# Reactivity of heavy rare gases with silicates at deep Earth conditions

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The incompatible [1-3] and inert [4-5] character of atmospheric rare gases varies with pressure and temperature. This variation is poorly understood, yet it challenges our current appreciation of the formation of Earth's atmosphere and mantle dynamics. The levels of the noble gas Xe in the atmospheres of Earth, and Mars are much lower than those of other noble gases, a puzzle known as the "missing Xe problem" [6]. One solution would be that Xe is hidden in other phases in a deep Earth reservoir. From a geochemical point of view, not only Xe, but all rare gases could be partly hiding in the deep Earth [7].

X-ray diffraction were conducted in situ on the $SiO_2$-Xe and San Carlos Olivine-Xe systems, and completed by chemical analysis and Raman spectroscopy on quenched samples. We have shown that at high T and P, the normally unreactive Xe can bond covalently with oxygen in quartz[5], displacing Si atoms in the crystal lattice. A similar behavior of Xe is observed in the olivine lattice. Xe could therefore be trapped in deep Earth silicates. The results provide an answer to the paradox of "missing Xe" in the atmospheres of the Earth and Mars. Preliminary results will be shown on silicate-Ar systems, and discussed in relationship with the observed solubility drop of Ar observed at high pressure in silicate melts[1-3].

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# Geographical distribution of helium isotope ratios and seismic tomography in Japan

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The $^3He/^4He$ ratios (*Ra*) of natural gas, volcanic fluid, and groundwater are compiled in the Japanese Islands and their geographical distributions are discussed in the tectonic frame work of subduction zone together with precisely-determined seismic velocity structures. In Northeastern (NE) Japan where typical island arc signatures are developed, there is a clear contrast of $^3He/^4He$ ratios perpendicular to the trench axis, low-*Ra* in the frontal arc and high-*Ra* in the volcanic arc. This may reflect the presence or absence of magma with high-*Ra* in the shallow crust [1]. As a carrier of primordial helium, source melt may be generated in low-V zone of the wedge mantle by dehydration of Pacific slab at about 150 km deep and may flow upward sub-parallel to the slab, which is well constrained by S-wave velocity perturbation [2]. In the Chugoku and Shikoku districts of Southwestern (SW) Japan, there is a geographical contrast of *Ra* similar to NE Japan except for the region at about 100 km from the volcanic front where medium-*Ra* was found. High-*Ra* observed in volcanic arc of the Chugoku district may be attributable to the mantle helium derived from the magma source generated below the Philippine Sea slab [3]. Medium-*Ra* in the Shikoku district is explained by dehydration of the young slab with a moderate aging effect [4]. These features are again consistent with the results of seismic tomography [5]. In the Kinki district of SW Japan, anomalously high-*Ra* was observed in the frontal arc region that was called by "Kinki Spot"[6]. Since the high-*Ra* is located at much wider region from the volcanic front when compared with NE Japan, the melt generated below the Philippine Sea slab may penetrate into the fissure of the slab tear and may arrive at the shallow crust by upwelling flow.

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