Goldschmidt 2024 Abstract
https://doi.org/10.46427/gold2024.23978

Rock melting? Oxygen fugacity matters

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Refractory oxygen bound to cations is a key component of the interior of rocky exoplanets. Its abundance controls planetary properties including metallic core fraction, core composition, and mantle and crust mineralogy. Interior oxygen abundance, quantified with the oxygen fugacity (fO_2), also determines the speciation of volatile species during planetary outgassing, affecting the composition of the atmosphere. Although melting drives planetary differentiation into core, mantle, crust, and atmosphere, the effect of fO_2 on rock melting has not been studied directly to date in detail. Here we experimentally determined the melting behaviour of a mid-ocean ridge basalt (MORB) composition and of natural peridotite KLB-1 at 2 GPa under buffered low and high fO_2 conditions. Results indicate that the liquidi and solidi of MORB and KLB-1 decrease by up to ~200 °C as oxygen fugacity increases by ~2 log units at 2 GPa. This implies that oxidation of Earth's upper mantle can trigger the generation of large volumes of magma.