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Reconstruction of the 3-D Shape and Crystal Preferred Orientation of Olivine: A Combined X–ray μ–CT and EBSD-SEM approach

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The complete reconstruction of the microstructure of rocks requires, among others, a full description of the shape preferred orientation (SPO) and crystal preferred orientation (CPO) of the constituent mineral phases. New advances in instrumental analyses, particularly electron backscatter diffraction (EBSD) coupled to focused ion beam–scanning electron microscope (FIB-SEM), allows a complete characterization of SPO and CPO in rocks at the micron scale [1-2]. Unfortunately, the large grain size of many crystalline rocks, such as peridotite, prevents a representative characterization of the CPO and SPO of their constituent minerals by this technique. Here, we present a new approach combining X-ray micro computed tomography (μ-CT) and EBSD to reconstruct the geographically oriented, 3-D SPO and CPO of cm- to mm-sized olivine crystals in two contrasting fabric types of chlorite harzburgites (Almírez ultramafic massif, SE Spain). The semi-destructive sample treatment involves drilling of geographically oriented micro drills in the field and preparation of oriented thin sections from μ-CT scanned cores. This allows for establishing the link among geological structures, macrostructure, fabric, and 3-D SPO-CPO at the thin section scale. Based on EBSD analyses, different CPO groups of olivine crystals can be discriminated in the thin sections and allocated to 3-D SPO in the μ-CT volume data. This approach overcomes the limitations of both methods (i.e. no crystal orientation data in μ-CT and no spatial information in EBSD), hence 3-D orientation of the crystallographic axes of olivines from different orientation groups could be correlated with the crystal shapes of olivine grains. This combined μ-CT and EBSD technique enables the correlation of both SPO and CPO and representative grain size, and is capable to characterize the 3-D microstructure of olivine-bearing rocks at the hand specimen scale.

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