

Phosphorus and oxygen fugacity: Probing Its Dual Geochemical Identity

STAMATIS FLEMETAKIS, MICHAEL FUX, CHRISTIAN
LIEBSKE AND MAX W SCHMIDT

ETH Zürich

Phosphorus (P) is an important yet often overlooked element in mantle geochemistry. The availability of P in the peridotitic mantle influences the stability of phosphates trace element partitioning, and redox-sensitive processes may play an important role in the deep Earth's P cycling. The crystallization of phosphates, such as apatite, at elevated P concentrations in the peridotitic mantle affecting the storage and mobility of volatiles and incompatible elements [1]. As a multivalent element, the behavior of P is strongly governed by oxygen fugacity (fO_2), which controls its speciation and partitioning between silicate and phosphate minerals, and both silicate and metal melts [2]. Variations in fO_2 not only affect P mobility but also determine the depth of the onset of redox melting in the mantle, where the fO_2 -dependent redox pair transition from P^0 to P^{5+} may influence the generation and composition of mantle-derived carbonated silicate melts [3].

Previous experimental studies on P partitioning between metal and silicate melts have revealed its dual behavior, exhibiting both lithophile and siderophile characteristics [4], which involves the transition between the $P^0 \leftrightarrow P^{5+}$ redox pair. However, the location of this transition in P oxidation state in the fO_2 space remains largely unexplored. Here, we present a systematic experimental investigation across a range of fO_2 , pressures, super adiabatic temperatures and melt compositions. Our data will help constraining the effects of fO_2 on P behavior in the mantle and assess its role as a geochemical tracer for incipient melt generation and the formation of intraplate alkaline magmas.

References:

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