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Trace element concentrations in steady-state, disequilibrium porous flow partial melts

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Recent modeling efforts in partial melting and two-phase mantle flow have produced open-source calculator tools for determining partial melt compositions during steady-state, one-dimensional porous flow [e.g., 1]. Those efforts have focused on uranium-series disequilibria, which are sensitive to both the timing of melting and the extent of chemical equilibration between the decompressing solid matrix and migrating partial melts. Prior work has also incorporated new solutions that calculate the effects of chemical exchange inhibited by differential transport rates between the solid and the liquid, using a scaled reactivity term and a Damköhler number. To date, however, a comparable tool for determining trace element concentrations in the same partial melts has been lacking, and such results would be useful for direct comparison with U-series outcomes.

While batch melting calculations for trace elements in progressive melting scenarios are straightforward, non-linear fractional melting and scaled reactivity processes require a numerical approach. This work aims to develop an additional melt modeling tool that expands existing porous flow models to include stable trace element calculations and scaled chemical equilibration rates. This tool will be part of the open-source pyUserCalc package, and can be used in a modular fashion alongside other calculators in that package, including two-dimensional streamline integration for triangular melting regimes and dynamic melting calculations. Future development goals include integration of pyUserCalc tools with empirical and thermodynamic models for determining the melting behavior and stable mineral assemblages for a variety of mantle lithologies and melting conditions.

[1] Elkins, L. J., & Spiegelman, M. (2021), *Earth and Space Science*, *8*(12), e2020EA001619.