Emerald at the Mountain River emerald occurrence is milky green and occurs in extensional quartz-carbonate veins hosted within organic-poor siliciclastic rocks. Oxygen isotope mineral pair equilibration thermometry indicates mineralization temperatures of 379 to 415°C. Fluid inclusion analyses indicate CO₂-N₂-bearing brines and homogenization temperatures between 118 and 258°C. Fluid pressures were on the order of 2.4 to 4.0 kbar, corresponding to depths of 9 to 15 km. Pyrite intergrown with emerald yields a 5 point Re-Os model 1 isochron age of 345 ± 20 Ma and an elevated initial $^{187}$Os/$^{188}$Os of 3.2, indicating a crustal source. The fluids involved in emerald mineralization were derived from deep-seated hydrothermal brines, and were likely the same fluids involved in producing the Manetoe facies dolomite and extensive carbonate-hosted zinc-lead occurrences throughout the Mackenzie Platform.

The Mountain River emerald occurrence shares many characteristics with Colombian-type emerald deposits. The Colombian emeralds are hosted in organic-rich black shales and formed during compressional deformation via thermochemical sulphate reduction of brines by organic matter. However, the Mountain River occurrence is hosted in organic-poor siliciclastic rocks and formed in an extensional back-arc environment via inorganic sulphate reduction. The Mountain River emerald occurrence thus represents a modification of the Colombian-type deposit model.