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Iodine versus Xenon degassing history of the Early Earth

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Xenon is missing from the atmosphere of the Earth relative to chondritic patterns, this is known as the "missing Xenon" problem. The Earth's atmosphere is enriched in 132Xe relative to 129Xe compared with chondritic and solar compositions. Xenon isotope 129Xe originates from the 129I decay (now extinct, half-life 1.6 x 107 yr). Still today there is no satisfactory explanation for such a fractionation that must have occurred during the Earth differentiation, during the first hundred million years of the Earth's history at the stage of the "magma ocean". Among the hypothesis, it is proposed that iodine was separated from xenon from a process involving water, because on a chemical point of view iodine is hydrophilic whereas xenon is hydrophobic. If true, both elements are expected to exhibit different behaviours when a hydrated magma is degassing. It is proposed that early intense water degassing occurred from the magma ocean at the Hadean, if true it may have caused iodine loss from the Earth (1). Partition coefficients of iodine and xenon have been measured in situ between molten silicate and aqueous fluids, from high temperatures (up to 820°C) and pressures (up to 1Ga) to ambient conditions using resistive-heating diamond-anvil cells (RH-DAC) combined with synchrotron X-ray fluorescence (SXRF). Residual contents of iodine and xenon have been measured in the quench glasses using particle induced X-Ray Emission (PIXE). Results show no strong differential behaviour of xenon relative to iodine: both elements are concentrated in the silicate melt at high pressure, and they partition significantly in favour the aqueous phase during decompression. The analysis of the quenched silicate melts (i.e. glasses) reveals that a non-negligible part of xenon is remained in the glass when almost all iodine is lost. Results are in agreement with a potential storage of xenon in silicate minerals and/or melts at depth (2), another hypothesis to explain the xenon missing paradox.

References

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