Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28894

Inefficient nitrogen transport to the lower mantle by sediment subduction

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The fate of nitrogen within subducting sediments is crucial for understanding the origin of nitrogen in the deep Earth. This study examines the behavior of nitrogen in slab sediments during the transition from phengite to K-hollandite under conditions of 10–12 GPa and 800–1100 °C. The stability of phengite is extended by 1–3 GPa in the nitrogen-bearing system. The partition coefficient of nitrogen between phengite and fluid is 0.031 at 10 GPa, while the nitrogen partition coefficients between K-hollandite and fluid range from 0.008 to 0.064, displaying a positive correlation with pressure and a negative correlation with temperature. These results suggest that during the phengite to K-hollandite transition, K-hollandite can only retain approximately 43% and 26% of the nitrogen from phengite along cold and warm slab geotherms, respectively. Considering the influx of nitrogen from slab sediments, it is estimated that a maximum of ~1.5×10^8 kg/y of nitrogen, representing ~20% of the initial nitrogen influx, may be transported to the lower mantle by K-hollandite. This suggests that subducted sediments may have contributed less than 15% of the nitrogen present in the lower mantle, with the majority likely originating from primordial sources.