirs. We present a new set of He-Ne-Ar isotopic compositions of lavas from the Cook-Austral Islands in the south Pacific, which exhibit HIMU and EM characteristics in terms of radiogenic isotopes. $^3He/^4He$ of the HIMU lavas are lower than MORB values, as previously demonstrated, but a coherent variation in $^3He/^4He$ with Pb isotopes indicates two-component mixing to form the lavas. Since the HIMU reservoir plots at the radiogenic Pb isotopic end of the mixing trend, $^3He/^4He$ of this reservoir must be 6 Ra or less. The other mixing component is the local lithosphere, which is commonly involved in EM lavas.

K/U of the HIMU reservoir is constrained by the relative abundances of radiogenic and nucleogenic ^4He, $^{21}Ne*$ and $^{40}Ar*$. The HIMU lavas show systematic variations in $^4He/^{40}Ar*$-$^4He/^{21}Ne*$ space, in which they define a trend that is parallel to, but offset from the trend previously observed for other OIBs. Using $^4He/^{21}Ne*$ to correct for elemental fractionation of noble gases, $^4He/^{40}Ar*$ of the HIMU reservoir is higher than the $^4He/^{40}Ar*$ production ratio in the mantle. This indicates that the HIMU reservoir had lower time-integrated K/U (approximately 3000) than the canonical mantle value (13000). Low $^3He/^4He$ and K/U are best explained by a model where the HIMU reservoir originates from ancient subducted oceanic crust that preferentially lost He and K relative to U by dehydration during its subduction.

Since the subducted oceanic crust is enriched in U, but not in K, the preservation of the subducted oceanic crust in the mantle modifies the previous estimates of K/U and K concentration in the bulk silicate Earth (BSE), that did not take this reservoir into consideration. The estimated K/U of BSE may be changed from 13000 down to 8000-10000, if significant amounts of subducted oceanic crust have accumulated to form an isolated reservoir. This fact partially (but not always totally) reconciles $^{40}Ar*$ paradox. More importantly, subduction and accumulation of the oceanic crust affects the distribution of fluid-mobile and fluid-immobile elements in the mantle.

Mapping of heavy metal sorption to cell-iron-mineral aggregates on the µm-scale

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The distribution of heavy metals such as Ni, Cu, Zn, As, Cd, and Hg in environmental biofilm-system is often controlled by the sorption to organic biomacromolecules and by the sorption to and co-precipitation with abiogenic and biogenic iron minerals [1,2]. Changes in pH or redox-potential in micro-environments can result in the release and mobilization of heavy metals in the environment and thus affect ecosystems and/or human health. Therefore, to understand the fate and environmental behaviour of metals in the environment it is essential to acquire information on the partitioning of the respective metals in complex systems such as biofilms which contain a heterogeneous mixture of intact cells, polysaccharides and iron miernals.

Whereas high-resolution imaging such as electron microscopy or scanning transmission X-ray microscopy are suitable to gain detailed insights into binding mechanisms of heavy metals, they usually do not allow for mapping regions at a spatial scale that is relevant for the environment. Thus, we use metal sensitive fluorescent dyes that were developed for cell-biology [3] in combination with confocal laser scanning microscopy (CLSM) [4] to qualitatively and semi-quantitatively map *in-situ* the distribution of heavy metals such as Ni, Cu and Zn within biofilms formed by Fe(II)-oxidizing bacteria at µm to mm-scales. At the same time we localize and map the organochemical composition of the biofilm using various DNA-, protein-, polysaccharide- and lipid-specific fluorescent dyes [3]. Mineral particles were mapped using the reflection signal of the laser. Correlation analysis allowed for identification of binding sites of heavy metals at the µm to mm scale within pristine and metal-contaminated environmental biofilms. Ni and Zn were mainly bound to bacterial cells and polysaccharides, but Cu was found to preferentially be bound to polysaccharides and iron minerals.

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