American Mineralogist, Volume 103, pages 1851–1868, 2018

High-pressure granulite facies metamorphism (~1.8 GPa) revealed in silica-undersaturated garnet-spinel-corundum gneiss, Central Maine Terrane, Connecticut, U.S.A.

Duncan S. Keller[1,*] and Jay J. Ague[1]

[1]Department of Geology and Geophysics, Yale University, PO Box 208109, New Haven, Connecticut 06520-8109, U.S.A.

Abstract

We quantify the metamorphic pressure-temperature (*P-T*) conditions for a newly discovered silica-undersaturated high-pressure granulite (HPG) from the Central Maine Terrane (CMT) in northeastern Connecticut, U.S.A. The rocks lie within the Acadian-Neoacadian orogenic belt (Devonian) and form part of the Brimfield Schist. The Brimfield and the adjacent Bigelow Brook Formation contain silica-saturated rocks that have previously been shown to have undergone ~1000 °C metamorphism. The pressure was less well constrained at ≥ ~1 GPa. Silica-undersaturated rocks hold underutilized potential for pinpointing peak metamorphic conditions, particularly pressure, because of their resilience to melting and the variety of refractory minerals they contain. The typical silica-undersaturated mineral assemblage is garnet + spinel + corundum + plagioclase + K-feldspar + biotite + ilmenite. Leucosomes are syenites consisting of two feldspars ± biotite. Plagioclase is commonly antiperthitic, particularly in feldspathic domains surrounding peritectic garnet; such garnet crystals reach ~10 cm in diameter. Alkali feldspars are perthitic. The rocks contain remarkable ellipsoidal spinels as much as 5.5 cm long comprising discrete crystallographic domains hosting crystallographically oriented lamellae of a Fe-Ti phase, most likely ilmenite. Corundum is usually colorless, but can also be found as sapphire in shades of pink, purple, and blue, particularly in antiperthite-rich domains surrounding large garnets. Some sapphires are concentrically color zoned. We carried out a *P-T* estimation using ternary feldspar reintegration thermometry of metamorphic antiperthites together with pseudosection modeling. Samples texturally and chemically record near-eclogite facies equilibration at minimum conditions of ~1040 °C and ~1.8 GPa, establishing the CMT in northeastern CT as the first known HPG locality in the U.S. These results are consistent with high P_2O_5 levels found in garnet (0.18 wt%), Ti-in-biotite thermometry, regional sillimanite pseudomorphs after kyanite, and preliminary experimental work on melt inclusions in garnet (Ferrero et al. 2017). The leucosomes provide strong evidence that partial melting of silica-undersaturated rocks at HPG conditions can produce syenitic magmata. Strongly melt-depleted silica-undersaturated rocks may also be protoliths for garnet + spinel + corundum xenoliths reported from kimberlites. The presence of HPG gneisses demonstrates that the large-scale thrusts of the CMT sample the deepest roots of the orogenic belt (60–70 km), and perhaps even deeper subduction zone lithologies as well.

Keywords: High-pressure granulite, silica-undersaturated, corundum, spinel, garnet, syenite