UNRAVELING THE FLUID-PRESENT METAMORPHISM OF SCHISTS FROM GARNET COMPOSITIONS IN THE BLACK HILLS, SOUTH DAKOTA

Yanying Chen

Dr. Peter I. Nabelek, Thesis Supervisor

ABSTRACT

Garnets in Proterozoic metapelites in the Black Hills, South Dakota, were analyzed to determine their pressure, temperature and hydrothermal conditions of growth and to elucidate pressure-temperature-time paths of their host rocks. The metapelites are the product of garnet-grade regional metamorphism due to the collision of Wyoming and Superior cratons and subsequent contact metamorphism by intrusion of the Harney Peak Granite. X-ray element maps and compositional profiles across garnets were determined using electron-probe microanalysis. Mineral assemblage diagrams (pseudosections) with garnet composition contours were constructed using the THERIAK-DOMINO software and then the P-T-t paths can be derived. Results show that internal chemical diffusion would have been too slow for modification of garnet chemistry after crystallization. Thus, the chemical zoning must reflect conditions during garnet growth. In the garnet and staurolite zones, garnets initially grew in a low a(H_2O) environment and the temperature of initial growth may have overstepped the equilibrium temperature. In the sillimanite zone, low-grade garnet partially or fully recrystallized in a higher a(H_2O) environment and compositions suggest equilibrium growth commensurate with sillimanite-grade temperatures. Garnet compositions suggest that the early regional metamorphism occurred at relatively low pressures (~3 kbar), whereas the region in close proximity to the Harney Peak Granite had a high-P history (>6 kbar) that is supported by an occurrence of kyanite in one sillimanite-zone sample.