Tracing the origin and evolution of volatile elements in the inner solar system by selenium isotopes

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Liquid water and other volatile compounds like CH_4, CO_2, and O_2 are playing key roles in planetary plate tectonics, regulation of surface temperatures, and continental erosion and weathering which are crucial for the origin and evolution of life. The only planet that we know of, that provides conditions to generate and sustain life, is the Earth. However, it is is still poorly understood how the rocky planets in our inner solar system acquired their volatile element budget including water.

To constrain the origin and addition of moderately to highly volatile components to the rocky planets of the inner solar system we studied the variation of the isotopes of the moderately to highly volatile, chalcophile, and siderophile element Se and its abundance in meteorites as well as terrestrial and lunar materials. The Earth and the Moon are depleted in volatiles compared to CI chondrites, either due to the loss by outgassing during different stages of their formation or due to an incomplete accretion of solar nebular material. While evidence from isotope abundances argues for a dry accretion of the Earth and later replenishment of volatiles (“Late Veneer”), the Moon is supposed to have lost volatiles by outgassing after core formation.

The $\delta^{82/76}$Se of several classes of meteorites is identical within the measurement uncertainty with a mean of -0.17 ± 0.52‰, pointing to a quantitative condensation of Se from the solar nebular and/or the absence of any significant Se isotope frationation during this process. The Earth`s mantle has a $\delta^{82/76}$Se of 0.20 ± 0.43 ‰ and is therefore indistinguishable from the meteorite data. This could be explained by i) the absence of significant isotope fractionation during the segregation of Se into the core or ii) an overprint of the $\delta^{82/76}$Se mantle signature by Late Veneer material. We will also present the first $\delta^{82/76}$Se data of lunar mare basalts and soils which will be used to contribute to the understanding of lunar evaporation and condensation processes.