Garnet coronas formed by mineral – melt interactions

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Plagioclase-rich coronas surrounding garnets in high-grade aluminous gneisses from the Sawtooth Metamorphic Complex, Idaho, USA appear to have formed by small amounts of local partial melting that was restricted to porphyroblast-matrix boundaries. The coronas, up to 1 cm in size, consist dominantly of anhedral plagioclase (pl) + quartz (qtz) + biotite (bt) with minor sillimanite (sil) surrounding embayed garnets (grt), and differ by grain sizes and modes from the bt-sil-rich matrix. Peak pressure (P)-temperature conditions for the samples are near 7 kb and 750^{o}C based on classical geothermobarometry.
Irreversible thermodynamic modelling of grain boundary diffusion was used in combination with phase equilibrium modelling to assess the hypothesis that the coronas formed by local dissolution-precipitation reactions among solid phases linked by grain boundary diffusion in a "Carmichael" style reaction mechanism. Irreversible thermodynamic models of material transport between reaction sites of the dissolving garnet and the matrix via grain boundary diffusion and local equilibrium conditions for a wide range of relative diffusion coefficients were not able to match minerals and modes. This suggests that the haloes are not simply the result of redistribution of components via grain boundary diffusional transport between the garnet and matrix phases. Rather, phase equilibrium modelling over a P range of about 3kb suggest that the coronas form by decompression melting at the interface between garnet porphyroblasts and matrix. The amount of melt formed and garnet dissolved is proportional to the P change required to produce the observed modes. Additional indications of former melt are that the original garnet boundary appears to be resorbed and the garnet texture at the interface has cusps and thin peninsulas. The lack of K-feldspar (ksp) in the melt may indicate an earlier melting event that removed K from the bulk system composition. Melt in these rocks is spatially restricted to microenvironments.