Advances in constraining the timing of deformation and metamorphism: Salinic through Acadian transpressional tectonics in the Central Appalachians

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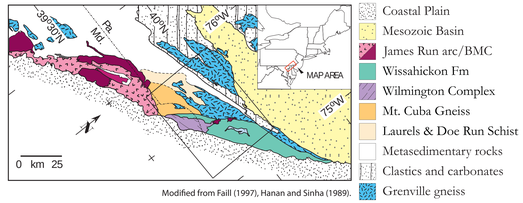
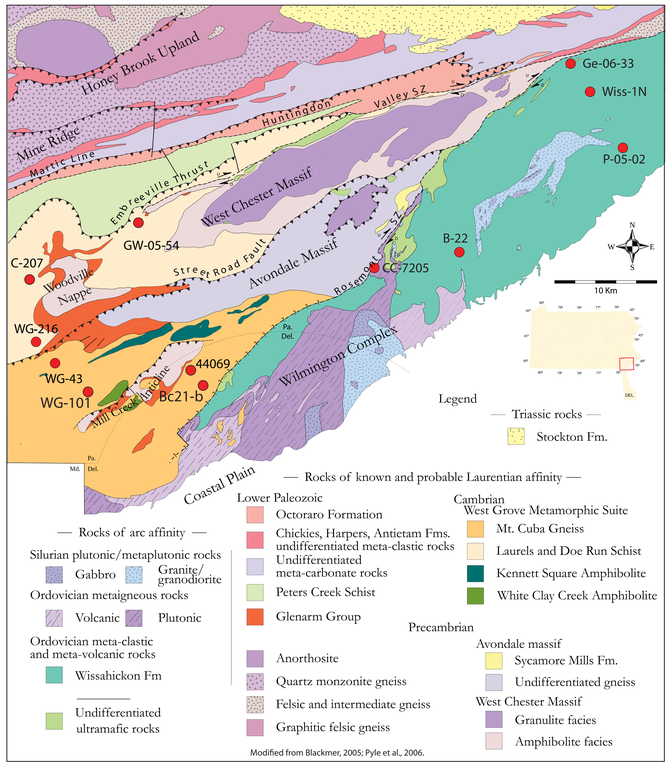
This poster focuses on the West Grove Metamorphic Suite (WGMS)- the Mt. Cuba Gneiss and Doe Run Schist and the arc-related Wissahickon Formation.

Simplified Geologic Map of the Central Appalachian Piedmont



Modified from Faill (1997), Hanan and Sinha (1989).

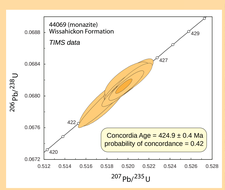
Geologic Map of Southeastern Pennsylvania and Northern Delaware

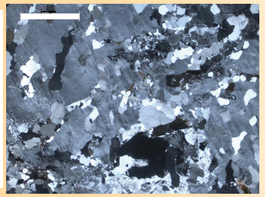


Modified from Blackmer, 2005; Pyle et al., 2006.

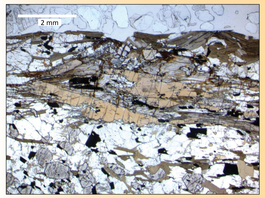
Mt. Cuba Gneiss

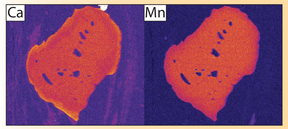
P-T conditions in Mt. Cuba Gneiss in the Mill Creek nappe, Yorklyn, De (loc. 44069) are estimated to have exceeded 750°C, based on the presence of perthitic feldspars, at pressures in the sillimanite stability field, but greater than 0.6 GPa, based on a lack of cordierite (Bosbyshell et al., 2011). SHRIMP and TIMS monazite ages, 426 ± 3 Ma and 424.9 ± 0.4 Ma, respectively (Aleinikoff, et al., 2006), constrain the timing of high-T metamorphism and deformation.

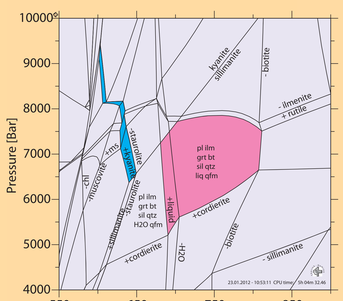


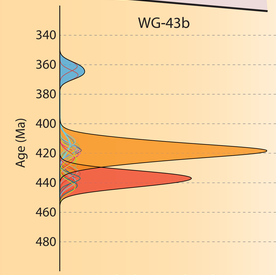


Mill Creek Nappe









The dominant foliation in the Mount Cuba Gniess above the Street Road Fault (sample WG-43) is defined by aligned sillimanite and biotite. Staurolite contains inclusions of foliation-parallel sillimanite and cross-cuts sillimanite fabrics. Kyanite occurs as small crystals which overprint sillimanite and high Ca-rims are present on garnet. This suggests a second period of mineral growth during isobaric cooling from peak temperatures.

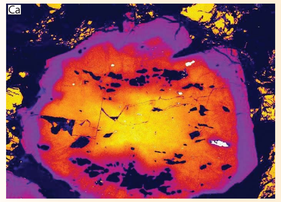
Monazite is complexly zoned and may contain two age populations: 419 ± 9.7 Ma and 437 ± 11.0 Ma. Both inclusions and matrix grains contain compositional domains which yield both ages. While there are instances where textures are consistent with this age difference, such examples are not ubiquitous. Thus it is not clear that these results indicate two distinct periods of monazite growth. The average of all analyses is 427 ± 14 Ma, similar to previously reported TIMS and SHRIMP results (above, Aleinikoff, 2006).

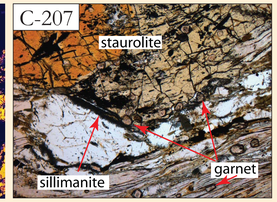
Street Road Fault

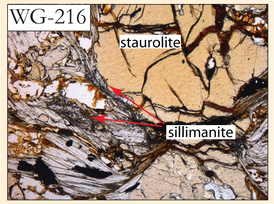
Avondale Massif

Rosemont Shear Zone

Doe Run Schist

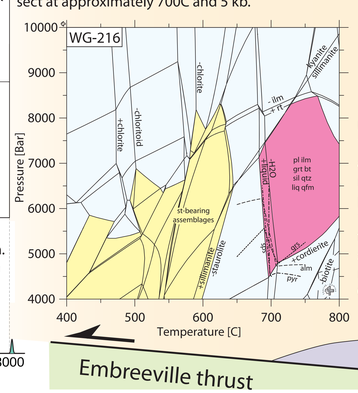


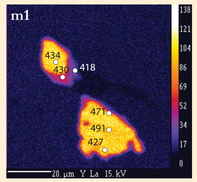




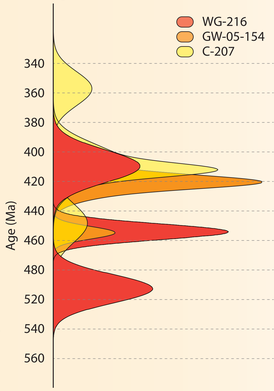
Ca x-ray map of garnet from WG-216. Low Ca rim is interpreted to correspond to garnet growth during high T staurolite breakdown (Srogi et al., 2007). Late garnet and sil after st (photomicrographs) is syn- to post-tectonic. Isopleths of this garnet rim compositon intersect at approximately 700C and 5 kb.

Width of field ≈ 6mm for both photos





Monazite with young, low-Y, high-Th rims is present in the matrix and as inclusions in the high-Ca garnet rims in WG-216. High-T metamorphism can be no older than 410 ± 11 Ma. Textural considerations on the timing of monazite growth similarly constrain the age of high-T metamorphism and deformation in C-207 to 411 ± 11 Ma.

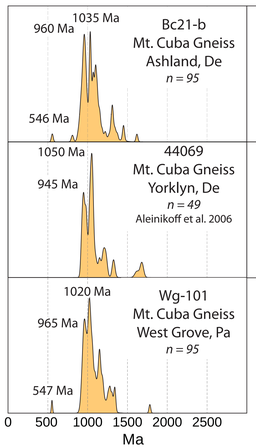


The Embreeville Thrust places the West Grove Metamorphic Suite and all structurally higher rocks above the greenschist grade Peters Creek Formation.

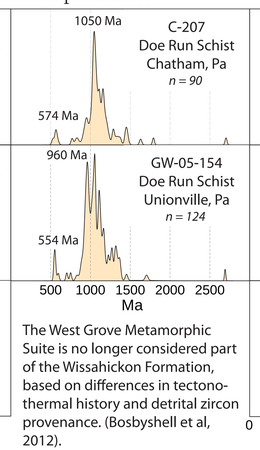
Embreeville thrust

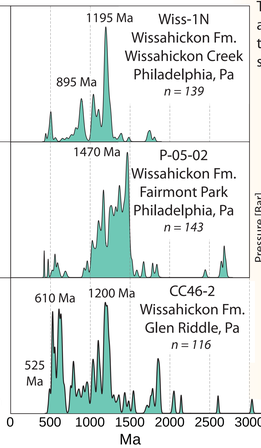
West Chester Massif

West Grove Metamorphic Suite



Wissahickon Formation

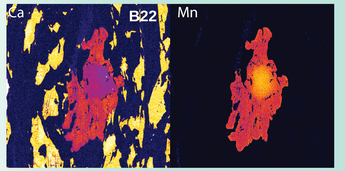


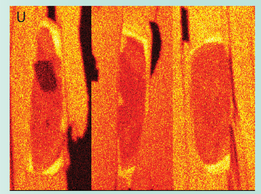


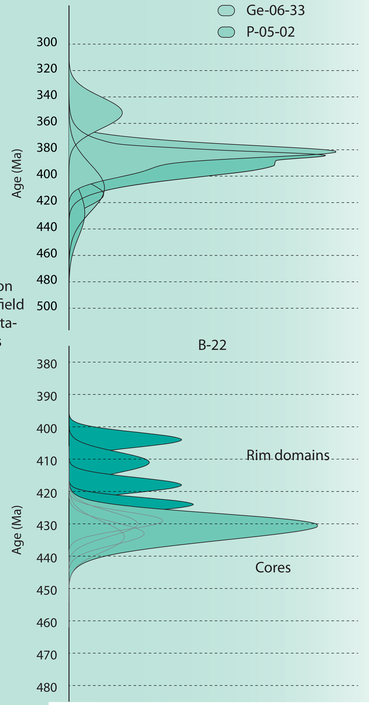
The West Grove Metamorphic Suite is no longer considered part of the Wissahickon Formation, based on differences in tectono-thermal history and detrital zircon provenance. (Bosbyshell et al, 2012).

Wissahickon Formation

While complexly deformed, the eastern Wissahickon Formation is characterized by a classic Barrovian, st-ky-sil metamorhpic field gradient and exhibits little evidence of the Silurian high-T metamorphism. Monazite ages indicate that this metamorphism is Devonian, approximately 384 Ma(Bosbyshell, 2008).

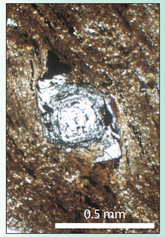


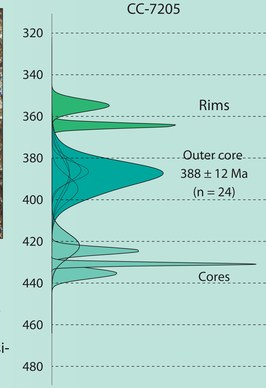




Sample B-22 demonstrates the metamorphic and deformational history of the western, probably lower portion of the Wissahickon Formation. Garnet maps show a low-Ca core, which formed during M1, high-T low-P metamorphism (andalusite-sillimanite grade), with a high-Ca overgrowth the formed during M2, higher-P, kyanite-grade metamorphism. The fabric in this rock, S3 wraps the M1 garnet core, but is included within M2 overgrowth. Monazite cores (433 ± 7 Ma) likely record the time of M1. Asymmetric high-U rims on monazite constrain the timing of S3 (average, 415 ± 14 Ma) and are included in high-Ca garnet rims.

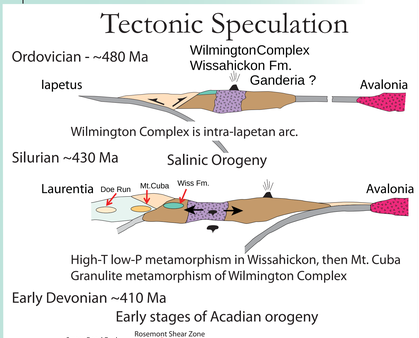
Rosemont Shear Zone





Above, syn-tectonic garnet in ultramylonite from the RSZ (loc. CC-7205). P-T estimates of 600C at 8 kb were obtained using the composition of this garnet with recrystallized matrix plagioclase and biotite. Syn-tectonic monazite is Devonian, 388 ± 12 Ma. The shear zone cuts high-T, low-P pelitic migmatite. Monazite cores record this earlier metamorphism and are similar in age to zircon and monazite in the adjacent Wilmington Complex (Aleinikoff et al., 2006).

Tectonic Speculation



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