This talk will highlight usefulness and limitations of noble gas isotopes to unveil processes taking place within the Earth. Particular emphasis will be placed on how we decode range of information preserved in samples experienced complex geo-tectonic histories in the mantle. It will be shown that there are some mantle rocks with a clear crustal signatures, while some crustal rocks exhibit mantle noble gas signatures, and that vestiges of seawater is now appeared to be ubiquitous in many mantle-derived samples; so a clear message from these recent outcomes is that a use of noble gases as tracers of Geofluid is becoming not as straightforward as it was in some two decades ago.

Earlier finding of distinct distribution of $^{3}$He/$^{4}$He ratios in MORBs and OIBs and their interpretation in a context of “degassed” and “less-degassed” mantle reservoirs is a classic text-book example of application of noble gas isotopes to non-chronological issues. Although the view that the mantle has at least two distinct domains has still been supported by many data produced ever since, heterogeneities of noble gas isotope signatures are now recognized to exist in various scales within the mantle. Such recognition is based mainly on analysis targeting samples with the range of tectonic settings and ages (e.g., mantle xenoliths, alpine peridotites, carbonatites, komatiites etc…).

Particularly, noble gas isotope ratios of mantle-derived xenoliths from the subcontinental lithospheric mantle (SCLM) appeared to provide a case example for the occurrence of multiple noble gas components of different origins from within a scale of single specimen (e.g., Matsumoto et al., 1997, 2000 and 2004) to a continental scale (e.g., Czuppon et al., 2009, 2010). Identified components includes the inherited MORB-like and plume-like components in fluid inclusions of constituent minerals of xenoliths of different metasomatic histories, and an in-situ produced radiogenic component in the metasomatically enriched part of the SCLM. Note that noble gas characteristics of this in situ component is indistinguishable from the crustal component; therefore, if some fluids are associated preferentially from the metasomatised part of the SCLM, then such fluid would easily be misinterpreted as being derived form the shallow crustal environment. There is also an example of a "crustal" component in the mantle as found in ultramafic rocks from the Finero complex (Matsumoto et al., 2005). Moreover, there is a case that some crustal metamorphic rocks yielded mantle noble
Another important noble gas component now recognized in the mantle is "atmospheric" noble gases. Indeed, virtually every analysis on samples from terrestrial environment has been affected by contamination from atmospheric noble gases, but it is now becoming clear that there is an inherited atmospheric noble gases in the mantle (Matsumoto et al., 2001, Holland and Ballentine, 2006, Sumino et al., 2010) most likely recycled by the subducting oceanic plate possibly with a form of pore water. So, even the atmospheric noble gas signature can be used as a tracer of the mantle-derived fluids at some particular tectonic condition. Under such circumstances, it would highly be advisable to use a combination of multiple noble gas isotope ratios preferably obtained by multiple steps of extraction or by different kinds of extraction methods to reach a plausible conclusion in any research using noble gases as tracers of fluids of unknown origin.

References


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Noble Gas Isotopes as Tracers for Fluids in the Earth: Their identities and origins.

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