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Mantle convection and the distribution of geochemical reservoirs in the silicate shell of the Earth

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We present a dynamic 3-D spherical-shell model of mantle convection and the evolution of the chemical reservoirs of the Earth‘s silicate shell. Chemical differentiation, convection, stirring and thermal evolution constitute an inseparable dynamic system. Our model is based on the solution of the balance equations of mass, momentum, energy, angular momentum, and four sums of the number of atoms of the pairs 238U-206Pb, 235U-207Pb, 232Th-208Pb, and 40K-40Ar. Similar to the present model, the continental crust of the real Earth was not produced entirely at the start of the evolution but developed episodically in batches [1-7]. The details of the continental distribution of the model are largely stochastic, but the spectral properties are quite similar to the present real Earth. The calculated Figures reveal that the modeled present-day mantle has no chemical stratification but we find a marble-cake structure. If we compare the observational results of the present-day proportion of depleted MORB mantle with the model then we find a similar order of magnitude. The MORB source dominates under the lithosphere. In our model, there are nowhere pure unblended reservoirs in the mantle. It is, however, remarkable that, in spite of 4500 Ma of solid-state mantle convection, certain strong concentrations of distributed chemical reservoirs continue to persist in certain volumes, although without sharp abundance boundaries. We deal with the question of predictable and stochastic portions of the phenomena. Although the convective flow patterns and the chemical differentiation of oceanic plateaus are coupled, the evolution of time-dependent Rayleigh number, Rat , is relatively well predictable and the stochastic parts of the Rat(t)-curves are small. Regarding the juvenile growth rates of the total mass of the continents, predictions are possible only in the first epoch of the evolution. Later on, the distribution of the continental-growth episodes is increasingly stochastic. Independently of the varying individual runs, our model shows that the total mass of the present-day continents is not generated in a single process at the beginning of the thermal evolution of the Earth but in episodically distributed processes in the course of geological time. This is in accord with observation. Finally, we present results regarding the numerical method, implementation, scalability and performance.

References

[1] Condie, K. C., Episodie continental growth models: Afterthoughts and extensions, Tectonophysics, 322 (2000), 153-162.

[2] Davidson, J. P. and Arculus, R. J., The significance of Phanerozoic arc magmatism in generating continental crust, in Evolution and Differentiation of the Continental Crust, edited by M. Brown and T. Rushmer (2006), 135-172, Cambridge Univ. Press, Cambridge, UK.

[3] Hofmann, A. W., Sampling mantle heterogeneity through oceanic basalts: Isotopes and trace elements, in Treatise on Geochemistry, Vol. 2: The Mantle and the Core, edited by R. W. Carlson (2003), 61-101, Elsevier, Amsterdam.

[4] Rollinson, H., Crustal generation in the Archean, in Evolution and Differentiation of the Continental Crust, edited by M. Brown and T. Rushmer (2006), 173-230, Cambridge Univ. Press, Cambridge, UK:

[5] Taylor, S. R. and McLennan, S. M., Planetary Crusts. Their Composition, Origin and Evolution. (2009), 1-378, Cambridge Univ. Press, Cambridge, UK.

[6] Walzer, U. and Hendel, R., Mantle convection and evolution with growing continents. J. Geophys. Res. 113 (2008), B09405, doi: 10.1029/2007JB005459

[7] http://www.igw.uni-jena.de/geodyn