Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35836

Superdeep diamond from Juína, Brazil: a rare corundum–ferropericlase assemblage

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Superdeep diamonds occasionally contain rare mineral inclusions that are a product of melt/fluid + host rock reactions deep in Earth's mantle. We report the first detailed geochemical characterisation of co-existing corundum and ferropericlase inclusions recovered from a single Type IIa diamond from Juína, Brazil. Ferropericlase exhibits an Mg# of 0.72 and NiO contents of 0.93–1.00 wt%. Both values are lower than those of ferropericlase in equilibrium with bridgmanite in harzburgitic and lherzolitic lithologies (Mg# >0.8 and NiO ~1.20–1.38 wt% [1]) — a fingerprint indicative of a hybridised mantle source at ≥250 km depth. Corundum is nearly pure Al_2O_3 (99.40 wt%) with minor but variable TiO_2 (0.75–1.17 wt%), and exhibits a fractionated trace element composition relative to CI Chondrite: a moderate enrichment in Ti, Hf and Zr, but depletion in Cr, Ni, Fe, Mg, and all rare earth elements. The presence of ferropericlase together with highly evolved, Ti–Zr-enriched corundum cannot be related to a single mantle assemblage. Instead, we propose diamond growth at a lithological boundary within a subducting slab. Ferropericlase records the reaction between ambient depleted mantle and an Al-saturated metasomatic agent (melt/fluid) released from the slab's basaltic crust, with corundum crystallizing concomitantly. Encapsulation of both phases in one diamond requires local oxidising conditions that stabilised corundum + ferropericlase. Our data provide direct mineralogical evidence for redox heterogeneity at slab–mantle interfaces in the transition zone–uppermost lower mantle, suggesting conditions where oxidised slab components generate redox gradients.

[1] Walter, M.J., Thomson, A.R. & Smith, E.M. (2022), *Reviews in Mineralogy and Geochemistry* 88, 393–450.