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Helium partitioning between mantle and the core at the early Earth

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Noble gases are geochemical tracers, providing information about the formation of our planet and serving as a record of conditions in Earth history. Each noble gas has at least one stable non-radiogenic isotope, which is residue either of Big Bang or supernovas, and at least one stable radiogenic isotope, product of nuclear decay reactions from unstable heavier isotope of another element. The ratio of non-radiogenic and radiogenic isotopes of the noble gases arriving at the surface are essential to understand processes occurring on various timescale in the Earth interior.

The isotopic signature of the noble gases in the mid-ocean ridge basalts (MORBs) are different than in the ocean island basalts (OIB) such as in Iceland, Hawaii, Galapagos, Réunion, or Samoa. One such example is the high $^{3}He/^{4}He$ ratio observed in OIB, which are explained as a signature of the core, which in this case becomes a hidden geochemical reservoir. Here, we study the Helium partitioning between molten pyrolite and liquid iron, which represent proxies for the crystallizing magma ocean and the growing core, respectively. We employ molecular dynamics simulations based on the density functional theory as implemented in the VASP package. We perform the simulations at several temperatures and pressures that sample the magma ocean adiabat.

These calculations will allow to derive some trends on the preference of Helium on the silicate or iron melts. In the long term, they will confirm or inform the existence of a hidden reservoir deep inside the Earth, to position it in space, and to determine its formation in time.

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