Xenon in the mantle below Europe: constrains on mantle plume and implications for early Earth's differentiation

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The noble gases allow unique insights into the Earth's interior and its differentiation with respect to the atmosphere. Xenon deserves particular attention because its isotope systematic can be related to specific processes during terrestrial accretion. Here, we report high precision xenon isotopic measurements in gases from the active Mt. Etna volcano (Italy), and the Eifel volcanic region (Germany), where volcanic activity ended 11 ka years ago.

Our data constrains the primordial Xe end-member as being "chondritic", and not solar, in the mantle sources feeding Mt. Etna and Eifel volcanism. This is consistent with an asteroidal origin for the volatile elements in Earth's mantle and it implies that volatiles in the atmosphere and in the mantle originated from distinct cosmochemical sources. Despite a significant fraction of recycled atmospheric xenon in the mantle, primordial xenon signatures still survive in the mantle.

Our data also show that the reservoirs below the Etna volcano and Eifel region contain heavy-radiogenic/fissiogenic xenon isotopes, whose ratios are typical of plume-derived reservoirs. This is very intriguing because the presence of mantle plumes in Europe was already inferred from geophysical and geochemical studies. This study supports that the MORB—type reservoirs appear to be well distinguished and more degassed than the plume sources supporting the heterogeneity of Earth's mantle.

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