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An old model in a new perspective: The dynamic melting column and its application in intracontinental basalt petrogenesis

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Basaltic melt generation has been thought to be a simple process, involving distinct and well-defined melt batches generated in the asthenosphere or in the lithospheric mantle. However in the last decade, it became clear that complex processes including magma mixing from several sources may take place during magma generation, therefore single melting models might not be able to describe the melting process properly.

We suggest that a trace element based melting column model assuming step by-step, dynamic melting caused by decompression would be a good estimation of how the mantle melts in intracontinental settings. This model makes it possible to assume a heterogeneous mantle source by adding melting cells with different composition and mineralogy, and can handle changes in bulk distribution coefficients caused by phase transitions for example the spinel-garnet transition in the upper mantle.

If the uppermost part of the melting column reaches the stability of spinel, partitioning of rare earth elements (REEs) change drastically, as heavy REEs are compatible in the garnet stability field during melting while moderately incompatible in depths where spinel is stable. This way, trace element concentrations in primitive basalts can provide information on melting depth. This depth can be quantified with the step-by-step dynamic melting column model if the geotherm or the potential temperature is known. This way the depth of the spinel-garnet transition will be definable. We assume that melting beneath intracontinental volcanic fields is limited to the asthenosphere, and that the top of the melting column will represent the lithosphere-asthenosphere boundary (LAB).

To test our model, we calculated lithospheric thicknesses for four Neogene-Quarternary basaltic volcanic fields from the Pannonian Basin, East Central Europe. Our results indicate slightly different LAB depths compared to previous, major element based calculations (Harangi et al., Int J Earth Sci, 2015).