Crystallographic orientation of a silicate mineral measured using Laboratory Diffraction Contrast Tomography

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X-ray Laboratory Diffraction computed tomography (LabDCT) produces three-dimensional (3D) maps of crystallographic orientation. The non-destructive nature of the technique affords the key benefit of full 3D context of these, and other, in-situ measurements. This study is the first to apply the technique to any material other than a metal or silicon. We report the first 3D measurements of the crystallographic orientation of olivine, which also makes this study the first to apply LabDCT to a) a non-cubic system and b) geological material.

First, we scanned fragments of olivine set in resin alongside glass microbeads, then reconstructed these data assuming an orthorhombic crystal system. We show that a) the regions within the experiment that index well according to the orthorhombic system correspond to olivine fragments in the Absorption Contrast Tomography image, b) crystalline regions not corresponding to olivine are not indexed assuming the same lattice parameters, and c) the diffraction data discriminates crystalline from non-crystalline materials as expected. Finally, we demonstrate that the method resolves sub-degree orientation differences between distinct regions within individual olivine fragments.

We conclude that DCT can be applied to the study of rocks and other crystalline or semi-crystalline materials, and offers major advantages over conventional techniques. We also note that LabDCT may offer a solution to the crystallographic measurement of substances that would otherwise be difficult to measure due to challenges in obtaining a perfect sample polish.