

Interactive comment on “Global scale modeling of melting and isotopic evolution of Earth’s mantle” **by H. J. van Heck et al.**

Anonymous Referee #2

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In this article the authors introduce their numerical model for simulating the isotopic evolutions of the earth’s mantle. Partial melting and its corresponding fractionation are the key process in this thermochemical convection model. The results of their numerical example show that the method is implemented correctly. I think that the documentation of this numerical model and their evaluation on the model are of interest to the scientific community and therefore recommend that this paper is published in GMD subject to the points below being addressed or justified properly.

(1) Many studies have shown that the surface plates of the earth play an important role in mantle convection (Hoink et al, 2012; Roberts and Zhong, 2006). In this article, in their model the mantle is iso-viscous, except that the lower mantle is 30 times more viscous than the upper mantle, which means that there is no plate at all. How does this

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simplification influence the mantle convection, thus the chemical evolution? Does this influence their results?

(2) Studies have shown that the processing rate or the processing time, i.e., the time that would be taken to process a mass that is equivalent to the whole mantle, is the most important parameter to understand the chemical evolution of the earth (e.g., Huang and Davies, 2007). In the plate tectonic regime, in addition to the degree of partial melting, the ocean ridges and their spreading rate control the processing time. In the model of this paper, what controls the processing time? and how to compare it with that of the present earth?

(3) As suggested, eclogitization may influence the chemical evolution because of the increase in density when basalt goes back into the mantle. I think the code should include this function even though at this moment, eclogitization is not their focus of interests.

Other minor comments: (1) In Figure 5c: what the “melt production rate” means? What is its unit? (2) In Figure 9 left: what the y label “Cumulative mass” means?

Reference: (1) Hoink, T., Lenardic, A., Richards, M.A., 2012. Depth-dependent viscosity and mantle stress amplification: implications for the role of the asthenosphere in maintaining plate tectonics. *Geophys. J. Int.* 191, 30-41. (2) Roberts, J.H., Zhong, S., 2006. Degree-1 convection in the Martian mantle and the origin of the hemispheric dichotomy. *J. Geophys. Res.* 111, E06013. (3) Huang, J., and G. F. Davies (2007), Stirring in three-dimensional mantle convection models and implications for geochemistry: Passive tracers, *Geochem. Geophys. Geosyst.*, 8, Q03017, doi:10.1029/2006GC001312.

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