Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 433

Helium Residence Time in the Subcontinental Mantle

Cecile Gautheron (gauthero@ipgp.jussieu.fr) & **Manuel Moreira** (moreira@ipgp.jussieu.fr)

Laboratoire Geochimie Cosmochimie, 4 Place Jussieu, 75252 Paris, France

Introduction

The subcontinental mantle was separated from the convective one. It presents a significantly different signature relative to that of the MORB mantle source: (1) its REE chemistry shows an enrichment in LREE, which is interpreted as the percolation of fluids and/or melts coming from the underlying asthenospheric mantle or/and from subducted slabs; (2) elements such as Rb, Sr, U or Th traduce the mixing between a MORB mantle source and these fluids and/or melts (Menzies & Hawkesworth, 1987). The interest of this study was to constraint the impact of this chemistry on the noble gases, in particularly helium. In fact, ^{3}He is a primordial gas, whereas ^{4}He is mainly added by U and Th radioactive decay. Therefore, a different $(U+Th)/^{3}He$ ratio than MORB mantle source in this reservoir will modify its noble gas signature.

Samples and results:

We are interested in volcanism sampling the subcontinental mantle, i.e. rocks coming from intra-continental rifting. Previous studies were done on samples from Europe (Massif Central, Germany, Austria, Italy), Australia, New Zealand, Southwestern USA and Antarctic (see (Gautheron et al., in prep) and reference inside). In order not to take into account ^{3}He produced by cosmogenic reactions, we use in this study isotopic data obtained by crushing only. The samples studied here are mineral phases of xenoliths (olivine) and olivine phenocrysts. The literature data concerning xenoliths and olivine phenocrysts show a very homogenous and radiogenic helium signature, with a $^{4}He/^{3}He$ ratio of 115,000±8,000 (R/Ra=6.29±0.43, Ra being the $^{3}He/^{4}He$ atmospheric ratio of 1.38410-6), compared to that of the MORB mantle source ($^{4}He/^{3}He$=88,000±11,000 or R/Ra=8.2±1 (Allègre et al., 1995)). The ^{4}He concentration ranges between very poor contents of 10^{-11} and relatively high concentration: 10^{-6} ccSTP/g (for reference, the ^{4}He content of MORB samples is typically : 10^{-5}-10^{-4} ccSTP/g). The helium content of our samples has to be seen as a minimum value, since we only measure the helium contained in fluid inclusions. Moreover, some xenoliths may have lost some of these inclusions by decrepitation (Andersen et al., 1984), whereas olivine phenocrysts come often from degassed magma. Moreover, in the studied xenoliths, pyroxenes are usually richer in helium but represent less than 20% of the peridotite, thus do not play an important role in the helium budget. The helium content of the subcontinental mantle is certainly underestimated ($>10^{-6}$ ccSTP/g).

Discussion:

The constancy of the helium ratio demonstrates that the radiogenic signature of the subcontinental mantle is worldwide. It can be thus bound to its geodynamic. The subcontinental mantle when aged became enriched in some elements by metasomatism via fluids/melts inclusions. We propose that this metasomatism introduces a helium flow from the asthenospheric mantle, with a concentration and an isotopic signature different from those of the subcontinental mantle. In order to explain the data, we invoke a model of steady state for the noble gases in this lithospheric mantle. Using equations of ^{4}He production and mass budget, we calculate a helium residence time comprised between 10 and 200 Ma. Furthermore, the ^{3}He flux is 0.23 mol/an for the subcontinental lithosphere with an U content of 10 ppb, compared to the ^{3}He flow of mid-oceanic ridges (1000 mol/an). The upwelling invoked here can be explained by the rise of rich melted fluids (small melting rates) or little diapirs from the asthenosphere enriching the subcontinental lithosphere in helium and LREE.

Menzies & Hawkesworth, *Academic Press Geology Series*, (1987).

Gautheron et al., *in prep*

Allègre et al., *Geoph. Res. Letters.*, **22**, 2325-2328, (1995).

Andersen et al., *Contrib. Min. Petrol.*, **88**, 72-85, (1984).