

C-O-H fluids and OH solubility in olivine under mantle conditions

XIAOZHI YANG¹

¹State Key Laboratory for Mineral Deposits Research, School of Earth Sciences & Engineering, Nanjing University, Nanjing 210046, China (xzyang@nju.edu.cn)

The storage of water as H-related defects in nominally anhydrous mantle minerals has received increasing attention in the past decades, due to the significant importance of such water, even on ppm levels, in affecting some physicochemical properties of the host phases and the upper mantle. Extensive data have been reported on water storage in olivine, the most abundant mineral in the upper mantle, and available studies have been nearly exclusively carried out by equilibrating or growing crystals in H₂O or in hydrous melts. However, fluids in the upper mantle are quite complicated, and are dominated by CO₂-H₂O in relatively oxidizing shallow depths (e.g., with oxygen fugacity close to the QFM buffer) and by CH₄-H₂O at reducing greater depths (e.g., with oxygen fugacity close to or below the IW buffer), but not H₂O only. Knowledge of water storage in olivine and its consequences on mantle processes, therefore, requires experimental annealing under conditions buffered by complex C-O-H fluids.

Using piston-cylinder and multi-anvil apparatus, we have experimentally studied the solubility of OH in olivine, with natural gem-quality olivine crystal as starting material, under peridotite-saturated conditions with coexisting fluid of CO₂-H₂O under Ni-NiO buffered oxidizing conditions and of CH₄-H₂O under Fe-FeO buffered reducing conditions, respectively, at 1-7 GPa and 1100-1350 °C (in comparison, OH solubility of olivine equilibrated with H₂O under otherwise identical conditions were also experimentally determined). The results show that the solubility of OH in olivine with either CO₂-H₂O or CH₄-H₂O as the coexisting fluid is much lower than that with H₂O as the coexisting fluid. Considering the partitioning coefficients of OH between mantle minerals, we suggest that the storage capacity of water in the upper mantle may have been largely overestimated in previous reports. Our results have profound influence on understanding partial melting, electrical conductivity anomalies and metasomatism in the upper mantle.