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Electron backscatter diffraction analysis of zircon: A systematic assessment of match unit characteristics and pattern indexing optimization

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Abstract

Quantitative microstructural analysis of zircon using electron backscatter diffraction (EBSD) requires a comparison of empirically collected electron backscatter patterns with theoretical patterns or "match units" derived from known crystallographic parameters. There are 23 possible crystallographic data sets for zircon, and associated match units, derived from natural and synthetic zircon and from theoretical calculations over a range of pressures and different rare earth element (REE) compositions. A systematic assessment of these match units has been undertaken by EBSD analysis of each of four zircons from a range of geological environments combined with principal components analysis and self-organizing map networks. Comparison of the different match units shows a systematic relationship across all samples that are related to changes in unit-cell dimensions associated with pressure and compositional variations. Systematic variations in the data generated from 96 EBSD maps, each comprising 10 000 electron backscatter patterns, indicate that match units associated with increasing pressure or REE dopants yield poorer quality EBSD data. The match units from low-pressure, undoped, natural zircon consistently yield the best EBSD results and are recommended for natural zircon EBSD studies irrespective of the zircon source or U content. The results provide a clear strategy for optimizing the acquisition and analysis of EBSD data from zircon from both crustal and mantle sources. In addition, the developed approach to match unit analysis may be applied to all other crystalline materials, potentially optimizing EBSD analyses from a range of materials.

Keywords: EBSD, microstructure, zircon, reflector file, match unit, REE, pressure, rare earth element