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Complete grain boundaries from incomplete EBSD maps: the influence of segmentation on grain size determinations

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Grain size analyses are carried out for a number of reasons, for example, the dynamically recrystallized grain size of quartz is used to assess the flow stresses during deformation. Typically a thin section or polished surface is used. If the expected grain size is large enough (10 μm or larger), the images can be obtained on a light microscope, if the grain size is smaller, the SEM is used. The grain boundaries are traced (the process is called segmentation and can be done manually or via image processing) and the size of the cross sectional areas (segments) is determined. From the resulting size distributions, 'the grain size' or 'average grain size', usually a mean diameter or similar, is derived.

When carrying out such grain size analyses, a number of aspects are critical for the reproducibility of the result: the resolution of the imaging equipment (light microscope or SEM), the type of images that are used for segmentation (cross polarized, partial or full orientation images, CIP versus EBSD), the segmentation procedure (algorithm) itself, the quality of the segmentation and the mathematical definition and calculation of 'the average grain size'. The quality of the segmentation depends very strongly on the criteria that are used for identifying grain boundaries (for example, angles of misorientation versus shape considerations), on pre- and post-processing (filtering) and on the quality of the recorded images (most notably on the indexing ratio).

In this contribution, we consider experimentally deformed Black Hills quartzite with dynamically re-crystallized grain sizes in the range of 2 - 15 μm. We compare two basic methods of segmentations of EBSD maps (orientation based versus shape based) and explore how the choice of methods influences the result of the grain size analysis. We also compare different measures for grain size (mean versus mode versus RMS, and 2D versus 3D) in order to determine which of the definitions of 'average grain size yields the most stable results.