Grain-scale dependency of metamorphic reaction on strain

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The Breaksea Orthogneiss in Fiordland, New Zealand preserves water-poor intermediate and mafic igneous rocks that were partially recrystallized to omphacite granulite and eclogite, resectively at *c*. 120 Ma, $P \approx 1.8$ GPa and $T \approx 850$°C. Metamorphism was more extensive in areas marked by higher strain and garnet mode, that are patchy on the grain to outcrop scale. Igneous and metamorphic garnet and omphacite can be distinguished by major and trace element copositions and microstructural features. Gradual and stepped change in lattic misorientation identified in EBSD indicate near-grain-scale lattice distortion of phenocrysts, which are enclosed by homophase areas with low-angle boundaries forming subgrais with reduced distortion. Plastic strain seems to have been intrinsically linked to metamorphic reaction, which resulted in comparatively grossular-rich garnet, jadeite-rich omphacite, clinozoisite and kyanite, and the consumption of plagioclase. The limited, peripheral chemical modification of less deformed garnet and omphacite phenocrysts reflects slower rates of intra-crystalline diffusion in grain areas that lack networks of interconnected 3D defects and subgrain boundaries. These boundaries appear to have acted as pathways to accelerate in-grain element transport and metamorphic recrystallization. Upscaling the textural relationships enabless the estimation that 65% of the igneous protoliths experienced metamorphism, the other 35% having retained lower density igneous mineralogy.