



Petrologic constraints on subduction zone metamorphism from a coesite-bearing metapelite in the Northern Appalachian Orogen

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The Caledonian orogen formed following Paleozoic subduction of the Iapetus Ocean and preserves evidence of ultrahigh-pressure (UHP) metamorphism and exhumation of crustal rocks from mantle depths. The Appalachian orogen similarly formed in the Paleozoic following subduction of Iapetus Ocean crust, but evidence for (U)HP metamorphism in exhumed Appalachian rocks has been challenging to identify. We present results from a metapelite from high-pressure rocks of the Tillotson Peak Complex in the northern Appalachians, which formed during the middle-Ordovician Taconic orogeny. This sample contained mm-cm scale garnet porphyroblasts that host abundant mineral inclusions. Confocal Raman microspectroscopy of inclusions in the rims of a garnet porphyroblast identified relic coesite, preserved as a bi-mineralic inclusion composed of coesite in α -quartz. Raman depth profiling and 2-dimensional mapping indicate the relic coesite is $\sim 10 \mu\text{m}^3$, suggesting that mineralogical evidence of UHP metamorphism in the Appalachians may be preserved only as μm -scale inclusions contained in polymetamorphosed rocks. We applied quantitative WDS X-ray maps acquired with electron microprobe, quartz-in-garnet elastic thermobarometry, and Zr-in-rutile trace element thermometry to further constrain the metamorphic history of the coesite-bearing metapelite. Garnet zoning patterns in conjunction with elastic and trace element thermobarometry applied to co-entrapped mineral inclusions suggest that garnet nucleated at 14-15.5 kbar and 420-520 °C, and continuously crystallized to 15-19.5 kbar and 470-560 °C during subduction zone metamorphism. Peak metamorphic conditions based on the stability field of coesite and on Zr-in-rutile thermometry from inclusions in the garnet rims suggest UHP metamorphism at >28 kbar and 530 °C. UHP metamorphism of pelitic sediments within the Taconic paleo-subduction zone invite comparisons with similar UHP rocks in the Caledonian orogeny. Future studies of UHP metamorphism in the Appalachian orogen will focus on constraining: 1) the spatial and temporal scales of UHP metamorphism, 2) the retrograde/exhumation P-T path of the coesite-bearing metapelite, and 3) the P-T history of other nearby metamorphic units, such as the Tillotson peak metabasites, to evaluate if these units shared a similar metamorphic history.