

Thermal conductivity of (Mg,Fe)O from ambient to deep mantle conditions

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The thermal conductivity κ is one important physical property that controls the structure and the dynamics of the Earth's mantle [1,2]. Furthermore, κ influences the heat flux at the core-mantle-boundary and thus the generation of the Earth's magnetic field [3]. In spite of its significance, this parameter is insufficiently constrained due to the great technical challenges to measure thermal transport properties at pressure and temperature conditions relevant for the lower mantle. Here, we use an alternative approach and predict the thermal conductivity of model (Mg,Fe)O by equilibrium molecular dynamics simulations. We first investigate the effect of isotope disorder on κ in pure MgO with natural isotopic composition by randomly distributing the three most abundant Mg isotopes in the simulation cell. At ambient conditions we find that earlier simulations of Haigis *et al.* [5], which used an average isotope mass for all Mg ions, overestimate the thermal conductivity by about 32%. This overestimation is comparable to the predicted 46% from phonon lifetime calculations [4]. With rising temperature, the influence of isotope disorder on κ decreases and becomes almost insignificant at deep mantle conditions. Next, we analyse how the substitution of 10% or 20% of Mg by Fe masses affects κ . Due to the larger mass difference between Fe and Mg ions compared to that between Mg isotopes, the reduction is now much larger at ambient conditions and still relevant at pressures and temperatures of the lower mantle. Combining our new results with those of Manthilake *et al.* for (Mg,Fe)SiO₃ perovskite [6], an aggregate mantle of 20% (Mg_{0.80}Fe_{0.20})O and 80% (Mg_{0.97}Fe_{0.03})SiO₃ perovskite has a thermal conductivity of 10±2 W/(m K) at 3000 K and 138 GPa.

[1] Dubuffet & Yuen (2000) *Geophys. Res. Lett.*, **27**, 17-20.
[2] Naliboff & Kellogg (2007) *PEPI* **161**, 86-102. [3] Gubbins & Sreenivasan (2007) *PEPI* **162**, 256-260. [4] Tang & Dong (2010) *PNAS* **107**, 4539-4543. [5] Haigis *et al.* (2012) *EPSL* **355**, 102-108. [6] Manthilake *et al.* (2011) *PNAS* **108**, 17901-17904.

Composition of the oceanic crust: where have all the noble metals gone?

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It has been speculated that the low noble metal abundances of many evolved MORBs may reflect sulfide fractionation, either during melting, or, as a consequence of fractional crystallization in the oceanic crust [e.g., 1].

The depletion of incompatible noble metals and Re in lherzolitic fractional melting residues from the depleted mantle [2] can be used to estimate bulk peridotite-silicate melt partition coefficients for these elements at the specific P-T-f_{O₂}-f_{S₂} conditions of melt extraction (D_{Pd}≈0.7, D_{Au}≈0.12, D_{Re}≈0.08). The data for Re are in good agreement with bulk partition coefficients calculated from experimental data at suitable upper mantle f_{O₂}. Calculated abundances of these elements in primitive melts at 5-10 % melting are 10 ppb for Pd, 10 to 6 ppb for Au, and 2 to 1 ppb for Re. This contrasts with typical abundances in MORB of 0.05-2 ppb Pd and 0.1-3 ppb Au, whereas Re shows good agreement [e. g., 1,3,4]. Because partial melting of depleted mantle lherzolite cannot explain noble metal abundances in "primitive" MORBs, fractional crystallization in the crust is commonly invoked [1,3]. New data for the PGE+Re in different lithologies of the lower oceanic crust at hole 735B (crust formed by very slow spreading at the SW Indian ridge), indicate even lower abundances of Pd, Au and Re than in many MORBs. Clearly, the main site of fractionation of the PGE must be deeper than the drilled section. Recent data from lower crust of the Wadi Tayin section of the Oman ophiolite suggests significantly higher PGE abundances in fast spreading oceanic crust [5]. However, even these higher abundances fall short of expected concentrations in the oceanic crust. We conclude from this that most of the noble metal fractionation in MORB magma likely occurs during magma transport in the uppermost mantle. Dunites and harzburgites from the mantle section of the Oman ophiolite are strongly enriched in Pt, Pd and Re, thus providing hints for such fractionation processes [6, 7].

[1] Hertogen *et al.* (1980), *GCA* **44**, 2125-2143. [2] Wang, Z. *et al.* (2013), *GCA* **108**, 21-44. [3] Rehkämper *et al.* (1999), *GCA* **63**, 3915-3934. [4] Gannoun *et al.* 2007, *EPSL* **259**, 541-556. [5] Peucker-Ehrenbrink *et al.* (2012) *Geology* doi: 10.1130/G32431.1 [6] Lorand *et al.* (2009) *Terra Nova* **21**, 35-40. [7] Hanghoj *et al.* (2010) *J. Petrol.* **51**, 201-227.