ID de Contribution: **105** Type: **Poster**

Tracing subducted carbon cycling by potassium isotopes of carbonatites

jeudi 22 mai 2025 13:15 (15 minutes)

Carbon cycling between Earth's surface and mantle reservoirs is crucial for maintaining planetary habitability. However, a significant yet poorly constrained aspect is the extent to which crustal carbon can withstand devolatilization during subduction, thereby influencing the deep Earth's carbon budget. Carbonatites offer an invaluable record to investigate this issue. Here, we present high-precision potassium isotope data from a comprehensive collection of carbonatite samples from continental and oceanic settings, spanning the last two billion years. Our modeling indicates that the enriched (heavy) potassium isotopic signatures observed in carbonatites originate from their mantle sources rather than magmatic or post-magmatic processes. These results provide compelling evidence for a robust link between oceanic crust subduction and the recycling of carbonates into the mantle sources of carbonatites. Consequently, our findings strongly support the hypothesis that subduction of carbonate-rich altered oceanic crust has served as a critical mechanism for transferring carbon into Earth's deep interior throughout geological history.

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Classification de Session: Posters

Classification de thématique: Earth, Environment and Space Sciences: Geochemistry