Paleozoic tectono-thermal evolution of the Key Anacon Zn-Pb-Cu-Ag deposit, Bathurst Mining Camp, Canada, from pyrite microfabric and thermodynamic modeling of garnet.

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Pyrite in the upper-greenschist to amphibolite-facies Ordovician metavolcanic and metapelitic rocks hosting the Key Anacon Zn-Pb-Cu massive sulphide deposits records brittle-ductile deformation microtextures. These are preserved as pulled-apart boudins aligned parallel to S_1 fabric assemblages of M_1 that is associated with F_1, and as fine-grained inclusions in garnet, cordierite, and andalusite. Isoclinal to tight F_1 and F_2 microfolds in pyrite layers relate to the ductile deformation stage during progressive regional metamorphism. Deformation reflects marked structural thickening that produced garnet-bearing metapelites followed by exhumation via ductile shearing. Garnet in the metapelites display compositional zoning, and records a series of growth and resorption stages, with an early formed core and the first annulus preserving S_1, whereas the other annuluses through to the rim are synchronous with S_2 development during M_2.

Pressure-temperature estimates using sphalerite-arsenopyrite geothermobarometry on the sulphides suggest an average pressure of 4.1 kbar and temperature of 400°C. The garnet-bearing metapelites record an average temperature of 536 ± 11°C at 2.5 kbar (THEMOCALC v.3.21), whereas garnet-biotite Fe-Mg exchange thermometers suggests metamorphic temperatures of 530°C. The P-T conditions of growth of the garnet core were derived from isochemical P-T diagrams generated using THERIAK-DOMINO using XRF-derived bulk compositional data. Isopleths intersections for the garnet core give a temperature estimate of 437°C and pressure of 0.57 kbar. Successive P-T estimates from the first garnet annulus through to the rim were calculated to infer a P-T path followed by the rock during its tectono-thermal history. Peak metamorphic conditions of the garnet rim are 570°C and 2.5 kbar and during this stage, pyrite recrystallization and plastic deformation predominated. The P-T path suggests burial of the rocks during D_2 regional metamorphism with attainment of peak pressure (4.1 kbar) at a temperature of 524°C, whereas peak temperature conditions occurred during the exhumation stage. Contact metamorphism associated with the intrusion of the Devonian Pabineau Granite is the third metamorphic event (M_3) that overprints earlier regional metamorphic assemblages associated with S_1, S_2, and S_3 fabric elements. This is characterized by recovery textures in pyrite, quartz, cordierite, andalusite, and random growth of biotite. Annealing of pyrite suggest that conditions during this episode were predominated by thermal metamorphism that followed exhumation of the rocks.

The temperature estimates of the massive sulphides are lower as compared to the garnet-bearing metapelites, since sulphide assemblages re-equilibrate early during regional metamorphism. However, the calculated pressure from the sphalerite geobarometer is consistent with peak pressure estimates from the forward modeling of garnet using THERIAK-DOMINO. The close correlation of results in the different bulk rock compositions of metapelites suggest that the estimates are realistic and have geological significance.

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