Institut für Geophysik

Geophysikalisches Kolloquium

Wintersemester 2023/24

Montag, 23.10.2023

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Thermochemical models of early Earth evolution constrained by isotopes and trace elements

Geochemical proxies such as rubidium-strontium (Rb-Sr) isotopic system and N/bU provide constraints on the production and recycling of oceanic and continental crust that happened during Earth's early evolution. Rb-87 decays to Sr-87 and due to the preferential partitioning of Rb into the crust (relative to Sr) during partial melting, 87Sr/86Sr ratio of the crust is higher than that of the mantle over time. Nb and U do not fractionate when mantle melts to form mafic magmas. On the other hand, Nb and U fractionate when mafic crust melts in the presence of water, i.e. during the production of the felsic magmas that form the bulk of continents. In this work, we model Rb-Sr and Nb/U evolution coupled with the melting processes in global convection models using the code StagYY [Tackley, 2008]. These geodynamical modelling results are then compared with the geochemical data obtained from the Weltevreden komatiite melt inclusions (Barberton greenstone belt, South Africa).

These models self-consistently generate oceanic and continental crust while considering both plutonic and volcanic magmatism and incorporate a composite rheology (diffusion creep and dislocation creep proxy) for the upper mantle. Pressure-, temperature-, and composition-dependent water solubility maps calculated with Perple X are also utilised, which control the ingassing and outgassing of water between the mantle and surface [Jain et al., 2022].

In our models, for the Hadean and the early Archean, the tectonic regime oscillates between mobile-lid and plutonic-squishy-lid, which is in agreement with the new geochemical data. The models also show intense production and recycling of continental crust, which is in agreement with new studies of melt inclusions in Weltevreden komatiites (87Sr/86Sr and Nb/U data) and previous geochemical box models [Rosas and Korenaga, 2018; Guo and Korenaga, 2020]. As the estimates of total amount of water (at the surface and in the deep interior) vary from 5-15 ocean masses (OMs) based on magma ocean solidification models to 1.2-3.3 OMs based on petrological models [Nakagawa et al., 2018], we also tested different initial values, which show

a strong influence on the amount of felsic melts produced. Ongoing work includes incorporating Sm-Nd, Lu-Hf isotopic systems and Th, Ce trace elements.

Das Kolloquium findet um 16:00 Uhr im Seminarraum GEO 315, Corrensstr. 24, 48149 Münster statt. Alle an dem Thema Interessierten sind hierzu herzlich eingeladen.

Die Dozenten des Instituts für Geophysik