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LETTER

Dislocation microstructures in simple-shear-deformed wadsleyite at transition-zone conditions: Weak-beam dark-field TEM characterization of dislocations on the (010) plane

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ABSTRACT

Dislocation microstructures of an (010)[001]-textured wadsleyite have been investigated in weak-beam dark-field imaging in a transmission electron microscope. ½<101> partial dislocations on the (010) plane are characterized with [100] dislocations on the (001) plane and ½<111> dislocations forming {011} slip bands. The partial dislocations are extended on the (010) stacking fault as a glide configuration (i.e., Shockley-type stacking faults with ½<101> displacement vector). The [001] slip on the (010) plane occurs by glide of the dissociated dislocations, which can play an important role in the generation of the crystallographic preferred-orientation patterns reported in water-poor deformation conditions. The glide mechanism on the (010) plane leaves the oxygen sub-lattice unaffected, but changes the cation distribution, forming a defective stacking sequence of the magnesium cations in the process of dislocation gliding. The mechanism might be related to transformation plasticity and related effects, such as transformation-enhanced weakening and deep-focus earthquakes in the mantle transition zone.

Keywords: Wadsleyite, slip systems, slip plane, Burgers vector, Shockley-type extended dislocation, Frank's rule, Chalmers-Martius criterion