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Early volatile degassing and the pre-subduction noble gas elemental pattern of the mantle

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The distribution and evolution of volatiles between the Earth's mantle and atmosphere played a critical role in establishing the habitability of the Earth. The noble gases hold a record of the terrestrial volatile accretion and evolution [1=4]. However, due to low abundances and ubiquitous air contamination, reading the noble gas record has been quite challenging. To unravel the Earth's accretional and early degassing history we will present all six krypton isotopes and all nine xenon isotopes resolved from air in a MORB sample from the Mid Atlantic Ridge between the Kane and Atlantis fracture zones. The measurements were made utilizing a heavy noble gas accumulation technique to minimize atmospheric contamination followed by distillation of Ar from Kr from Xe and using a dual stainless steel cold trap and high-precision mass spectrometry using a Noblesse HR mass spectrometer [5-7].

The $^{20}Ne/^{22}Ne$ ratio of the accumulate gas was 12.4, nearly identical to the mantle value of 12.5, suggesting the accumulated gas was almost entirely free of shallow-level atmospheric contamination. The results are also confirmed by the $^{129}Xe/^{130}Xe$ of 7.54 ± 0.01 in the accumulated gas, which is close to the mantle value of 7.58 ± 0.02 for the sample determined from step crushing and correlation of Ne=Ar=Xe isotopic ratios.

The high-precision Kr and Xe isotopic measurements allow us to not only deconvolve primordial, subducted, radiogenic and fissiogenic components in the mantle more precisely than previously studies, but to also derive the noble gas elemental ratios in the Earth's mantle prior to the injection of atmosphere-derived volatiles. In this presentations, we will utilize the pre-subduction noble gas elemental ratios, along with ratios of iodine-derived radiogenic xenon and plutonium-derived fissiogenic xenon, to provide new insights into processes affecting the distribution of noble gases during Earth's accretion and the early degassing history.

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