

SPECIAL COLLECTION: OLIVINE

Formation of phosphorus-rich olivine in Dar al Gani 978 carbonaceous chondrite through fluid-assisted metamorphism

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ABSTRACT

Phosphorus-rich olivine ($P_2O_5 > 1$ wt%) is a mineral that has been reported only in a few terrestrial and extraterrestrial occurrences. Previous investigations suggest that P-rich olivine mainly forms through rapid crystallization from high-temperature P-rich melts. Here, we report a new occurrence of P-rich olivine in an ungrouped carbonaceous chondrite Dar al Gani (DaG) 978. The P-rich olivine in DaG 978 occurs as lath-shaped grains surrounding low-Ca pyroxene and olivine grains. The lath-shaped olivine shows a large variation in P_2O_5 (0–5.5 wt%). The P-rich olivine grains occur in a chondrule fragment and is closely associated with chlorapatite, merrillite, FeNi metal, and troilite. Tiny Cr-rich hercynite is present as inclusions within the P-rich olivine. The lath-shaped texture and the association with Cr-rich hercynite indicates that the P-rich olivine in DaG 978 formed by replacing low-Ca pyroxene precursor by a P-rich fluid during a thermal event, rather than by crystallization from a high-temperature melt. The large variation of P_2O_5 within olivine grains on micrometer-scale indicates a disequilibrium formation process of the P-rich olivine. The occurrence of P-rich olivine in DaG 978 reveals a new formation mechanism of P-rich olivine.

Keywords: Phosphorus-rich olivine, fluid-assisted metamorphism, Dar al Gani 978, carbonaceous chondrite