A Structural and U-Pb Zircon Geochronology Investigation of Selected Units in the Eastern Merrimack Belt: Implications for Post-Acadian Deformation, Eastern Massachusetts

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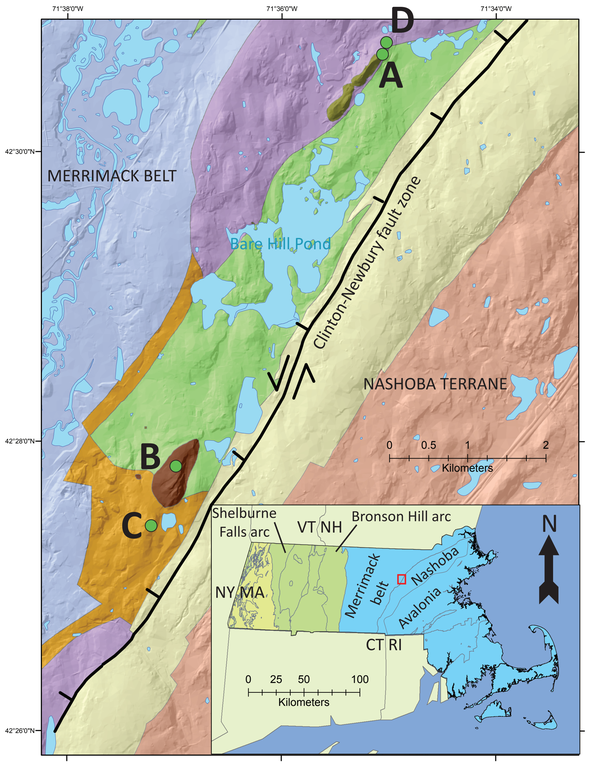
Abstract

The Silurian metasedimentary Merrimack belt of the NE Appalachians was deformed by at least two generations of isoclinal folds that were thought to be related to the Acadian orogeny. Along the eastern margin of the Merrimack belt in Massachusetts, the Harvard Conglomerate (HC) lies noncomformably above the Ayer Granite (AG). It is tightly folded and has been thought to be Carboniferous, suggesting that significant deformation in the HC and perhaps elsewhere in the Merrimack belt occurred during the Alleghanian orogeny. We tested this by:
(1) detailed structural analysis.
(2) detrital zircon U-Pb Laser Ablation – Inductively Coupled Plasma – Mass Spectrometry (LA-ICP-MS) analysis on the HC, the Vaughn Hill Conglomerate (VHC) directly south of the HC that has previously been mapped as HC, and the Vaughn Hill Formation (VHF) that possibly underlies the VHC.
(3) U-Pb Chemical Abrasion –Thermal Ionization Mass Spectrometry (CA-TIMS) analysis on the AG.
(4) CA-TIMS analysis on the youngest detrital zircons of the HC and VHC.

Field Area and Geochronology Sample Sites



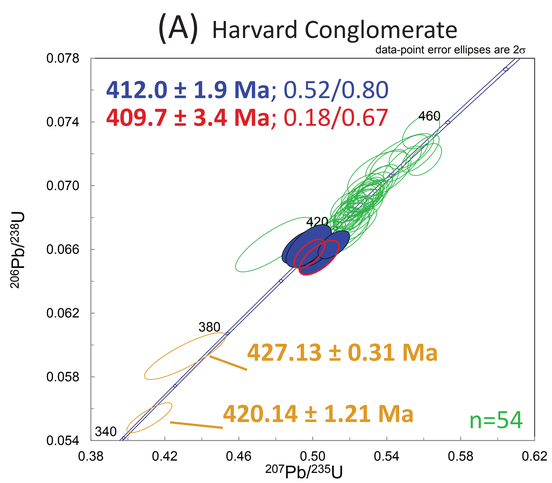
Merrimack Belt Units
- Harvard Conglomerate
- Vaughn Hill Conglomerate
- Vaughn Hill Fm.
- Ayer Granite
- Devens Gneiss Complex
- Oakdale Fm.

Nashoba Terrane Units
- Tadmuck Brook Schist
- Nashoba Fm.

Inset
- Laurentia
- Peri-Laurentian Terranes
- Peri-Gondwannan Terranes

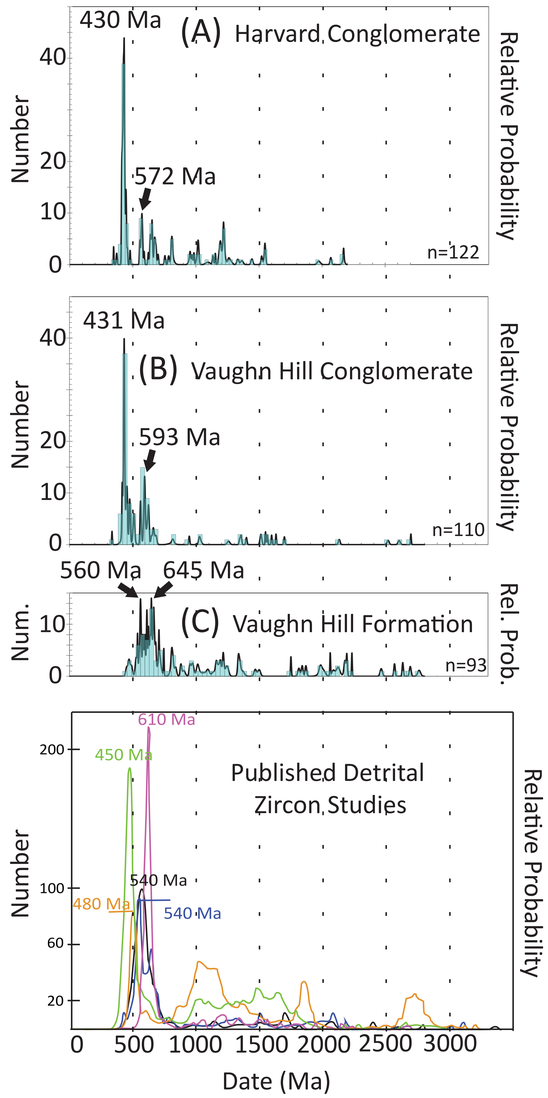
Inset altered from Skehan et al., 1993; Aleinikoff et al., 2007; Pollock et al., 2007; Loan, 2011

Youngest Detrital Zircon Populations



Zircon was analyzed by LA-ICP-MS at the University of Kansas element ICP-MS geochronology lab. The three young grains (orange) in (A) and (B) were analyzed at the University of Kansas lab (LA-ICP-MS) and the MIT geochronology lab using CA-TIMS.

Detrital Zircon Provenance

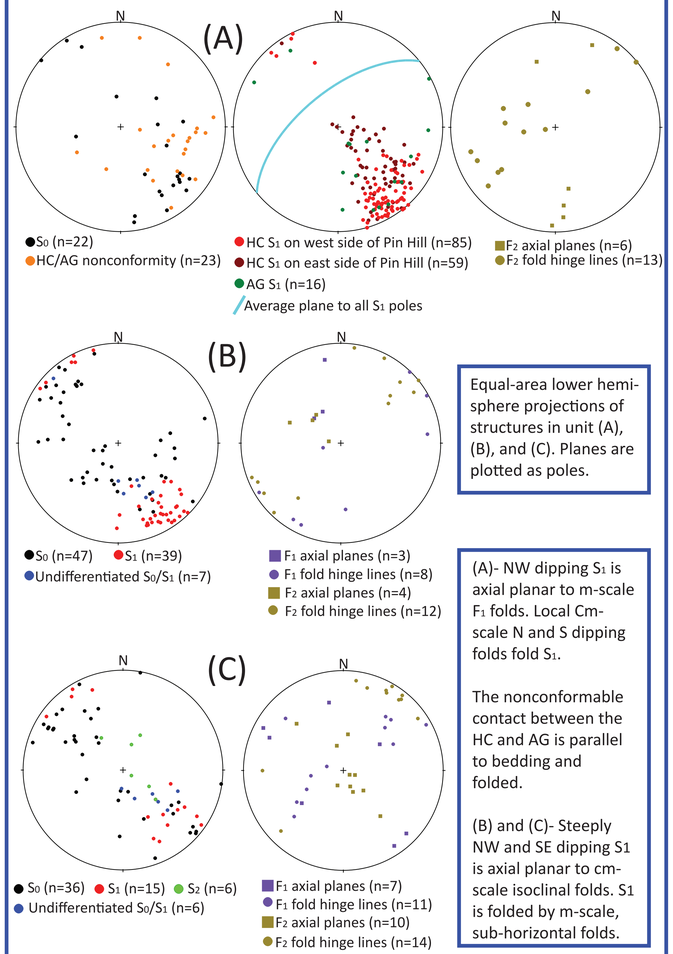


Probability density plots of units (A), (B), and (C). Published cumulative probability plots of detrital zircon ages for various metasedimentary units (Merrimack Belt and Nashoba terrane), the Laurentian margin, and the micro-continents Ganderia and Avalon. Probability plots are scaled to the histogram y-axis to reflect the number of grains. Ages of largest peaks shown.

- Merrimack Belt (Sorota, 2013)
- Nashoba terrane (Loan, 2011)
- Laurentian Margin (Cawood & Nemchin, 2001; Pollock et al., 2007)
- Ganderia (Pollock et al., 2007; Fyffe et al., 2009)
- Avalon (Thonpson and Bowring, 200; Hepburn, 2008; Pollock et al., 2009)

Concordia diagrams of the youngest zircon clusters. Green: youngest concordant cluster. Blue: youngest distinct zircon populations with associated ages. Red: youngest cluster overlapping at the 1σ (68%) level with associated ages. Orange: $^{206}Pb/^{238}U$ CA-TIMS dates of the youngest zircons. e.g. **412.0 ± 1.9 Ma**; 0.52/0.80 means $^{206}Pb/^{238}U$ weighted average age; MSWD/probability of fit.

Structural Data



Equal-area lower hemisphere projections of structures in unit (A), (B), and (C). Planes are plotted as poles.

(A)- NW dipping S_1 is axial planar to m-scale F_1 folds. Local Cm-scale N and S dipping folds fold S_1.

The nonconformable contact between the HC and AG is parallel to bedding and folded.

(B) and (C)- Steeply NW and SE dipping S1 is axial planar to cm-scale isoclinal folds. S1 is folded by m-scale, sub-horizontal folds.

Conclusions

Youngest grain populations for the HC and VHC are ~409 Ma and ~414 Ma respectively. The youngest grain population for the VHF is ~526 Ma. The units were deposited sometime after these dates, respectively.

The HC and VHC have detrital input from very similar sources with major peaks at ~430 Ma and smaller peaks at ~580 Ma. The VHF has a peak-valley signature from ~560-645 Ma with older smaller peaks at ~1000-1500 Ma and 1700-2600 Ma.

Possible sources of detrital zircon for the HC and VHC are recycled Merrimack belt rocks (~430 Ma peak) and recycled Laurentian margin, Ganderian/Nashoba terrane and Avalonian rocks (~ 580 Ma peaks and older smaller peaks). Possible sources for the VHF are recycled Ganderian/Nashoba terrane and Avalonian rocks (~560 -645 Ma peaks) and the Laurentian margin (older smaller peaks).

The HC nonconformably overlies the 420.13 ± 0.11 Ma AG (collected at site (D), analyzed at the MIT geochronology lab) and has been correlated with the Pennsylvanian aged, fossiliferous Coal Mine Brook Fm. based on lithology. The HC and VHC have very similar detrital signatures suggesting they are syn-depositional, which would make the VHC Pennsylvanian in age if the HC is equivalent to the Coal Mine Brook Fm.

The VHF and VHC show similar deformation histories, which are different from that of the HC. If the VHC is Pennsylvanian in age, and has similar deformation styles to units in the Merrimack Belt unit, then significant post Acadian deformation in the eastern Merrimack belt may have occured.