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Vaporization of He and C from a Pyrolite Melt: Implications for the Early Earth's Atmosphere and Magma Ocean

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Many of Earth's primitive volatiles were contained in the magma ocean, from which they could be released into the early atmosphere through degassing processes. Knowledge of the flux of volatiles between magma ocean and atmosphere is imperative to better constrain Earth's volatile budget and the composition of the early atmosphere. Using first principles molecular dynamics, we investigate the vaporization behavior of helium and carbon from a pyrolite melt at low pressures and temperatures between 2,000 and 5,000 K. We find that both helium and carbon are quickly devolatilized, that carbon is devolatilized more rapidly than helium, and that degassing is dependent on both pressure and temperature. Additionally, we find that there is more vaporization of helium and carbon when both elements are present in the pyrolite melt. We evaluate the implications of the vaporization behavior of helium and carbon for the composition and formation of the early Earth atmosphere and the degassing of magmas present in the Earth today.