PROCESSES: A Microsoft Excel workbook for modeling magmatic differentiation and metasomatic processes.

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PROCESSES is a program for quantifying magmatic and metasomatic processes using major and trace elements and isotopes. The program can model the main magmatic processes: crystal fractionation (Rayleigh fractionation, equilibrium, and in situ crystallization), assimilation fractional crystallization (AFC and ABLF), magma mixing (two or three end members of mixing and mixing test), modal and non-modal partial melting (dynamic, batch and fractional melting), partial melting inversion modeling (batch and dynamic) and zone refining. Some parameters required for the modeling of trace elements and isotopes (e.g., assimilation/crystallization rate or fractionated mineral proportions) can be estimated separately, either by major-element-based least-squares modeling, namely the OPTIMASBA program of Cabero et al. (2012) included in PROCESSES, or by using the formulation of Aitchetson & Forrest (1994), resulting in a robust two-step modeling. However, the program also allows these parameters to be entered arbitrarily, resulting in one-step modeling. Metasomatic processes can also be constrained by mass transfer modeling using the EASYGRESGRANT code of López-Moro (2012) implemented in PROCESSES. The results can be presented numerically and graphically. The numerical output includes publication-ready tables. The graphical output includes binary plots, normalized multi-element patterns, and chondrite-normalized REE patterns. In binary plots, theoretical vectors show the results of the modeling, which are represented by a set of patterns in normalized plots. Plots can be easily printed or copied and pasted into a word processor or drawing program. Error-free models can be created because the program displays warnings if a variable is missing. The program can model multiple processes simultaneously, making it easy to compare and visualize the results and determine the dominant process of differentiation.

References

Aitcheson & Forrest (1994), *Journal of Petrology* 35, 461-488.

Cabero, Mecoleta & López-Moro (2012), *Computers & Geosciences* 42, 206-211.

López-Moro (2012), *Computers & Geosciences* 39, 191-196.