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Single-outcrop petrochronology to constrain heterogeneous prograde reactivity in the Central Appalachians

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Along eastern North America, Appalachian cover sequences of quartz, marble and schist record the late Ediacaran to Late Ordovician rift-to-drift and convergent history of the Laurentian Margin. In the Northern Appalachians, this sequence has been the focus of foundational petrological, geochronological, and structural studies. However, equivalent studies are less common in the Central Appalachians, where the rocks are more poorly exposed in urban settings. In Baltimore City, the youngest of this Appalachian stratigraphy is the metapelitic Loch Raven Schist, which is generally interpreted to have experienced a single episode of metamorphism and deformation associated with Taconic orogenesis at c. 440 Ma.

In this contribution, we present petrochronological results derived from a single outcrop of Loch Raven Schist. Combined, our data allude to a far more complex history of metamorphism and reactivity than previously identified. Multiple mineral paragenesis, phase equilibria, and Sm–Nd garnet and U–Pb monazite geochronology of a highly reactive aluminum-rich metapelite attest to two phases of metamorphism: an early, low-pressure phase overprinted by a subsequent kyanite-stabilizing event at c. 380 Ma. This date provides evidence of significant crustal disturbances in the Central Appalachians during Avalonian collision, an event also associated with a marked (likely fluid-induced) change in the reactive bulk composition. In an aluminum-poor horizon, zoned garnet geochronology alludes only to a protracted, early phase of garnet growth at c. 440–425 Ma. Plausible interpretation of this age is that it dates the early low-pressure phase of metamorphism and therefore either (a) extends the duration of the Taconic event or (b) provides new evidence for metamorphism associated with Salinic tectonism in the Central Appalachians. However, perhaps most puzzling is the absence of textural, geochemical, or geochronological overprinting during peak Acadian metamorphism at c. 670 ˚C and 8 kbar. Here, we discuss the potential controls on the apparent lack of reactivity in this sample, and what this may mean for both our understanding of both prograde metastability and our approaches to petrochronology moving forward.