Partial Melting Inverse Modeling of Earth Upper Mantle by Evolutionary Programming Optimization

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Abstract

Quantitative geochemical modeling has been developed in order to study partial melting processes of the Earth Upper Mantle, a major goal in Igneous Petrogenesis. The first such quantitative models were proposed about 45 years ago. Such conventional "direct" methods attempt to duplicate, essentially by trial and error, the observed trace-element composition in primary magmas (supposed to be derived from the mantle partial melting without later modification by differentiation processes, e.g., fractionated crystallization, assimilation, and/or magma mixing), assuming the chemical and mineralogical composition of source and other parameters (degree of melting, partition coefficients, and the relative participation of the mineral phases during the process). In contrast, using a minimum number of geochemical assumptions, "inverse" models are useful for computing the geochemical and mineralogical composition of the mantle source starting from the variations in trace-element concentration of a cogenetic suite of rocks produced by different degrees of melting. However, the "inverse" problem has been solved applying relatively simple models based in the parameter number reduction. In this work, we present an alternative approach based on the metaheuristic Evolutionary Programming with a minimum of parameter restrictions (e.g., geochemical and mineralogical source composition intervals, partition coefficients, and degree of melting range). This approach has been able to successfully reproduce the rare earth element composition of a hypothetical source from liquids generated from it at different degrees of melting.

References

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