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The application of electron backscatter diffraction and orientation contrast imaging in the SEM to textural problems in rocks

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ABSTRACT

In a scanning electron microscope (SEM) an electron beam sets up an omni-directional source of scattered electrons within a specimen. Diffraction of these electrons will occur simultaneously on all lattice planes in the sample and the backscattered electrons (BSE), which escape from the specimen, will form a diffraction pattern that can be imaged on a phosphor screen. This is the basis of electron backscatter diffraction (EBSD). Similar diffraction effects cause individual grains of different orientations to give different total BSE. SEM images that exploit this effect will show orientation contrast (OC). EBSD and OC imaging are SEM-based crystallographic tools.

EBSD enables measurement of the crystallographic orientation of individual rock-forming minerals as small as 1 μm, and the calculation of misorientation axes and angles between any two data points. OC images enable mapping of all misorientation boundaries in a specimen and thus provide a location map for EBSD analyses. EBSD coupled to OC imaging in the SEM enables complete specimen microtextures and mesotextures to be determined. EBSD and OC imaging can be applied to any mineral at a range of scales and enable us to expand the microstructural approach, so successful in studies of quartz rocks, for example, to the full range of rock-forming minerals. Automated EBSD analysis of rocks remains problematic, although continuing technical developments are enabling progress in this area.

EBSD and OC are important new tools for petrologists and petrographers. Present and future applications of EBSD and OC imaging include phase identification, studying deformation mechanisms, constraining dislocation slip systems, empirical quantification of microstructures, studying metamorphic processes, studying magmatic processes, and constraining geochemical microsampling. In all these cases, quantitative crystallographic orientation data enable more rigorous testing of models to explain observed microstructures.