Structural and petrological analyses of blocky serpentinite in the Sanbagawa belt, central Shikoku, Japan: Implications for deep slow earthquakes

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In southwestern Japan, deep slow earthquakes such as tectonic tremor and slow slip events occur along a plate interface near the tip of the mantle wedge. In order to understand the relationship between deep slow earthquakes and deformation of mantle-wedge serpentinites, we perform structural and petrological analyses of a paleo-mantle-wedge serpentinite body in the Sanbagawa belt, central Shikoku, Japan. The serpentinite body examined was formed at pressure and temperature conditions corresponding to source areas of deep slow earthquakes. The serpentinite exhibits a block-in-matrix structure, formed by open and shear cracking under differential stress conditions. Block size distribution analysis yields fractal dimensions (D=1.3~6.5), indicating that the cracking occurs at various length scales. Antigorite aggregates in the matrix are coarse grained, formed through dissolution and precipitation of antigorite in the blocks. In addition, antigorite aggregates along localized shear planes deform by dislocation creep with a slip system of [010](001). Strength profiles along a subduction plate interface at southwestern Japan, obtained using friction and flow laws of antigorite, indicate these cracking occurs only at near-lithostatic and supra-lithostatic fluid pressures. We therefore suggest that episodic tremor and slip is caused by open and shear cracking following a localized plastic (viscous) deformation in the serpentinized mantle wedge, which is linked with perturbations in fluid pressure.

Keywords: serpentinite, slow earthquake, mantle wedge, Sanbagawa belt, fractal analysis

