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Transmission electron microscopy characterization of the dislocation populations in the dense hydrous magnesium silicate "superhydrous B"

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Water can be carried into the mantle through hydrous phases, as serpentines, during subduction of oceanic slabs. However the temperature and the pressure increase during subduction destabilize serpentines at ca. 200 km depth. However dense hydrous magnesium silicate (DHMS), are further potential water-carriers at deeper levels. Phase A is the first DHMS which appears during subduction. For cold slabs, the stability range of phase A extends from ca. 200 to 390 km. It is followed by phase E (from ca. 390 to 440 km), then by superhydrous B (from ca. 440 to 730 km), and finally by phase D. Serious attention is being paid on the deformation mechanism of superhydrous B in the pressure and temperature conditions of subduction, as the stability domain of this DHMS is large and coincides with the transition zone depths. The crystal structure of superhydrous B is orthorhombic with a *Pnnm* space group. The lattice parameters are a = 5.0895 Å, b = 13.969 Å et c = 8.6956 Å, and the chemical composition is $Mg_{10}Si_3O_{14}(OH)_4$.

In this study, we report synthesis and experimental deformation of superhydrous B in the multianvil apparatus followed by characterization of dislocations by transmission electron microscopy.

In order to synthesize this phase, three pure oxides (MgO, SiO_2 et $Mg(OH)_2$) are mixed and pressurized at 20 GPa, and at 1100°C during 4 hours. The recovered sample is then deformed, at 20 GPa and T= 1000-1100°C during 30 min in an assembly designed to generate deviatoric stresses. The deformed specimen is then prepared with a transmission electron microscope operating at 300 kV.

The results can be described in a quasi-hexagonal framework with a_{qh} = 8.6956 Å and c_{qh} = 13.969 Å as lattice parameters. The [010] and [001] axes of the orthorhombic system correspond to the $[0001]_{qh}$ and the $[11\text{-}20]_{qh}$ axes of the pseudo-hexagonal system, respectively. We have observed $\frac{1}{2}[1\text{-}100]_{qh}$ dislocations which move by climb, and sub-grain boundaries composed of these dislocations. Moreover, $[01\text{-}10]_{qh}$ perfect dislocations and $[10\text{-}10]_{qh}$ weakly dissociated dislocations (dissociation length of approximately 20 nm), with the following dissociation law: $<01\text{-}10>_{qh} \Leftrightarrow \frac{1}{2} <01\text{-}10>_{qh} + \frac{1}{2} <01\text{-}10>_{qh}$, are found. These dislocations glide on the basal plane and $\{2\text{-}1\text{-}11\}_{qh}$ pyramidal planes. Perfect ?$[11\text{-}20]_{qh}$ dislocations are also observed, but their gliding planes have not currently been characterized.