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The effects of temperature and water concentration on the olivine to wadsleyite transformation.

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We have performed multianvil experiments in order to understand the effects of temperature and mantle H_2O concentration on the sharpness and depth of the 410km discontinuity. It is generally accepted that d410 is caused by the transformation of $(Mg,Fe)_2SiO_4$ olivine to wadsleyite. Seismology provides estimates for the width of $d410$ that vary from $<$4 to $>$20 km thick. There are a number of factors that may affect the width of this transformation e.g. temperature and the partitioning of water. If these effects can be experimentally calibrated it may be possible to draw firm conclusions about the nature of the mantle on a regional scale from local estimates of the discontinuity width, position and velocity jump. Determining variations in the transformation interval arising from chemical or temperature effects using phase equilibria experiments is very difficult at these high pressures (14GPa), because the variations in width are for the main part likely to be below the precision of such high pressure experiments ($\sim$0.5 GPa).

The effect of temperature on the width of the dry olivine to wadsleyite phase transformation has been studied using Fe-Mg partitioning experiments between olivine, wadsleyite, ringwoodite and magnesiowüstite to calibrate a thermodynamic model for the phase relations. Results indicate that the dry transformation is significantly narrower than predicted by previous studies. The effect of H_2O concentration on the olivine to wadsleyite transformation has been investigated in the Mg_2SiO_4-H_2O system. Simple phase equilibria experiments in this system are complicated by a number of kinetic factors and suffer from the relatively poor precision in pressure determination. We have instead studied two parameters that are crucial to the determination of the important phase relations i.e. the solubility of H_2O in each phase as a function of

temperature and the pressure of the water saturated phase transformation relative to the dry transformation. The lowest pressure at which hydrous wadsleyite becomes stable has been bracketed in a series of experiments where dry $(Mg,Fe)_2SiO_4$ compositions were also present in the same sample assembly. Precise pressure measurements can be made using the compositions of coexisting dry $(Mg,Fe)_2SiO_4$ phases. Forsterite with as much as 5000ppm H_2O has been synthesised at pressures of 12 GPa. These results indicate that the solubility of H_2O in forsterite may be much higher than previously thought at conditions of the 410