Geophysical Research Abstracts
Vol. 20, EGU2018-4738, 2018
EGU General Assembly 2018

Variations in magnetic anisotropy related to strain and serpentinization gradients in two shear zones from the New Caledonia ophiolite

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The anisotropy of magnetic susceptibility (AMS) is a mineral fabric indicator. The orientation of principal susceptibility axes, degree, and shape of the AMS ellipsoid can provide valuable information on the strain field if single crystal properties of the AMS carrier minerals are known. We investigate variations in principal directions, degree, and shape of anisotropy as a function of strain gradient and mineralogy/serpentinization in peridotites from two 10-km wide high-temperature shear zones in New Caledonia: the Bogota Peninsula and Tontouta Valley shear zones. These pre-obduction shear zones developed as part of ridge-transform systems in abyssal mantle peridotites and provide a high-temperature strain gradient that tracks the conditions from peridotite protomylonite to mylonite (1000-800°C). The shear zones also display serpentinization gradients that developed during low-temperature hydration of the peridotite.

Magnetic fabrics are investigated through low-field and high-field methods, the latter allowing for separation of paramagnetic and ferromagnetic contributions to the fabric. The degree of serpentinization, including the production of magnetite, is estimated from the sample density and mean susceptibility. An independent characterization of crystallographic preferred orientation (CPO) of olivine, clinopyroxene and orthopyroxene crystals is obtained from electron backscatter diffraction (EBSD) data. Olivine CPO varies from girdle to point distributions, and simulations based on measured or modeled CPO estimate the contribution of olivine to the overall AMS. Because low-field AMS mainly reflects the orientation of serpentine veins in serpentinized peridotite, high-field data are used to characterize the primary silicate fabrics. This study shows how mineral (shape, crystallographic) and magnetic fabrics vary along strain gradients, and illustrates how serpentinization affects low-field AMS data. In particular, the Bogota Peninsula shear zone provides an opportunity to study the AMS variations for different generations of serpentinization, from high-temperature antigorite to low-temperature lizardite. Results shown here provide a solid basis for interpreting magnetic fabrics in serpentinized peridotites, and a better understanding of serpentinization as a function of deformation/hydration gradients in mantle rocks.