An internally consistent thermodynamic data set for dense hydrous magnesium silicates up to 35 GPa, 1873K

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Water-absent high-pressure experiments were carried out in the system MgO-SiO2-H2O in a multi-anvil apparatus from 11.0 to 21.5 GPa, and from 1073 to 1473K in order to constrain water-absent solid-solid reaction. From the determined water-absent phase equilibria, thermodynamic parameters of high-pressure hydrous phases were retrieved by the linear programming method. Together with dry mantle minerals from the existing data set, one set of thermochemical and thermophysical parameters with internal consistency for dense hydrous magnesium silicates (DHMSs) was evaluated up to 35 GPa and 1873K. High-pressure hydrous phases involved in the data set are, phase A, phase E, clinohumite, phase D, superhydrous phase B, hydrous wadsleyite, and hydrous ringwoodite. In addition, by calculating water-bearing reactions we have estimated the water activities in the fluid phase. The water activity decreases with increasing pressure and temperature, suggesting the amount of silicate component dissolved in the fluid phase increases with pressure and temperature. The calculated petrogenetic grid consisting of 89 univariant reactions can be used for the discussion of water circulation in the mantle. In the subducting slab peridotite, water in phase A as a post-serpentine phase is transferred to other DHMSs only by the solid-solid reactions down to the bottom of the upper mantle. At the 660-km depth, in the stagnant slab heated from the surrounding mantle, the free fluid will be released by the dehydrations of superhydrous phase B and phase D. The released fluid will be trapped by wadsleyite or ringwoodite in the surrounding mantle. In the case of very cold subduction without stagnation at the 660-km depth, DHMSs will survive into the middle of the lower mantle condition. In the upwelling plume through water-bearing transition zone, the free fluid will be produced when the plume passes the 410-km depth. The fluid generated in the plume will facilitate the movement of upwelling. Finally water will be released to the Earth's surface by magmatism. The fluid generated in the deep mantle contains significant amounts of silicate component. Therefore, at the 410- and 660-km depths, some chemical differentiation will be processed.