Heavy noble gas systematics in MORBs and OIBs: Modeling of subduction impact on mantle composition

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A chondritic signature has been detected in the Earth's mantle for heavy noble gases as reported by [1] [2] in CO_2 well gases. As CO_2 well gases are thought to derive from the same reservoir as MORBs [3], this signature should be observed in MORBs and OIBs as well. As such, we have performed analyses for all noble gases of MORBs and OIBs samples using a HELIX SFT. Here we will present preliminary results obtained via a new protocol designed to improve data quality. As part of this protocol, samples were stored in a glovebox, alternating between vacuum and nitrogen atmosphere to lower the atmospheric contamination and then crushed in large amounts (3-8g).

Despite detection of a chondritic signature, MORB and OIB compositions appear atmospheric for stable isotopes of Xe as already reported by [4] [5]. Subduction of atmospheric noble gases through geologic time could explain such a convergence. To test this scenario, we performed modeling for Ar and Xe in three distinct reservoirs: atmosphere, mantle and continental crust. Several processes are taken into account to reproduce the evolution of the Earth: degasing in two phases as in [6], atmospheric distillation to explain the missing Xe paradox and the present Xe isotopic signature of the atmosphere, as well as extraction of parent elements to the continental crust. Finally, subduction of noble gases can be described as a simple incorporation of air into the mantle. During this process elemental fractionation of atmospheric noble gases can occur and seems to operate in favour of heavy noble gases. This is in agreement with high (Xe/Ar) ratios of subducted material compared to the atmosphere: sediments [7] [8], seawater [9], old or exhumed oceanic crust [8] [10]. We show that starting with a chondritic composition, the present mantle composition can be reproduced and that subduction plays a major role as it explains the nearly atmospheric signature of the mantle for Xe stable isotopes and considerably lowers the radiogenic isotopic ratios.

[1] Caffee *et al*, Sci. (1999) [2] Holland *et al*, Sci. (2009) [3] Staudacher, Nat. (1987) [4] Kunz *et al*, Sci. (1998) [5] Trieloff *et al*, Sci. (2000) [6] Sarda *et al*, EPSL (1985) [7] Matsuda & Nagao, Geoch. J. (1986) [8] Staudacher *et al*, EPSL (1988) [9] Mazor *et al*, Deep-Sea R. (1964), [10] Kendrick *et al*, Nat. Geo. (2011)