Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.8144

Modelling the global water cycle – the effect of Mg-sursassite on the amount of globally subducted water

NILS BENJAMIN GIES[1] AND MATTHIAS KONRAD-SCHMOLKE[2]

[1]University of Gothenburg Department of Earth Sciences
[2]Earth Science Department, University of Gothenburg
Presenting Author: nbgies@gmail.com

Subduction of hydrated lithospheric mantle is the most important process regarding the transfer of significant amounts of water to depths exceeding 350 km. Hence, the interplay of the thermal structure within the subducted slab together with the PT-stability fields of hydrous ultra-high pressure phases control the dehydration of the slab and the amount water transported into the deeper mantle.

Regarding the thermal structures of subduction zones much effort has been spent for the compilation of a global dataset and several quantitative constraints on the global amount of deeply subducted water have already been published. Nevertheless, an evaluation and implementation of published thermodynamic data for the hydrous ultra-high pressure phases into 2D thermodynamic models is still missing. Especially the potential stability of Mg-sursassite has not been considered in previous publications.

We evaluated the effect of different thermodynamic datasets of Phase A and Mg-sursassite on the Earth’s deep water cycle. We implement these data in a global set of subduction zone thermal patterns [1] in a two-dimensional thermodynamic forward model that considers intra-slab fluid migration.

Based on published thermodynamic data, Mg-sursassite increases the limit of potential stability of hydrous phases (so-called "choke point line") by ~150 °C. This implies that the potential water transport to larger depths in moderately hot subduction zones is significantly enlarged. However, the steep slope of the experimentally determined Mg-sursassite dehydration reaction in the P-T space leads to dehydration of slabs with shallower geotherms between 4-7GPa which enter the Mg-sursassite stability field. Nevertheless, the stability of Mg-sursassite prevents complete dehydration of the plate for some subduction zones with steep geotherms.

Our quantitative determinations of the globally subducted water are between 1.3-3.55x10^8Tg/Ma, which is in the order of previously published data. The different thermodynamic datasets, associated experimental errors and equations of state used for Phase A and Mg-sursassite can lead to a difference of about 23% regarding the amount of globally subducted water.

Both, thermal patterns of subduction zones, especially at depths exceeding 7GPa and compressibilities and thermal expansivities of Phase A and Mg-sursassite must be improved to precisely quantify the global deep water cycle.

[1] Syracuse,van_Keken,&Abers, (2010),*The_global_range_of_subduction_zone_thermal_models.* Physics_of_the_Earth_and_Planetary_Interiors*, 183(1-2),_73-90.*