Garnet porphyroblast inclusion trails as an independent kinematic indicators

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Abstract

The proper interpretation of microscopic textures can have a profound impact on the interpretation of a region's geological history. The central Coast Mountains near Prince Rupert, British Columbia, provides an ideal setting to study microstructural textures because rocks of mid-crustal depth are now exposed at the surface (Hollister, 1982). The region experienced crustal thickening from oblique thrusting that produced inverted metamorphic field gradients and transpression in crustal-scale shear zones referred to as the western metamorphic belt (WMB) (Crawford and Hollister, 1982). Metamorphism in the WMB has been well constrained to ~105 Ma through Lu-Hf dating of garnet, with porphyroblast-matrix relationships that indicate garnet growth was synchronous with deformational fabric development (Wolf et al., 2009).

Units in the WMB trend NW-SE with an average strike of 315° and dip of 65° NE. Compositional layering can still be observed in the samples and is identified as S_0. The unit has experienced an S_1 flattening, recorded by the development of the NW-SE trending fabric. This fabric is overprinted by a late S_2 during N-S shortening and significant chlorite growth occurred parallel to axial surfaces of folded fabrics. In the vicinity of Prince Rupert Harbour these fabrics are vertical and E-W.

Thin section G-16 D presents a mineral assemblage of garnet-biotite-muscovite-quartz-sillimanite-ilmenite. Various kinematic indicators, such as sigma clasts, C' shear bands, crenulation cleavages, and asymmetrical folds indicate left-lateral shear. Inclusion trails of ilmenite in the garnet curve continuously from the core where the inclusions are straight to the rims where the inclusions curve smoothly into the matrix foliation (Figure 1). The inclusion trails near the rims of the garnet curve into parallelism with the matrix foliation and present a curvature between 35 and 65 degrees. The curvature of the inclusion trails is consistent with fabric rotation around the garnet rather than garnet rotation within a stable fabric. If the inclusion trails are interpreted in terms of garnet rotation, the shear sense would be opposite to that inferred from independent shear sense indicators. However, it is important to note that the garnet inclusion trails are not parallel from garnet to garnet in the thin section. This indicates that the garnets either overgrew a previously folded fabric or experienced minor and varied rotation.

Thin section 98-114A presents a mineral assemblage of garnet-quartz-chlorite-biotite and thin section 98-148 shows a mineral assemblage of garnet- muscovite-biotite-chlorite-zoesite-quartz-anthophyllite-plagioclase. At the outcrop scale, kinematic indicators such as boudins,

shear bands, and asymmetric quartz vein arrays record left-lateral shearing. Garnets and other winged porphyroclasts support left-lateral shear at the thin section scale. The relationship observed between the garnet inclusion trails and other kinematic indicators is consistent with G-16 and support fabric rotation around the garnet.

Microstructural analyses of these samples indicate that the fabric rotated around garnet during deformation. Garnet growth occurred during sinistral deformation recorded by the kinematic indicators including sigma clasts, C' shear bands, and asymmetric crenulation cleavages. Garnet growth preceded the final deformation as evidenced by the relatively straight inclusion trails in the garnet cores. Our results show that rotation or non-rotation of garnet porphyroblasts can be constrained by comparing the geometry of curved inclusions to independent kinematic indicators.

References

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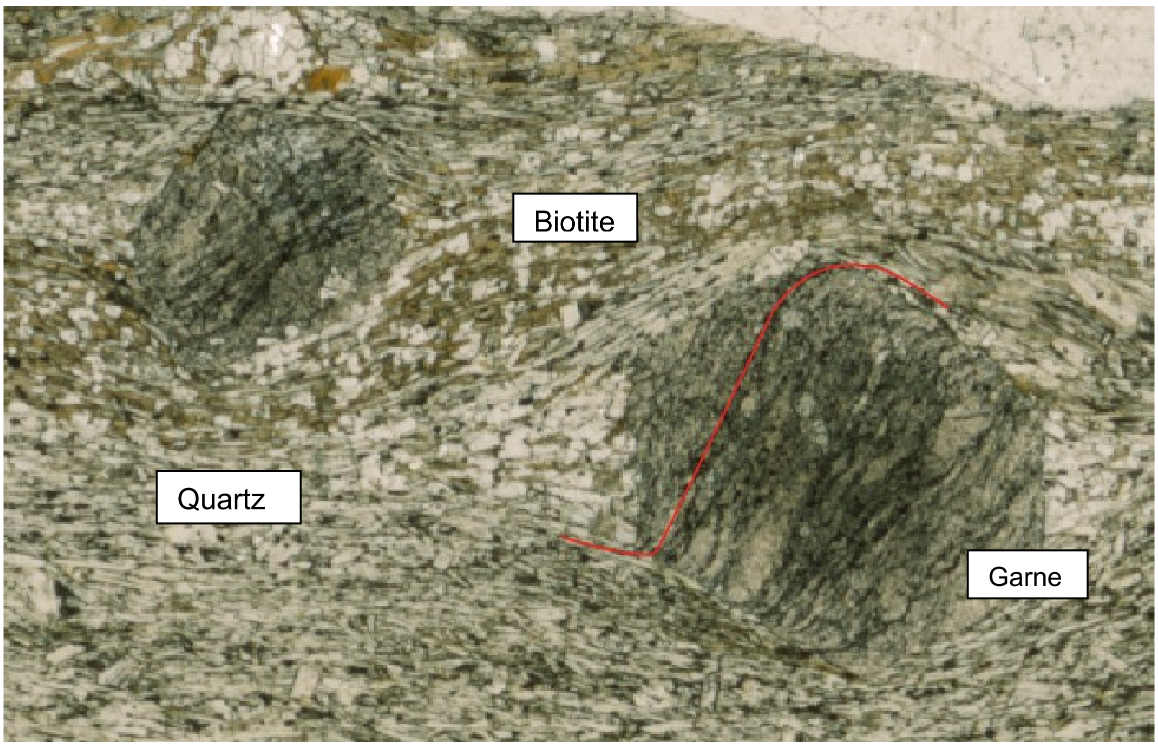

Figure 1: Sample G-16-D. Example of garnet with curved inclusion trails showing the relatively straight inclusions in the cores and curvature into the matrix foliation at the rim.