Prograde and retrograde: CO_2-rich fluid inclusions from the Pikwitonei Domain, Manitoba, Canada

J.K. VRY[1] and P.E. BROWN[2]
[1]*School of Earth Sciences, Macquarie University, NSW 2109, Australia*
[2]*Department of Geology and Geophysics, University of Wisconsin, Madison, WI 53706, USA*

Texturally early fluid inclusions in the cores of 13 granulite-facies garnets are CO_2-rich, with approximately 10 to 20 volume percent (vol%) H_2O and only minor CH_4 or N_2. The mean CO_2 homogenization temperature to liquid (Th) for inclusions in 12 samples is $+15.2^\circ$ C, corresponding to a CO_2 density of 0.82 g/cc ($n = 125$, $2\sigma = 8.2^\circ$ C). Inclusions in the remaining sample have lower Th (mean = $+5.4^\circ$ C, $n = 24$). The early, relatively low-density fluid inclusions in the cores of garnets do not provide information about the highest metamorphic temperature and pressure conditions for the Pikwitonei region (approx. 800° C and 8 kbar, or 1.09 g/cc for hypothetical inclusions of CO_2). Instead, the inclusions were probably trapped during early garnet growth at relatively low pressures (for the 12 samples $\leq$ 4.3 to 5.8 kbars at 750° C, for 0 to 20 vol% H_2O), and appear to have undergone only limited, or possibly no subsequent re-equilibration. This interpretation is consistent with the anti-clockwise P-T-t path determined for the region by other workers. For such a prograde path, early entrapped fluid inclusions would experience internal underpressures during most of the subsequent prograde and retrograde phases of metamorphism.

The compositions and densities of most of the fluid inclusions in quartz are probably related to conditions encountered during retrograde cooling and uplift. Rare, well-isolated CO_2-rich fluid inclusions in matrix quartz and feldspar could have been trapped either near the peak metamorphism or during retrogression. The average Th for CO_2 in these samples is -5.8° C(range = -12 to -0.2° C, $n = 14$) corresponding to an average CO_2 density of 0.96 g/cc (5.3 to 6.9 kbars at 750° C for 0 to 20 vol% H_2O). The highest density CO_2-rich fluid inclusions in the region are texturally late, and appear to be associated with severe hydrous retrogression of orthopyroxene. These inclusions could, perhaps, represent residues of fluids released after the peak of metamorphism, as the rocks cooled through the minimum melting point of granite.