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Index-mineral growth in regional-contact metapelites from Harpswell, Maine

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Metapelitic rocks of the Orrs Island-Harpswell Neck region, Maine, U.S.A record the following sequence of index-mineral based zones: garnet, staurolite, andalusite, and sillimanite [1]. The region is famous for unusual zoning patterns in Mn, Fe, and Mg found in metapelitic garnets from the lowest metamorphic grade [2]. Previous studies have mapped the major-element compositional zoning in over 200 individual garnets from a single outcrop spanning an area < 1 km^2 [2,3,4]. We use these detailed observations from the garnet zone as the foundation for an investigation of the progressive metamorphism of pelites to higher grade.

Petrographic analysis has revealed mineral assemblages and textural relationships across the metamorphic field gradient. Garnet occurs in all zones and staurolite persists into the andalusite and sillimanite zones. Whole-rock major-element compositions of pelites record the wide range of MnO contents (0.09 to 2.81 wt%). In Mn-richer pelites major-element zoning of garnet is patchy and X_{Mn} (= Mn/(Mn+Mg+Fe^{total})) of biotite, staurolite, and garnet rims is higher. Uniform differences between the X_{Mn} of biotite, staurolite, and garnet rims in individual samples indicates systematic partitioning of these elements [*e.g.*, 5]. Trace-element zoning patterns in garnet from different metamorphic grades are examined to determine the extent of garnet growth and resorption across the sequence and the relative mobility of trace and major elements.

Together, these observations have elucidated the recrystallisation processes within the prograde metamorphic sequence, allowing a comparison with predictions from phase equilibrium modelling. Differences in the composition and modal abundance of phases between rocks of varying Mn concentrations is investigated through T-X_{Mn} phase diagrams.

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