Heterogeneous noble gas compositions in subcontinental lithospheric mantle (SCLM) beneath Eastern Australia

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Noble gas elemental and isotopic compositions of mantle-derived xenoliths have been measured from different localities along eastern margin of Australia from north Queensland to Tasmania.

The observed noble gas composition of xenoliths samples from northernmost locality (Mt. Quincan, North Queensland) is very similar to those reported from mid-ocean ridge basalts (MORBs) including the following features: (1) the $^{3}He/^{4}He$ ratios cover a narrow range from 8Ra to 10Ra, the $^{40}Ar/^{36}Ar$ (300-4000) and the $^{3}He/^{3}6Ar$ (0.0012-0.07; corrected for some recent elemental fractionation) ratios plot on the well-established MORB line, and (3) correlated excesses in ^{129}Xe and ^{136}Xe with regard to atmospheric xenon, as found for MORB.

The noble gas isotopic compositions of xenoliths from Tasmania indicate contributions of MORB-like and radiogenic components. The typical features of the radiogenic component include (1) lower helium the $^{3}He/^{4}He$ ratios than those in MORB (2) excesses in ^{136}Xe relative to the MORB composition. The MORB-like component is characterized by the $^{3}He/^{4}He$ ratios between 7-9Ra.

The contributions of MORB-like noble gas component to the xenoliths from both regions indicate a large-scale occurrence of this component in SCLM beneath eastern Australia. This MORB-like fluid addition is likely linked with rifting tectonic settings when asthenospheric fluid (and magma) could rise into the subcontinental lithospheric mantle. Eastern margin of Australia has been controlled by rifting tectonic setting during Mesozoic and Cenozoic when opening of Tasman Sea and subsequent extension phase took place. The MORB-like component found xenoliths might reflect these tectonic events.

The presence of radiogenic component in xenoliths from Tasmania might reflect subduction events when the mantle wedge and SCLM could be metasomatised by U, Th rich fluids. Subduction processes have played important role in the evolution of Eastern Australia during the Paleozoic; the radiogenic component likely associated with this event. Although this Paleozoic subduction was extended from Tasmania to Northeastern Australia, the samples from North Queensland do not indicate contribution of subduction related (i.e. radiogenic) noble gas component showing pure MORB-like noble gas composition. Thus, the fluid-entrapment responsible for this MORB-like signature likely overwrites any pre-existing signature or even replaces it with MORB-like mantle by physical removal of previously metasomatised lithospheric mantle (i.e. delamination).