American Mineralogist, Volume 93, pages 270–282, 2008

Metamorphosed Ordovician Fe- and Mn-rich rocks in south-central Maine: From peri-Gondwanan deposition through Acadian metamorphism

David P. West Jr.,[1,*] Martin G. Yates,[2] Christopher Gerbi,[2] and Nellie Q. Barnard[1]

[1]Department of Geology, Middlebury College, Middlebury, Vermont 05753, U.S.A.
[2]Department of Earth Sciences, University of Maine, Orono, Maine 04469, U.S.A.

Abstract

The Wilson Cove Member of the Cushing Formation is a thin (up to 120 m thick) metamorphosed Fe- and Mn-rich unit exposed discontinuously over a distance of >75 km in southern Maine. Cathodoluminescence imaging of zircon grains from the unit reveal texturally isolated detrital cores surrounded by distinct metamorphic overgrowths. U-Pb SHRIMP core ages range from 463 to 2058 Ma with a strong peak in the Neoproterozoic-Early Cambrian. This distribution of ages is consistent with a peri-Gondwanan source region and a Middle to Late Ordovician depositional age. Zircon rims have an age of 373 ± 4 Ma, consistent with growth during late Acadian metamorphism. Whole-rock geochemistry reveals considerable major- and trace-element variability with generally elevated abundances of Fe_2O_3(t) (15–43 wt%), MnO (0.1–12.1 wt%), Ba (4–2503 ppm), and As (7–1161 ppm). Geochemical discrimination diagrams suggest the protoliths were mixtures of hydrothermal exhalatives and terrigenous clastic sediment, with these materials most likely having been deposited in a marine back-arc basin proximal to a peri-Gondwanan continental source region. Late Devonian low-pressure, amphibolite-facies metamorphism of these bulk compositions produced assemblages dominated by grunerite + garnet + biotite + quartz. These and other mineral assemblages found in the Wilson Cove unit in south-central Maine are consistent with peak metamorphic conditions of 550 to 600 °C and 3–4 kbar previously determined from nearby metapelites. Mineral assemblages, mineral modes, and mineral compositions in these Fe- and Mn-rich rocks are strongly influenced by whole-rock bulk compositional variability. In particular, the compositions of co-existing garnet and grunerite vary systematically as a function of whole-rock MnO concentration.

Keywords: Metamorphic petrology, analysis, chemical (rock), analysis, chemical (mineral), geochronology, ironstone, Maine