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Crystallographic orientation relationships in host–inclusion systems: New insights from large EBSD data sets

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Abstract

Crystallographic orientation relationships (CORs) between mineral inclusions and their hosts could potentially deliver information about inclusion formation processes and conditions. Most previous studies are based on small numbers of analyses. This paper uses EBSD to study host–inclusion CORs in an inclusion-rich Permian metapegmatite garnet (Koralpe region, Eastern Alps, Austria), demonstrating the importance of large data sets and of EBSD in particular for the analysis of CORs. The distribution of measured orientations reflects host garnet point group symmetry for 89% of inclusions analyzed (total N = 530). Each inclusion phase (rutile, corundum, and ilmenite) shows at least three different CORs to host garnet. "Statistical" CORs are introduced to describe distributions of inclusion orientations that have one or two degrees of freedom with respect to the host, but still reflect host crystal symmetry. Two end-member characteristics of statistical CORs are distinguished: rotation and dispersion. Most statistical CORs observed show a mixture of both. Each inclusion phase shows at least one statistical COR. Multiple coexisting CORs and statistical CORs are not restricted to rutile. Re-examination of previous garnet–rutile COR studies in light of the new results indicates that COR information may have been overlooked when using small data sets. Variation in COR parameters correlates with broad differences in assumed metamorphic conditions for new and literature samples, suggesting that petrogenetic information may be available if COR formation can be understood. The favorability of the detected CORs cannot be explained by a simple model involving minimization of misfit between lattice planes, implying that other interface properties or the inclusion formation mechanism are important controls on COR development.

Keywords: Electron diffraction, corundum, garnet, ilmenite, rutile, pegmatites, metamorphic petrology, inclusions, electron microscopy, igneous petrology