Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28335

Understanding the temporal evolution of continental crust formation and recycling through a geochemical perspective.

ALEXANDER V. SOBOLEV

Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, IRD, Univ. Gustave Eiffel

The predominant mechanism in the evolution of the Earth's silicate portion (BSE) is the formation and potential recycling of continental crust (CC). Although the remnants of the felsic crust (Hadean zircons) have been recognized since 4.3 billion years ago, there remains no agreement regarding the timing and mechanisms of substantial CC formation, nor the extent of its subsequent recycling into the mantle. The resolution of these issues is fundamentally linked to the understanding of Earth's geodynamic evolution, the investigation of the initiation of plate tectonics, and the exploration of prior conditions.

The conventional geochemical method for evaluating CC production involves monitoring its impact on mantle composition by utilizing BSE for trace elements, CHUR for Sm-Nd and Lu-Hf isotope systems, or BABI for Rb-Sr isotopes as a reference for the initial state. This approach must acknowledge that the production of CC is a multi-stage process, involving the formation of mafic crust followed by its subsequent melting under hydrous conditions. Consequently, a challenge with this approach is distinguishing the geochemical impacts of the production of CC from those of mafic-ultramafic oceanic crust (OC). The most effective tracers for this monitoring are canonical ratios of elements (e.g., Nb/U or Ce/Pb ratios), which remain unaffected by the formation of OC through "dry" melting of mantle but exhibit significant fractionation during hydrous melting of mafic or ultramafic compositions required for the generation of CC. In addition to the production of CC, the fractionation of elements of isotope pairs in the mantle, including Sm-Nd, Lu-Hf, and Rb-Sr, also reflects the generation of OC, albeit to a lesser extent.

The objects that are used for monitoring the production of CC are zircons, mantle-derived rocks, and olivine-hosted melt inclusions and ^{147}Sm-^{143}Nd, ^{176}Lu-^{176}Hf, ^{146}Sm-^{142}Nd and ^{87}Rb-^{87}Sr isotopes, several stable isotopes, and trace elements. This presentation will critically evaluate the limitations and findings of these studies.

The recent results argue for substantial CC production and recycling in Hadean and Eoarchean time. Nonetheless, a common challenge with these findings is that the magnitude and precise age of the observed effects could not be directly assessed and required support from geodynamical modeling.