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Crystallographic preferred orientation of talc determined by an improved EBSD procedure for sheet silicates: Implications for anisotropy at the slab–mantle interface due to Si-metasomatism

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Abstract

Talc is widely distributed over the Earth's surface and is predicted to be formed in various tectonic settings. Talc is a very soft and anisotropic sheet silicate showing very low friction behavior. Therefore, the formation of talc is expected to weaken the strength of talc-bearing rocks and may be associated with the initiation of subduction, and with a decrease in the coupling coefficient resulting in aseismic movements along faults and shear zones within subduction zones. For these reasons, understanding the crystallographic preferred orientation (CPO) of talc is important to quantify the anisotropy and physical properties of the host rock. However, it is difficult to measure a significant number of talc crystal orientations and to evaluate the accuracy of the measurements using electron-backscattered diffraction (EBSD). Therefore, talc CPO has not been reported, and there is uncertainty regarding the estimation of the strength of deformed talc-bearing rocks. Using methods developed for antigorite, we report the first successful EBSD measurements of talc CPO from a talc schist formed due to Si-metasomatism of ultramafic rocks by subduction zone fluids. We used a combination of W-SEM and FE-SEM measurements to examine domains of various grain sizes of talc. In addition, we used TEM measurements to evaluate the accuracy of the EBSD measurements and discuss the results of talc CPO analysis. Talc CPO in the present study shows a strong concentration of the pole to the (001) plane normal to the foliation. The strongest concentration of the [100] direction is parallel to the lineation. The talc schist produces similar S-wave splitting and P- and S-wave anisotropy as antigorite schist in deeper domains, thus identifying talc-rich layers in subduction zones may require a combination of geophysical surveys, seismic observations, and anisotropy modeling. The presence of strong talc CPO in rocks comprising the slab–mantle interface boundary may promote spatial expansion of the slip area during earthquakes along the base of the mantle wedge.

Keywords: Talc, crystallographic preferred orientation (CPO), electron-backscatter diffraction (EBSD), Si-metasomatism, anisotropy, sheet silicates, seismic observations, aseismicity