Foreland zone faults and veins related to along-strike propagation of slab breakoff at the end of the Taconic Orogeny (T6; Paper 20-1)

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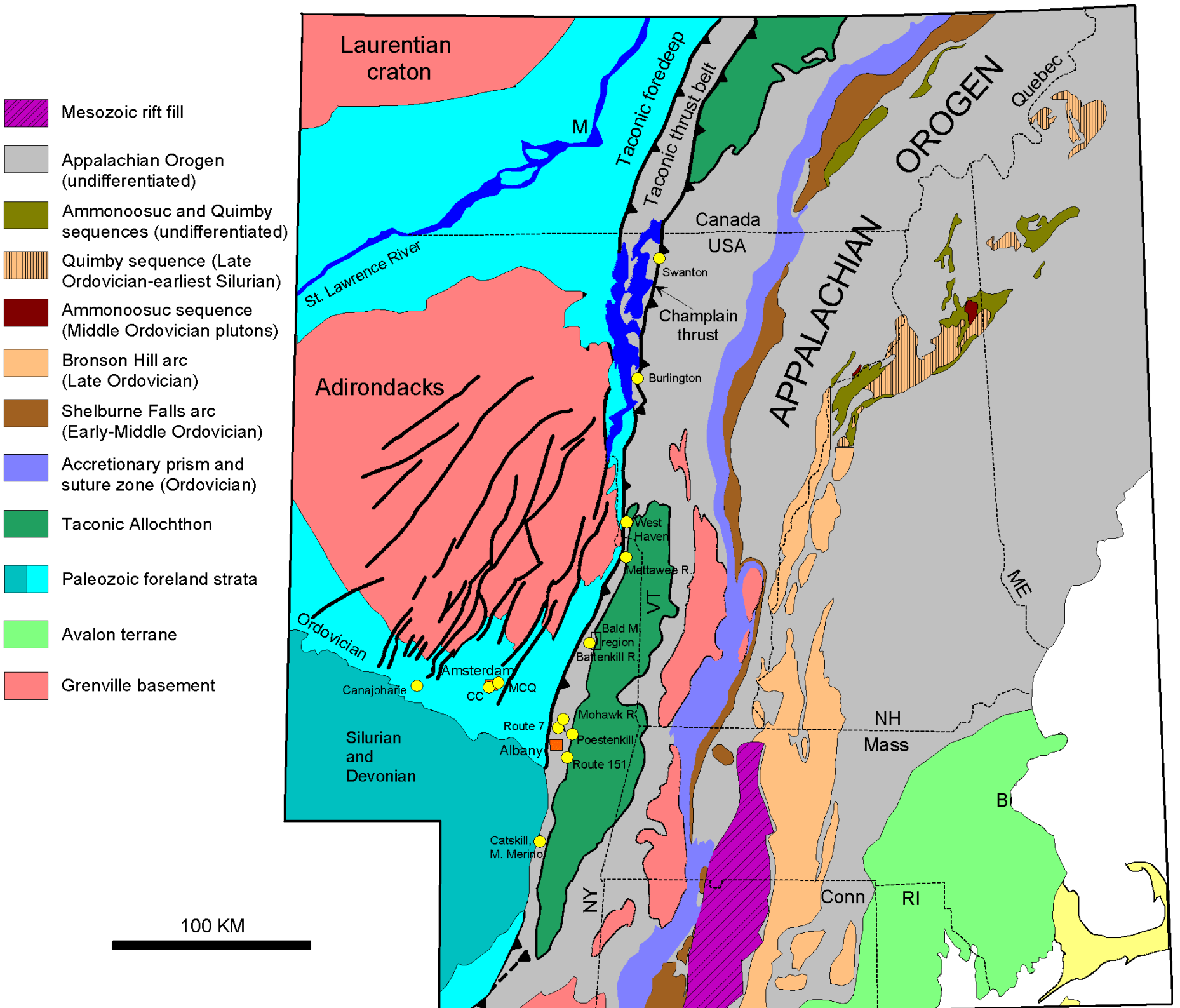
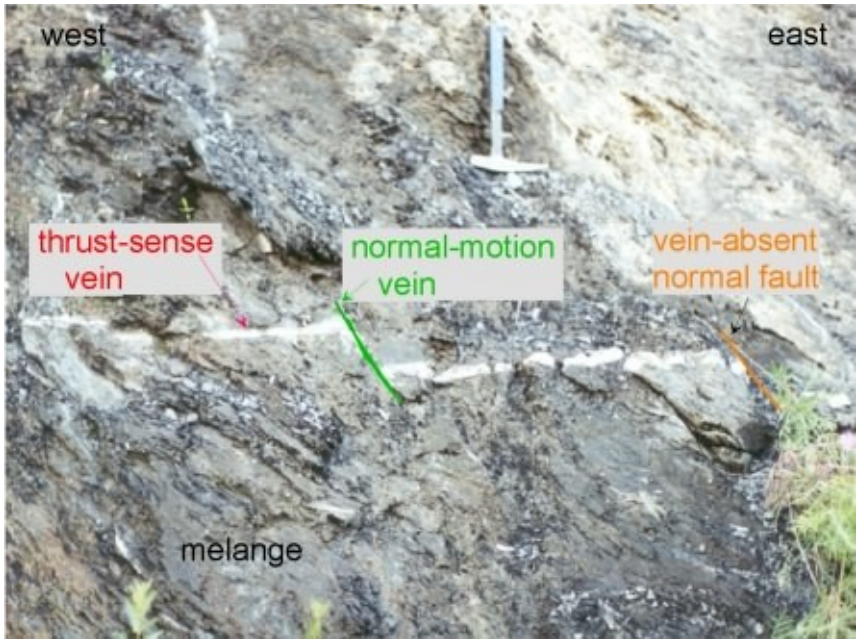
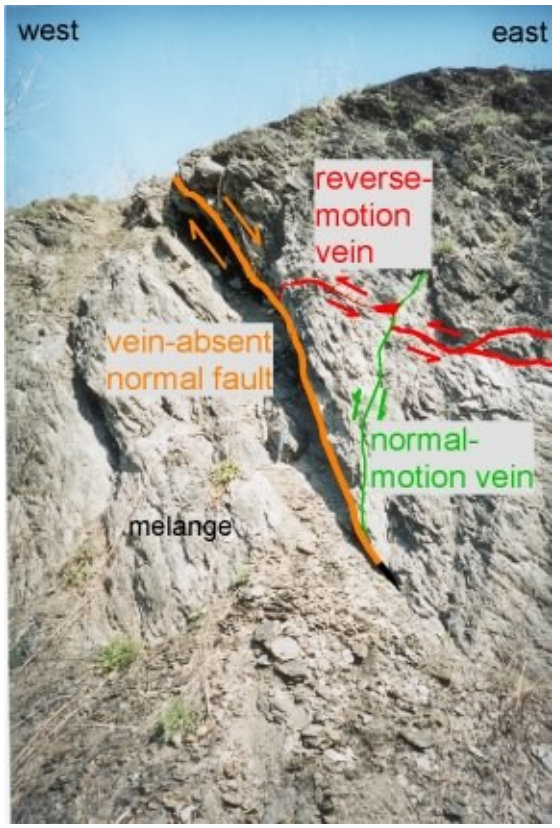

Mesozoic rift fill
Appalachian Orogen (undifferentiated)
Ammonoosuc and Quimby sequences (undifferentiated)
Quimby sequence (Late Ordovician-earliest Silurian)
Ammonoosuc sequence (Middle Ordovician plutons)
Bronson Hill arc (Late Ordovician)
Shelburne Falls arc (Early-Middle Ordovician)
Accretionary prism and suture zone (Ordovician)
Taconic Allochthon
Paleozoic foreland strata
Avalon terrane
Grenville basement
Laurentian craton
M
Taconic foredeep
Taconic thrust belt
OROGEN
Quebec
Canada
USA
St. Lawrence River
Swanton
Champlain thrust
APPALACHIAN
Burlington
Adirondacks
West Haven
Mettawee R.
VT
ME
Ordovician
Bald M. region
Battenkill R.
Amsterdam
Canajoharie
CC
MCQ
Mohawk R.
Route 7
Poestenkill
Albany
Route 151
NH
Mass
Silurian and Devonian
Catskill, M. Merino
NY
Conn
RI
100 KM

Examples of veins and faults in Cohoes Melange
NY Route 7 roadcuts
Latham, NY





Melange deformation is followed by:

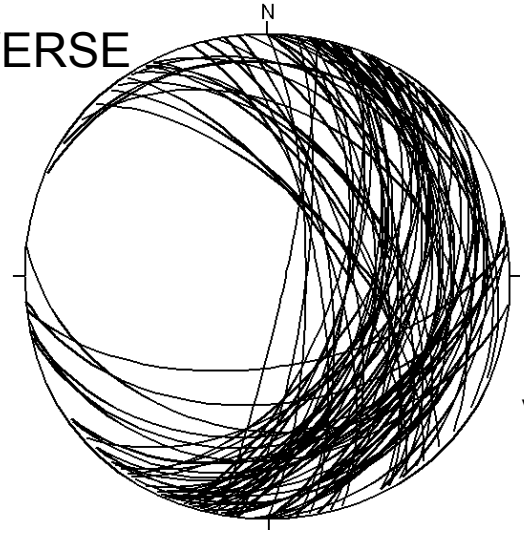
1 – Thrust-sense veins

2 – Normal sense veins

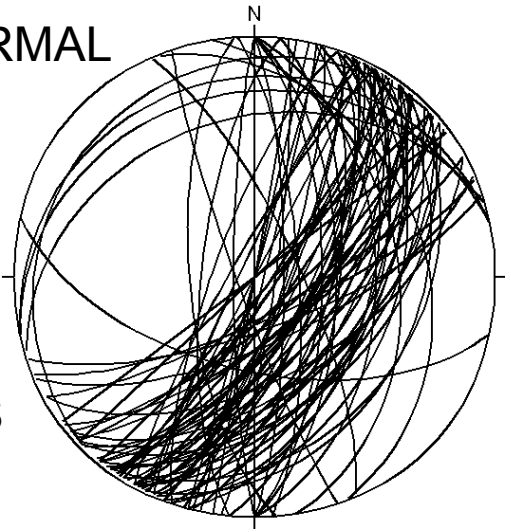
3 – Vein-absent normal faults

Note that veins folded and disrupted in the melange are not found

REVERSE
(73)

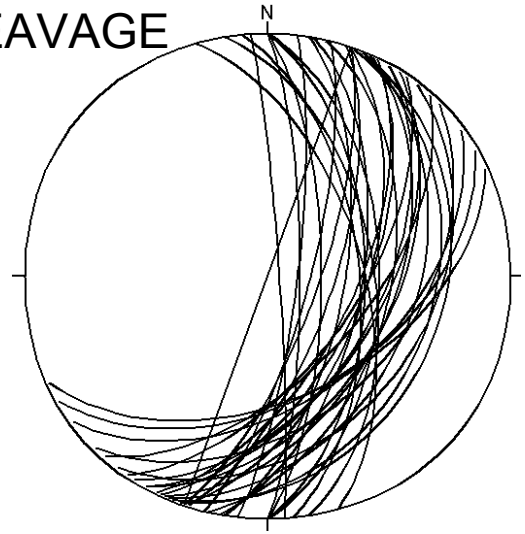


NORMAL
(80)

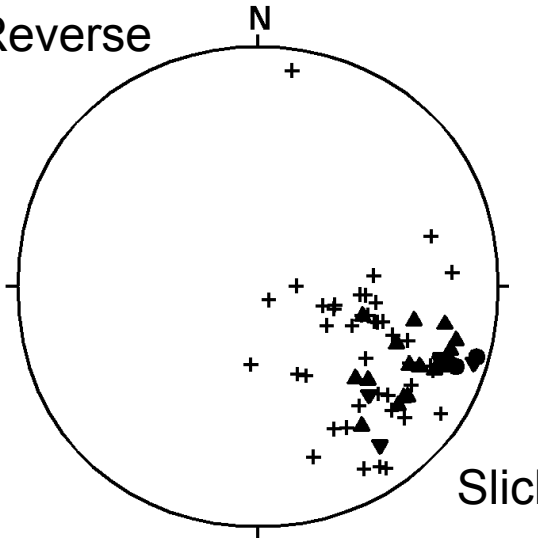


VEINS

CLEAVAGE
(34)

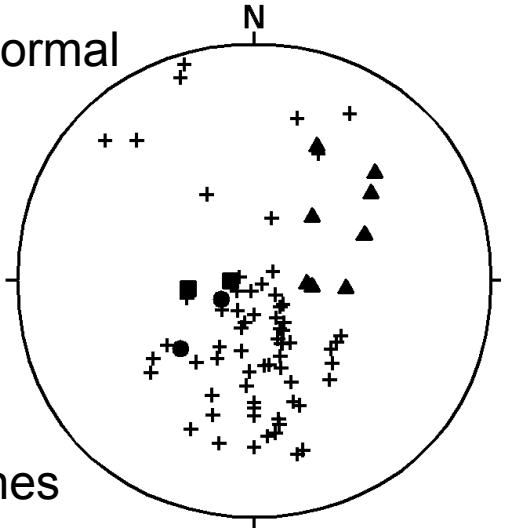


Reverse



mean 120/35

Normal



mean 163/68

Slickenlines

Reverse-sense slickenlines towards 300º

Normal-sense slickensides, and vein-absent faults,
are mostly east-side-down

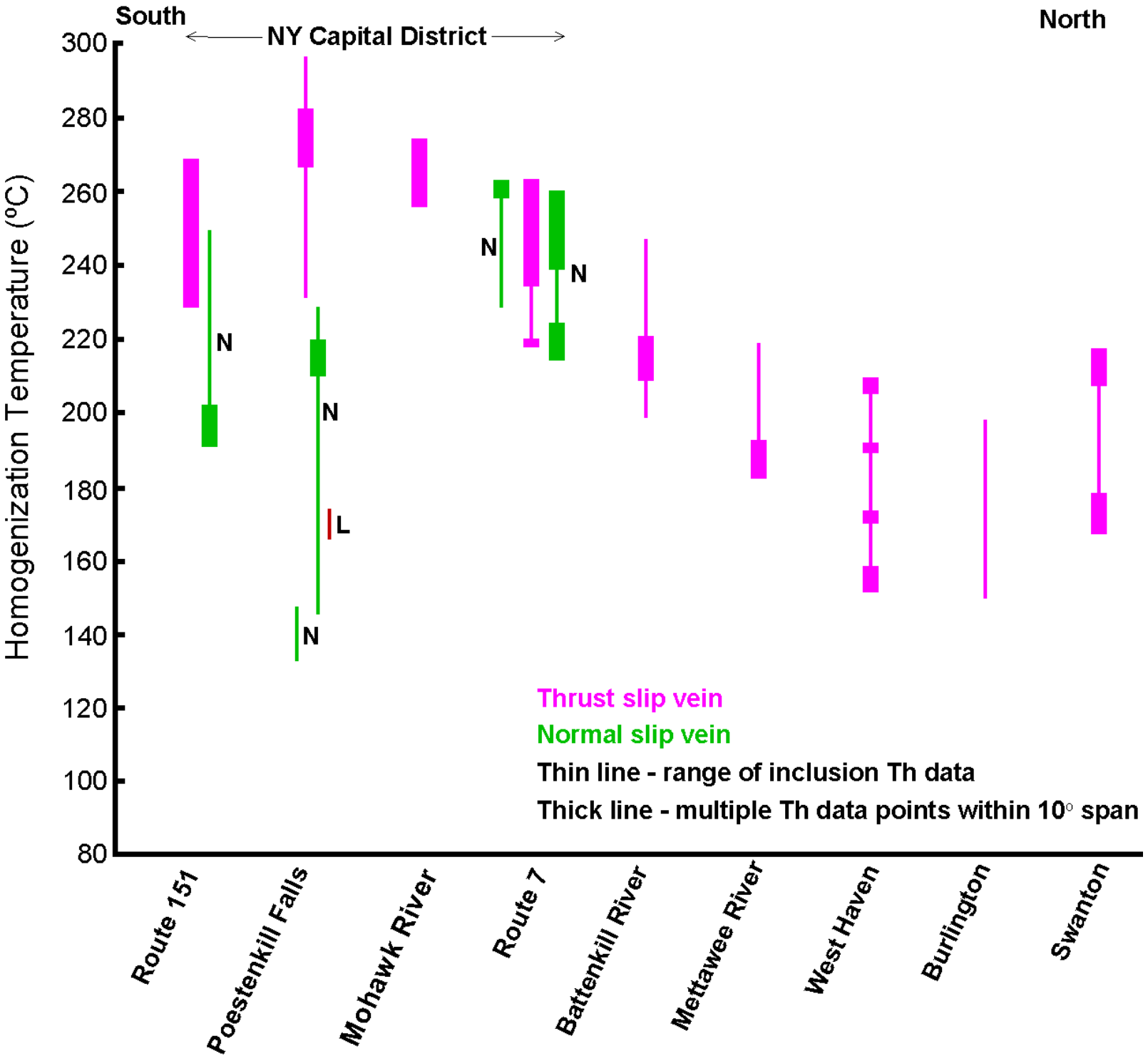
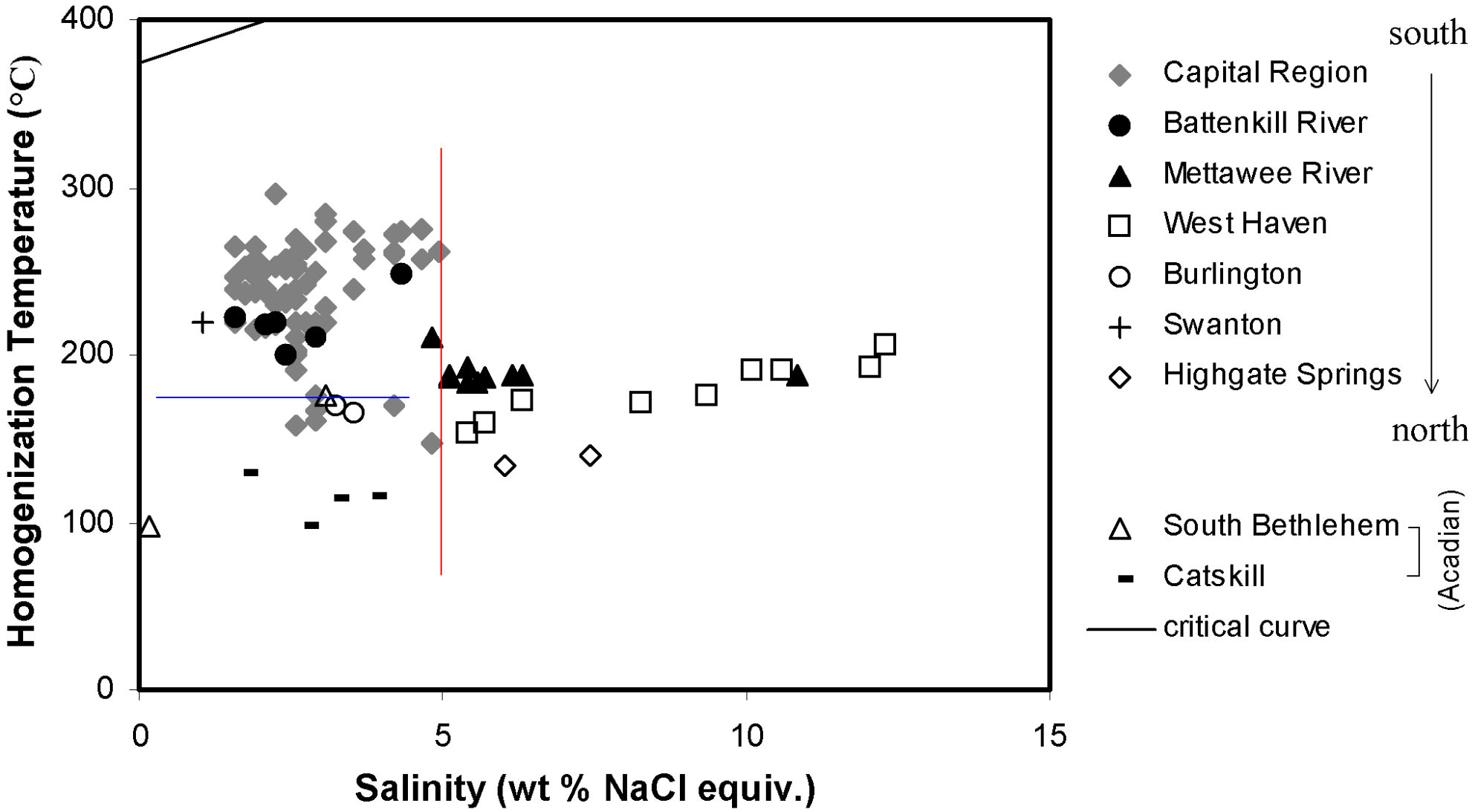

South
NY Capital District
North
Homogenization Temperature (°C)
300
280
260
240
220
200
180
160
140
120
100
80
N
N
N
N
L
N
Thrust slip vein
Normal slip vein
Thin line - range of inclusion Th data
Thick line - multiple Th data points within 10° span
Route 151
Poestenkill Falls
Mohawk River
Route 7
Battenkill River
Mettawee River
West Haven
Burlington
Swanton

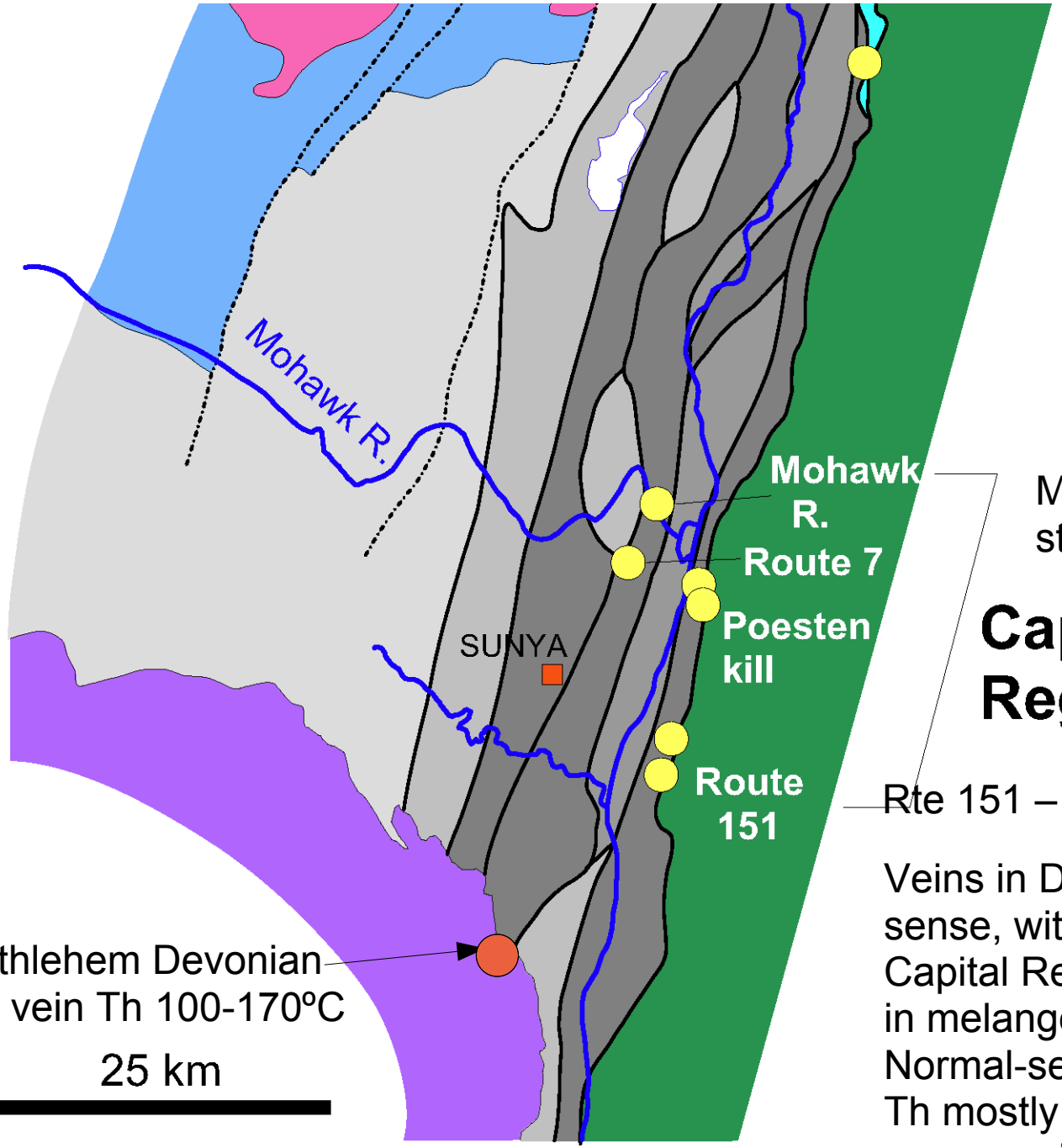
Table 4. Depth of vein precipitation estimated from quartz-calcite thermometry

locality	calibration	temperature (ºC)	fluid pressure (bar)	overburden (lithostatic)	overburden (hydrostatic)
Route 151	S & K	315	920	3.5 km	9.4 km
		342	1320	5.0 km	13.5 km
	F & O	298	720	2.7 km	7.4 km
		361	1600	6.1 km	16.4 km
Mohawk R.	S & K	290	330	1.3 km	3.4 km
		310	540	2.1 km	5.5 km
	F & O	318	630	2.4 km	6.5 km
		336	830	3.2 km	8.5 km
Battenkill R.	S & K	265	680	2.6 km	7.0 km
		283	1000	3.8 km	10.3 km
	F & O	306	1300	4.9 km	13.3 km
		312	1430	5.4 km	14.7 km

1 – Trapping temperatures of 290-360ºC for Capital Region thrust veins

2 – If near lithostatic fluid pressures, ~2-5km overburden


Homogenization Temperature (°C)
400
300
200
100
0
0
5
10
15
Salinity (wt % NaCl equiv.)
south
Capital Region
Battenkill River
Mettawee River
West Haven
Burlington
Swanton
Highgate Springs
north
South Bethlehem
Catskill
(Acadian)
critical curve



Battenkill River

Melange belts are Ordovician structures

Capital Region

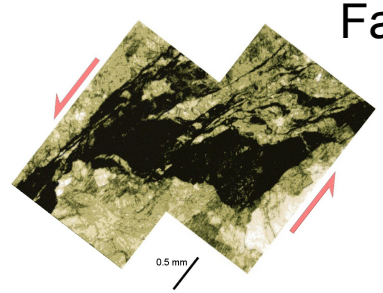
Rte 151 – thrust vein Th 230-270ºC

Veins in Devonian are only thrust sense, with Th much lower than Capital Region thrust-sense veins in melange

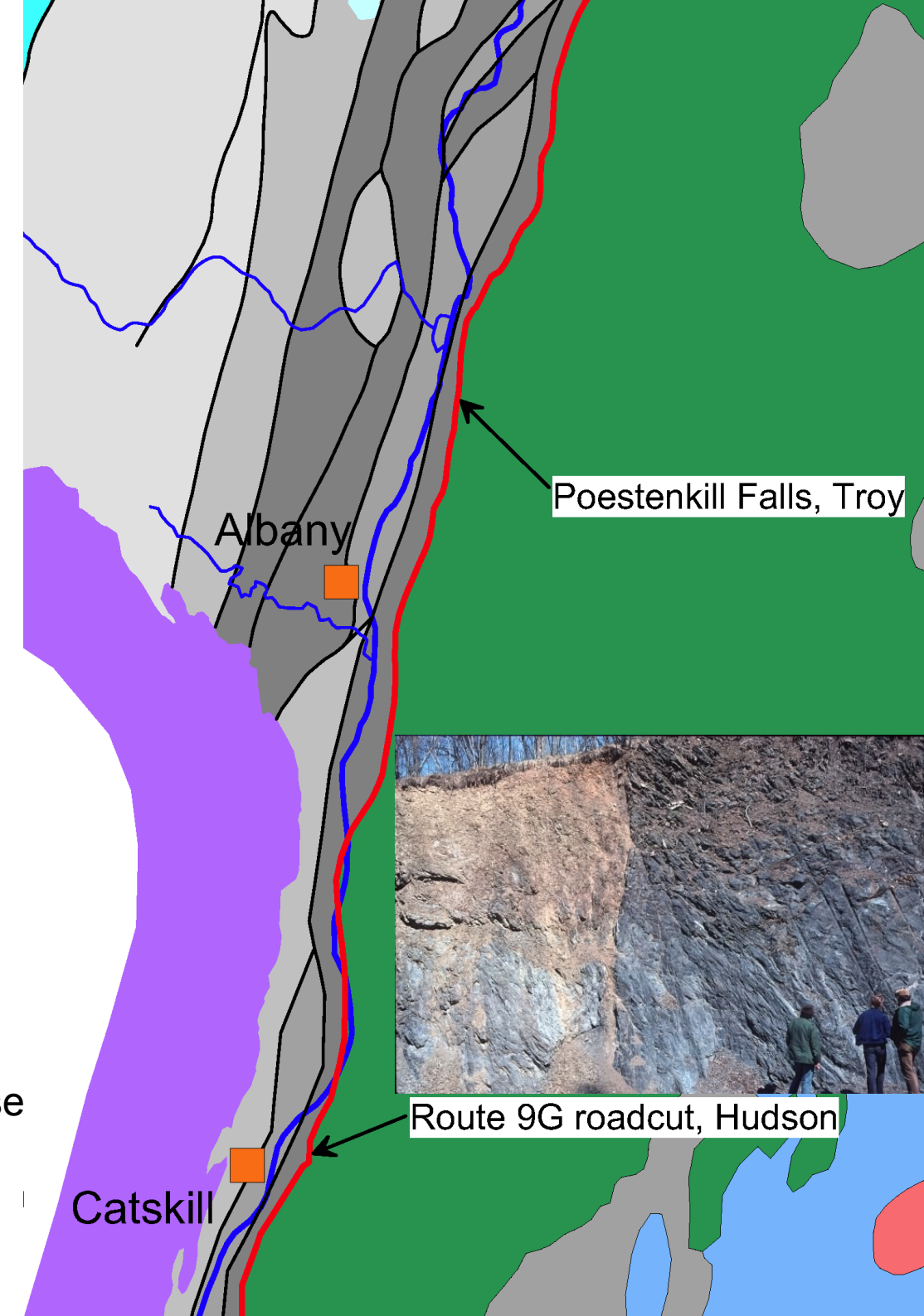
Normal-sense veins in melange have Th mostly higher than Devonian thrust -sense veins

Normal faults downthrown to east include the Taconic Frontal Fault along a substantial part of its length

Falls of the Poestenkill in Troy



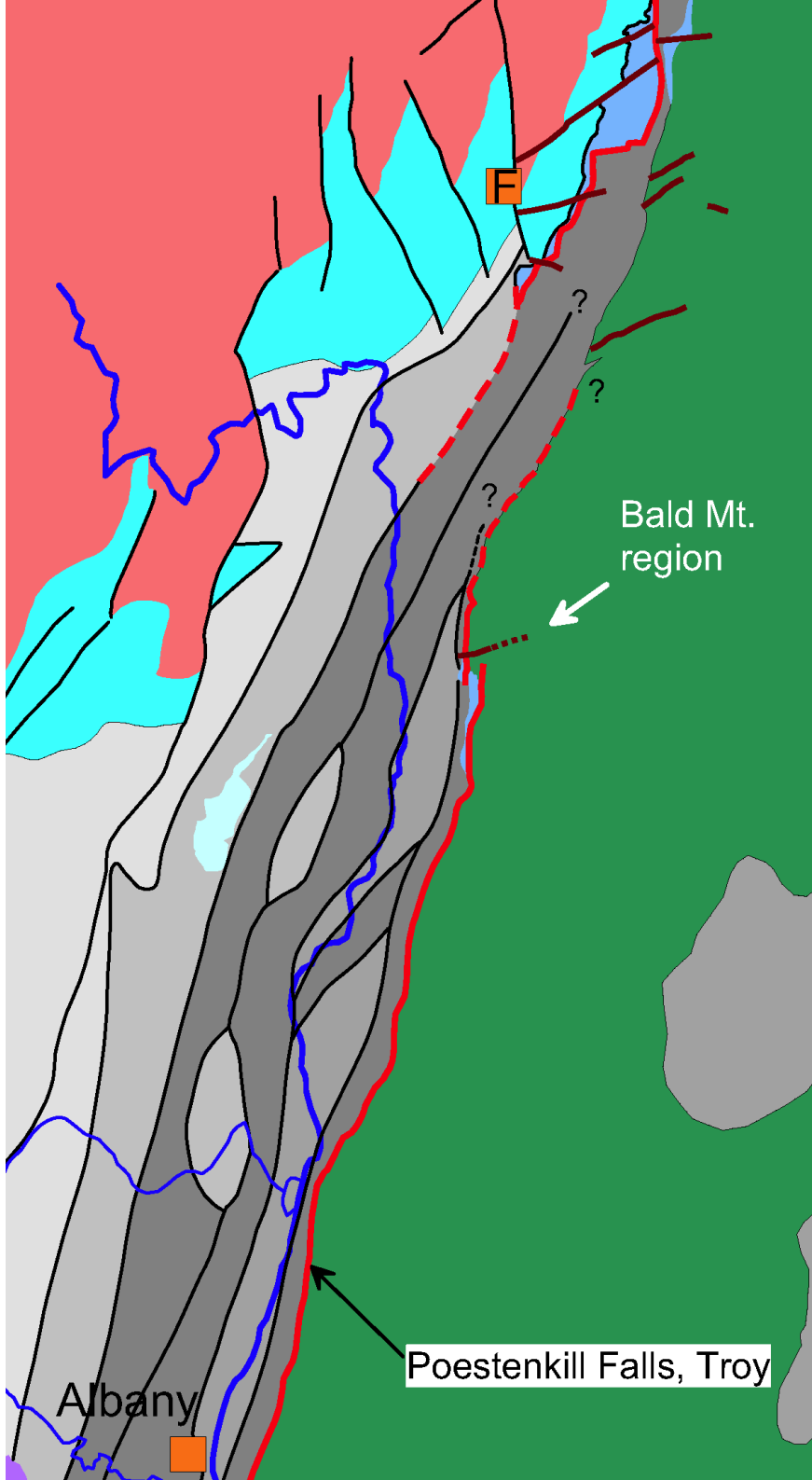
- dip averages around 50E
- local vein slickenside shows normal slip
- Th temperature consistent with normal-sense veins in melange of this outcrop



Near Fort Ann [F] another substantial strike-parallel east-down normal fault (the Mettawee River Fault) cuts the southern extension of the Champlain Thrust, and projects south into the Taconic melange belt

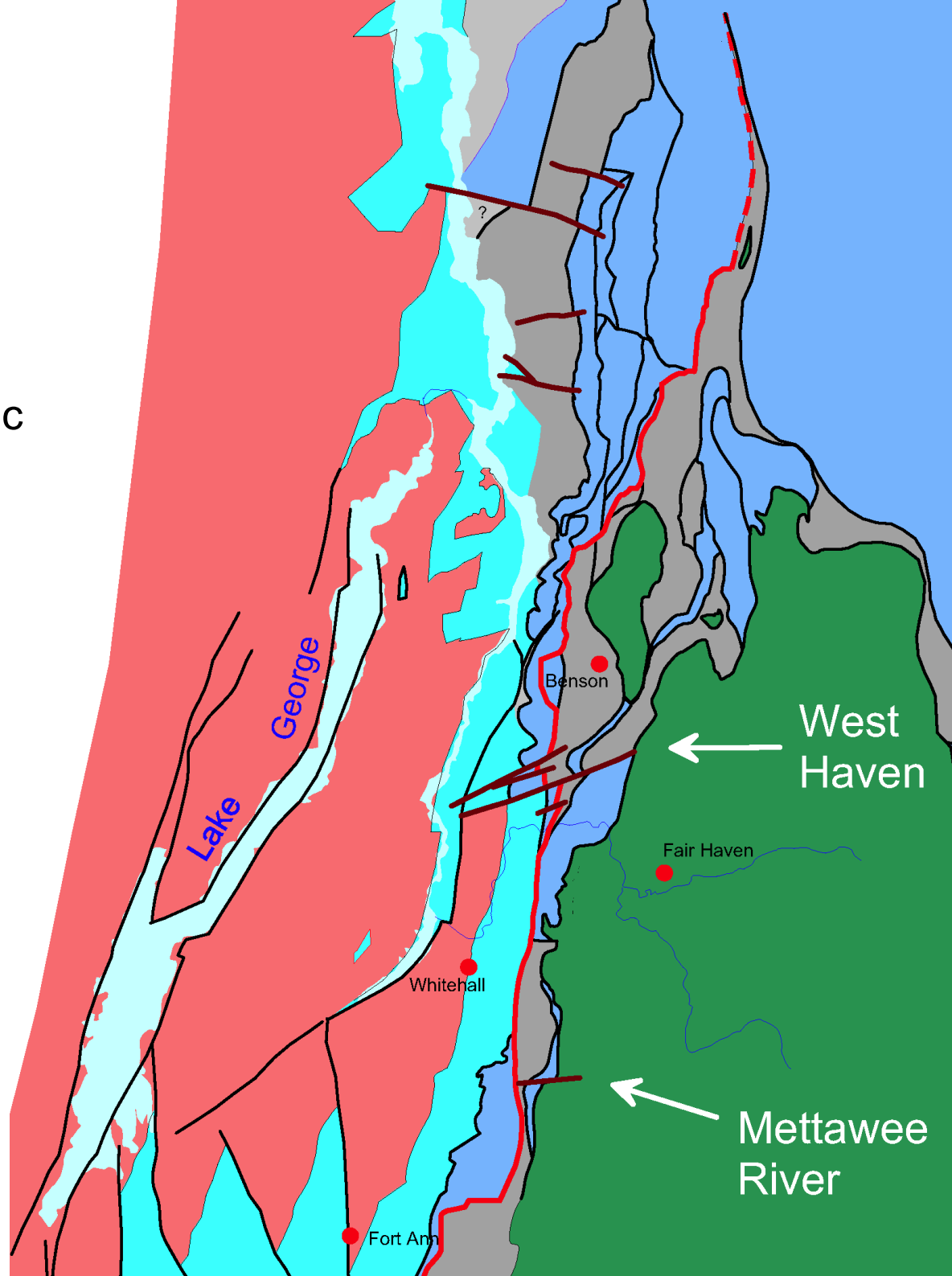
We think the Taconic Frontal Fault at the surface is mostly a normal fault north to the Bald Mtn area

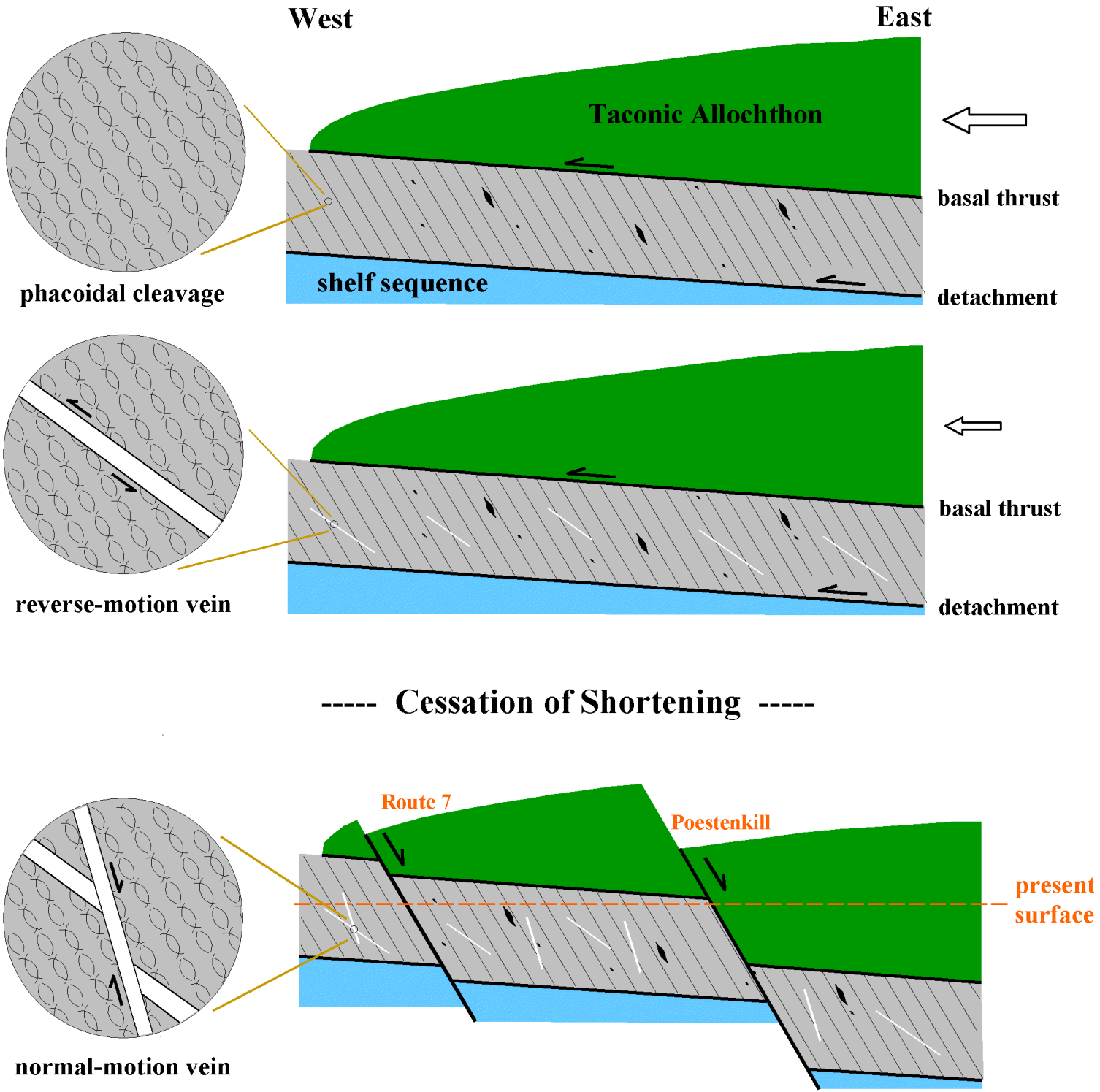
Note that this is only a late modification of the primary overthrust relationship of the Taconic Allochthon!

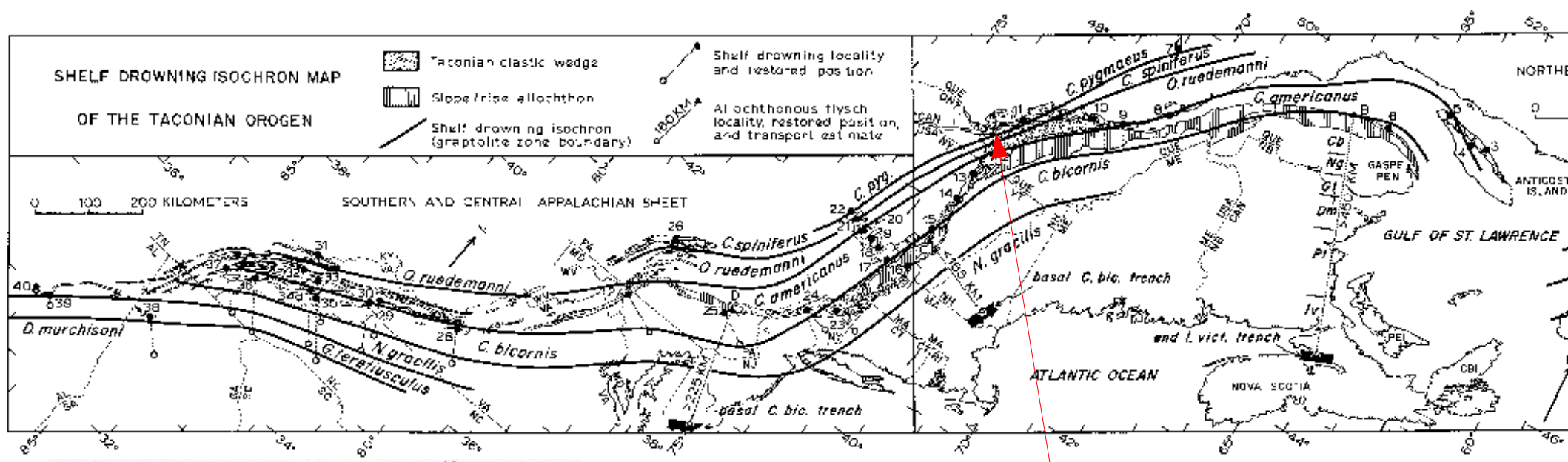


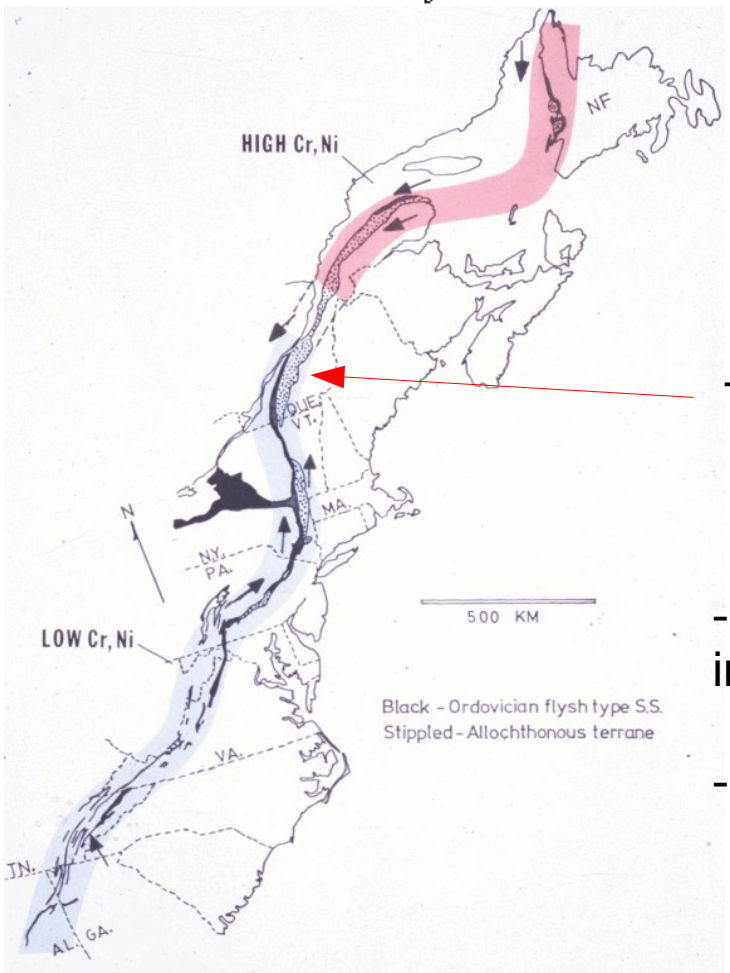
The Mettawee River Fault can be traced north to near Middlebury; near Orwell it cuts two strands of the Champlain Thrust system

We think this fault is also a Taconic structure
(not Acadian, not Alleghenian, and not Jurassic)




West
East
Taconic Allochthon
basal thrust
shelf sequence
detachment
phacoidal cleavage
basal thrust
detachment
reverse-motion vein
----- Cessation of Shortening -----
Route 7
Poestenkill
present
surface
normal-motion vein





Bradley (1989) graptochrons show youngest shelf drowning in S. Quebec

Globensky (1985) demonstrated youngest flysch below Queenston in foreland basin adjacent to Taconic deformation front in S. Quebec

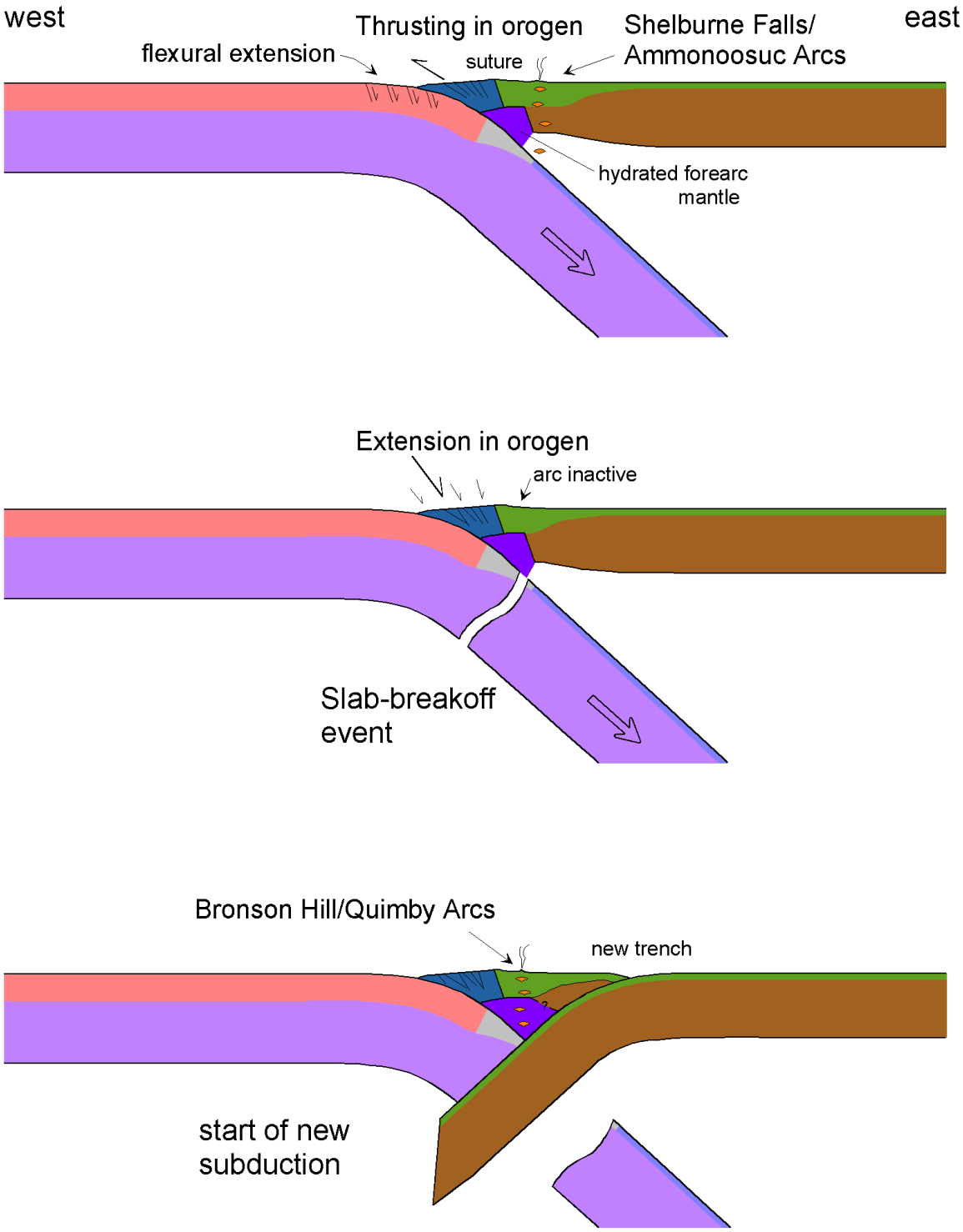
Tanski (1984) showed flysch paleocurrents and clastic provenence directed to S. Quebec

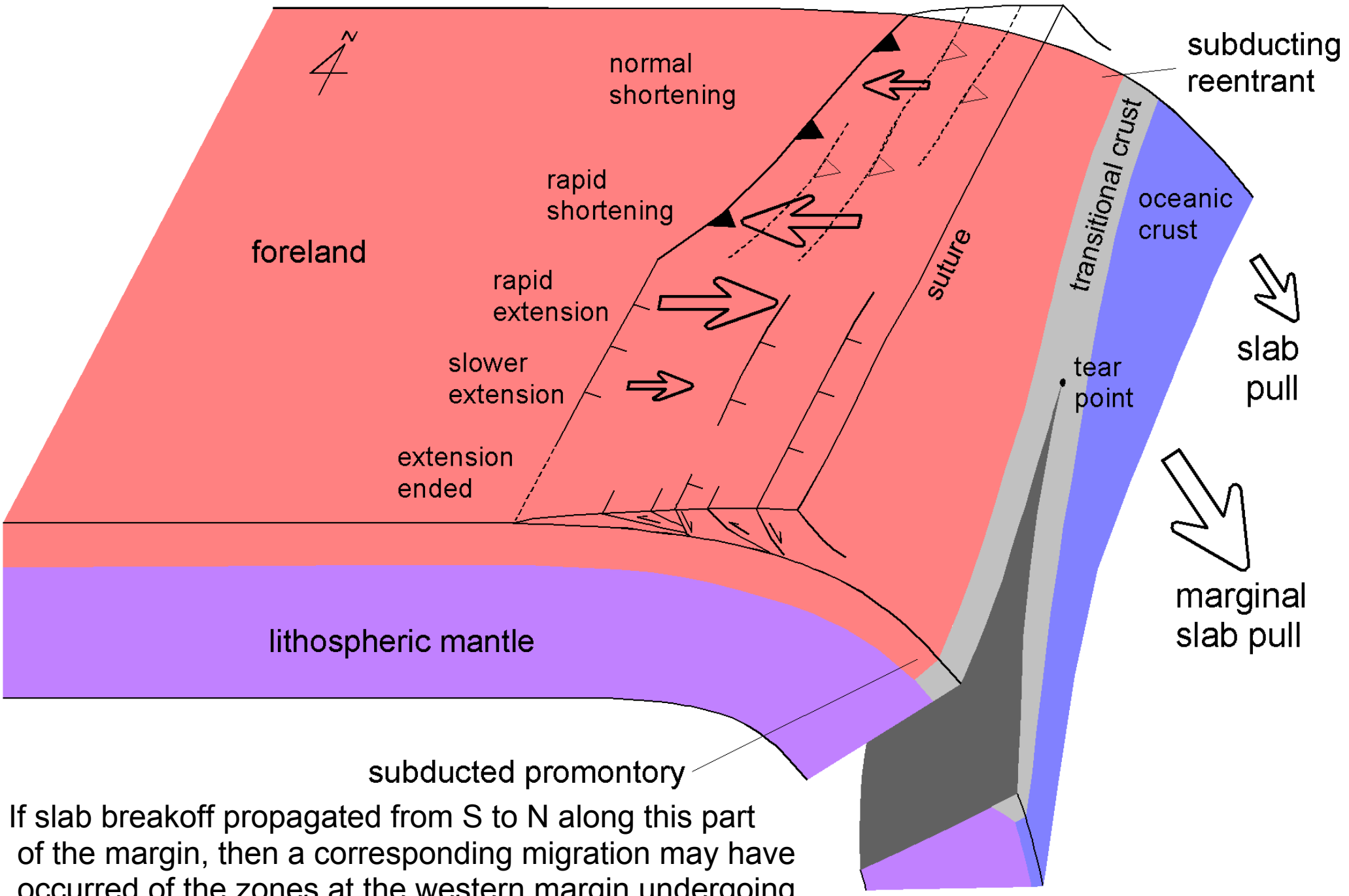
- Oblique and diachronous involvement of Laurentian margin in Taconic collision

- S to N progression of collision along the NY to S Quebec part of the margin

The implications of the age ranges of activity of the Taconic magmatic arcs of New England require that there was a slab breakoff event

Tucker and Robinson, 1990;
Karabinos et al., 1998;
Moench and Aleinikoff, 2002)

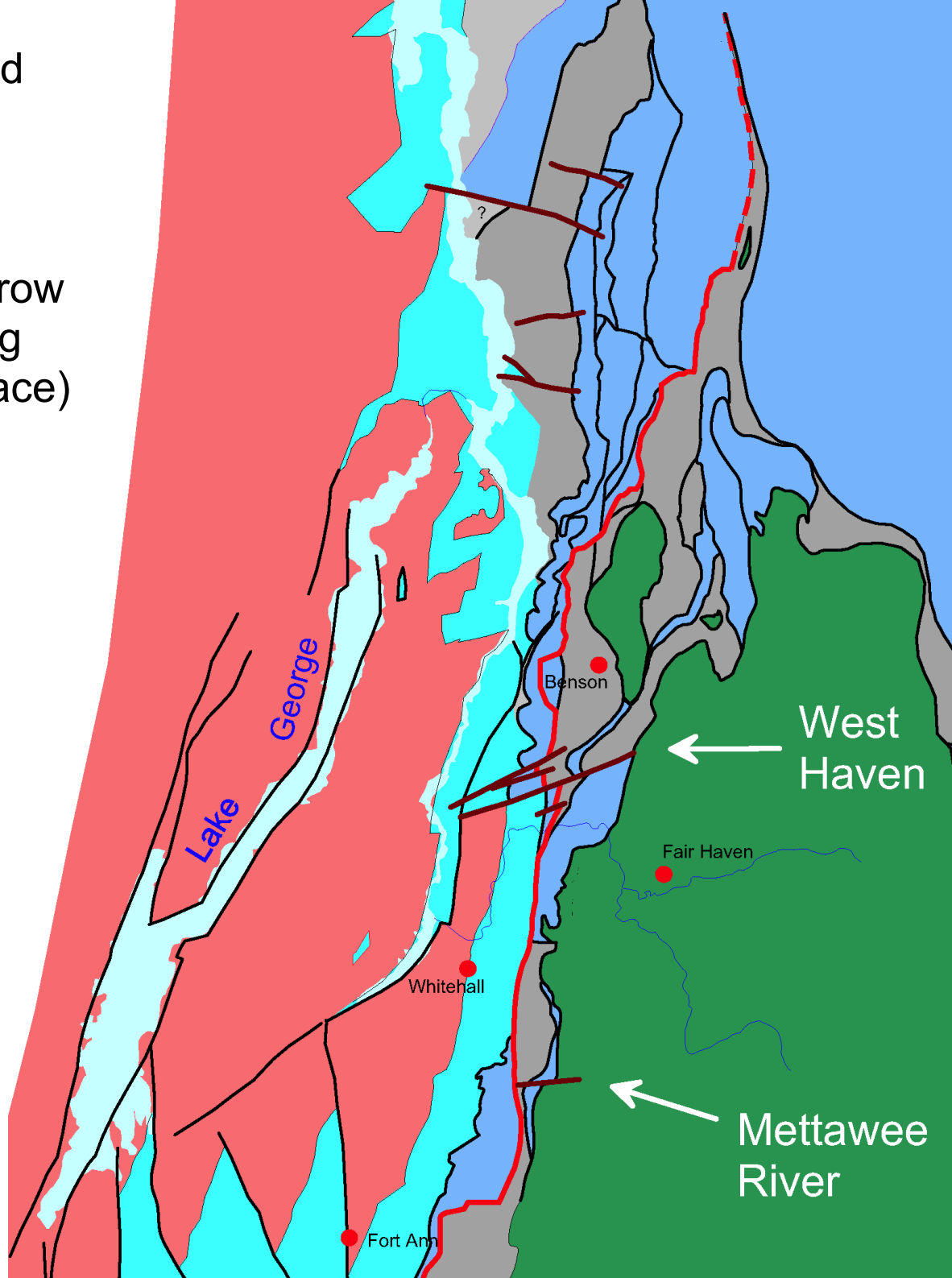




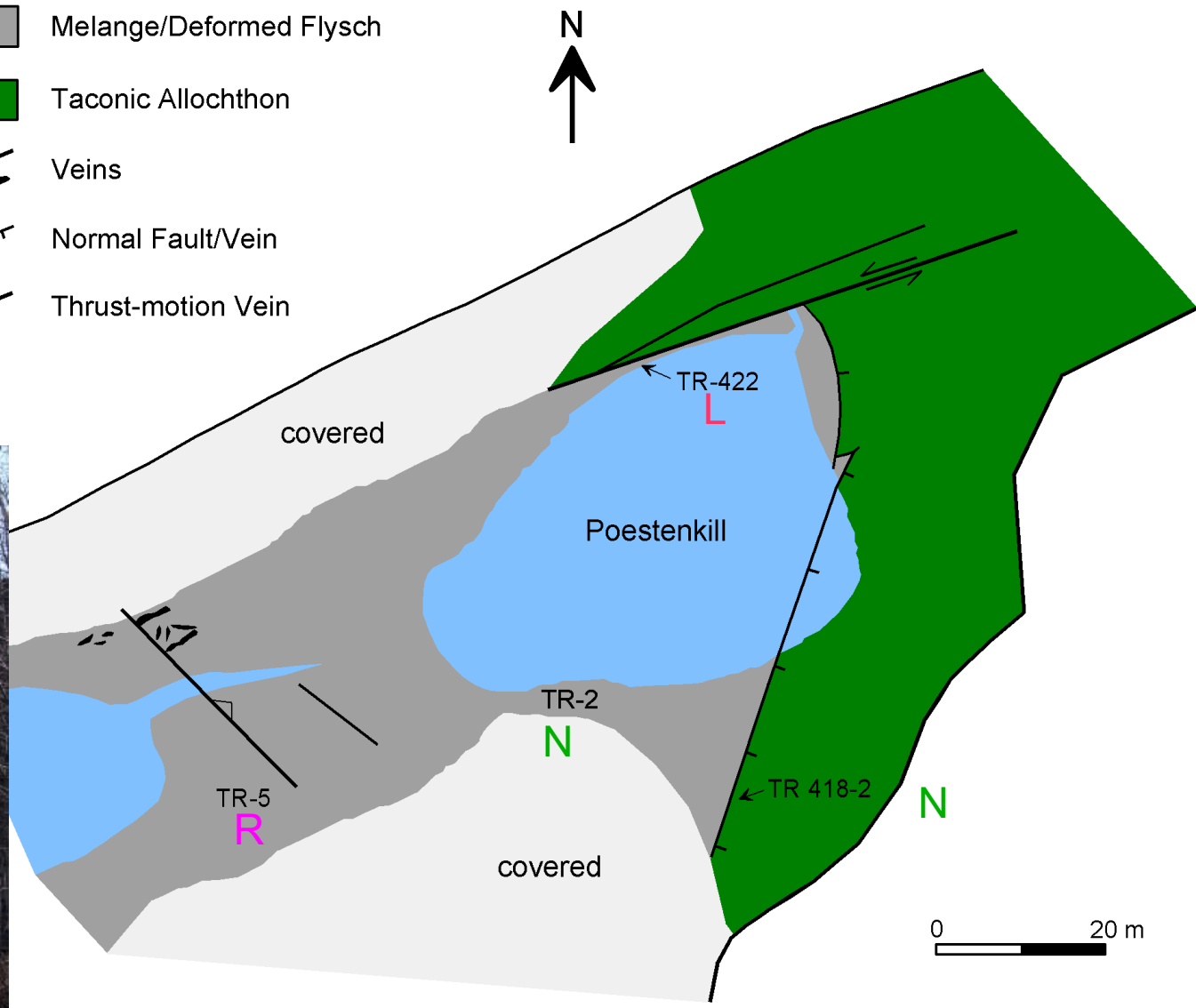
If slab breakoff propagated from S to N along this part of the margin, then a corresponding migration may have occurred of the zones at the western margin undergoing shortening and extension

The Mettawee River Fault is cut and offset near West Haven by several apparent left-lateral cross-faults

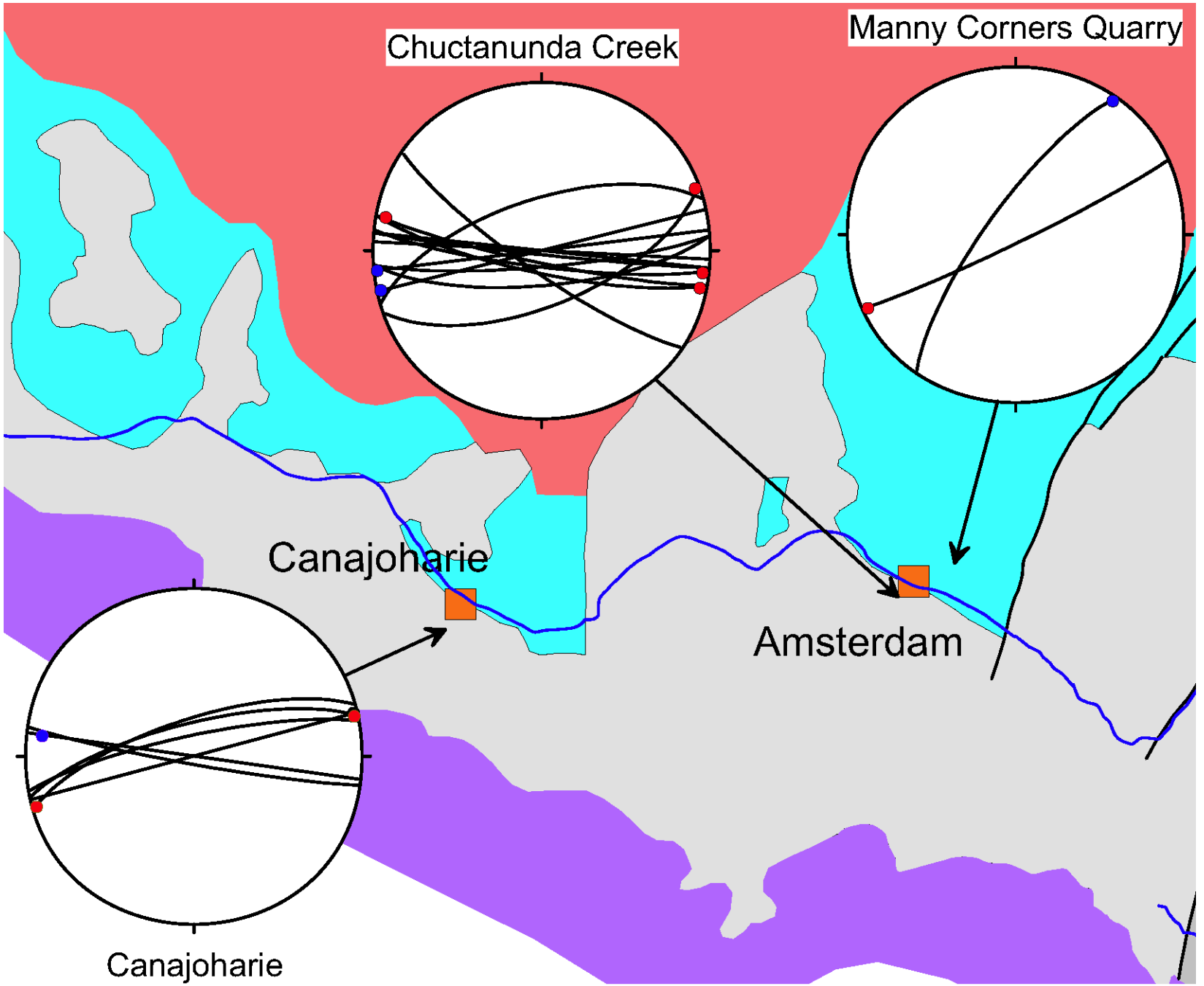
Veins in an outcrop in West Haven show real left-lateral offsets on narrow veins parallel with the WSW-striking cross faults (view down of top surface)



Strike-slip cross-fault cuts normal fault bounding the Taconic Allochthon;
fluid Th suggests this fault was a Taconic-age structure

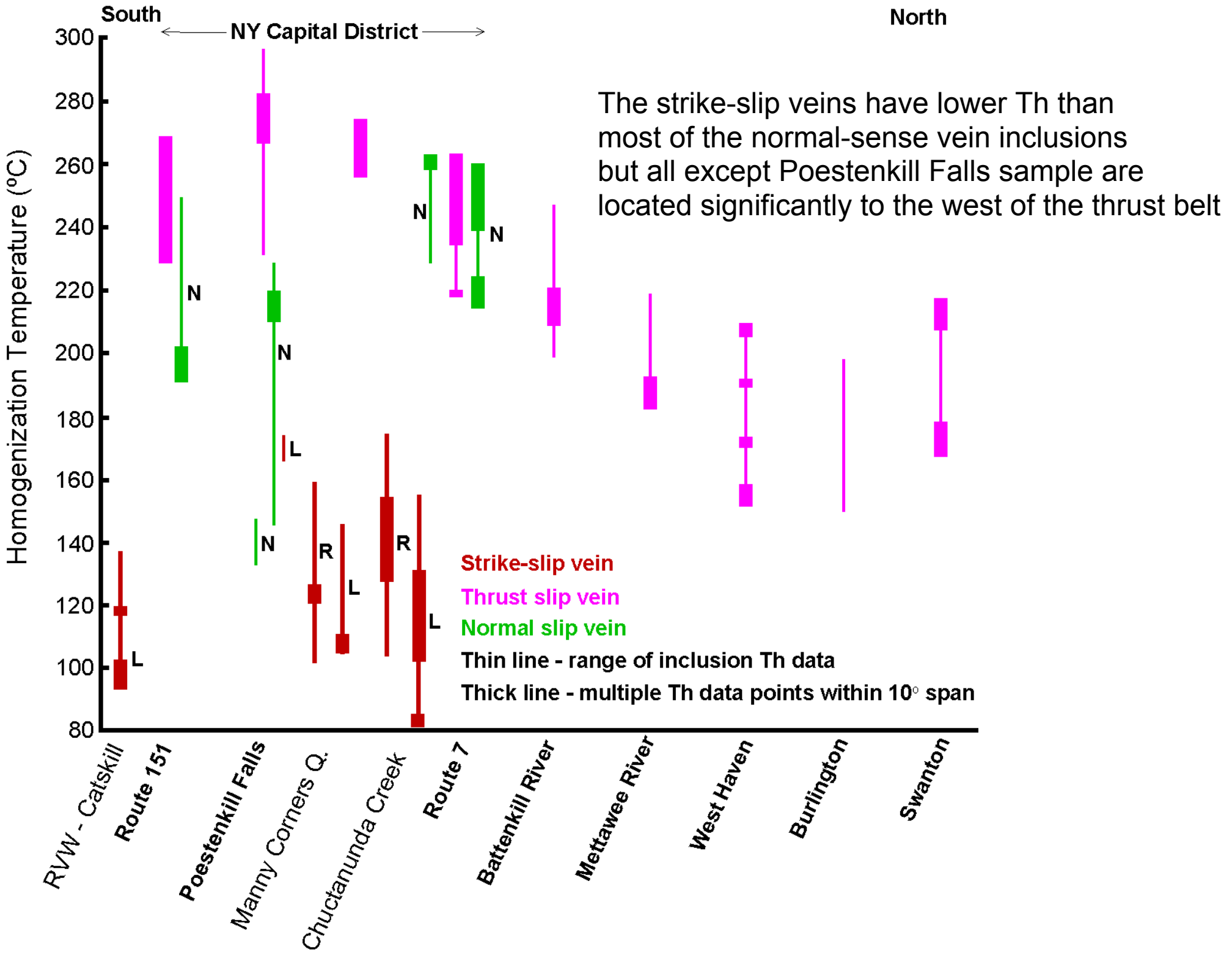


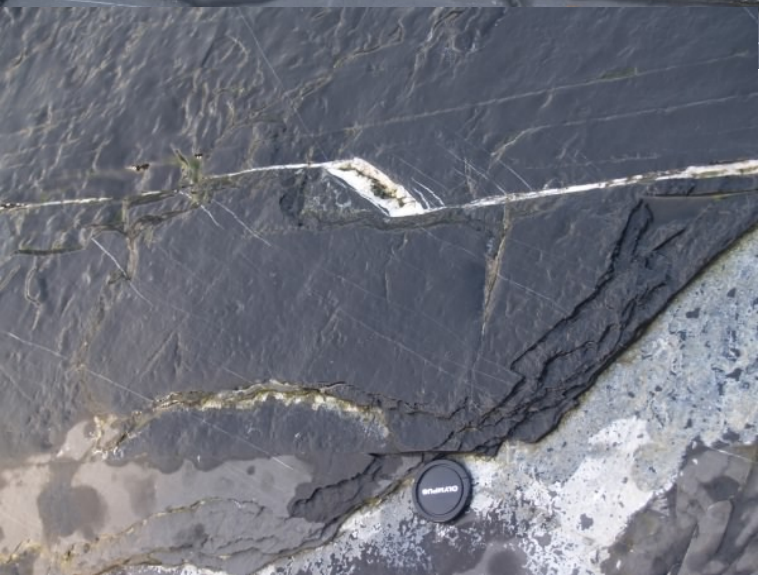
Reverse-sense veins Th 270-285 (235-295)
Normal sense veins Th 210-220 (150-230)
Left-lateral strike-slip vein Th 165-175

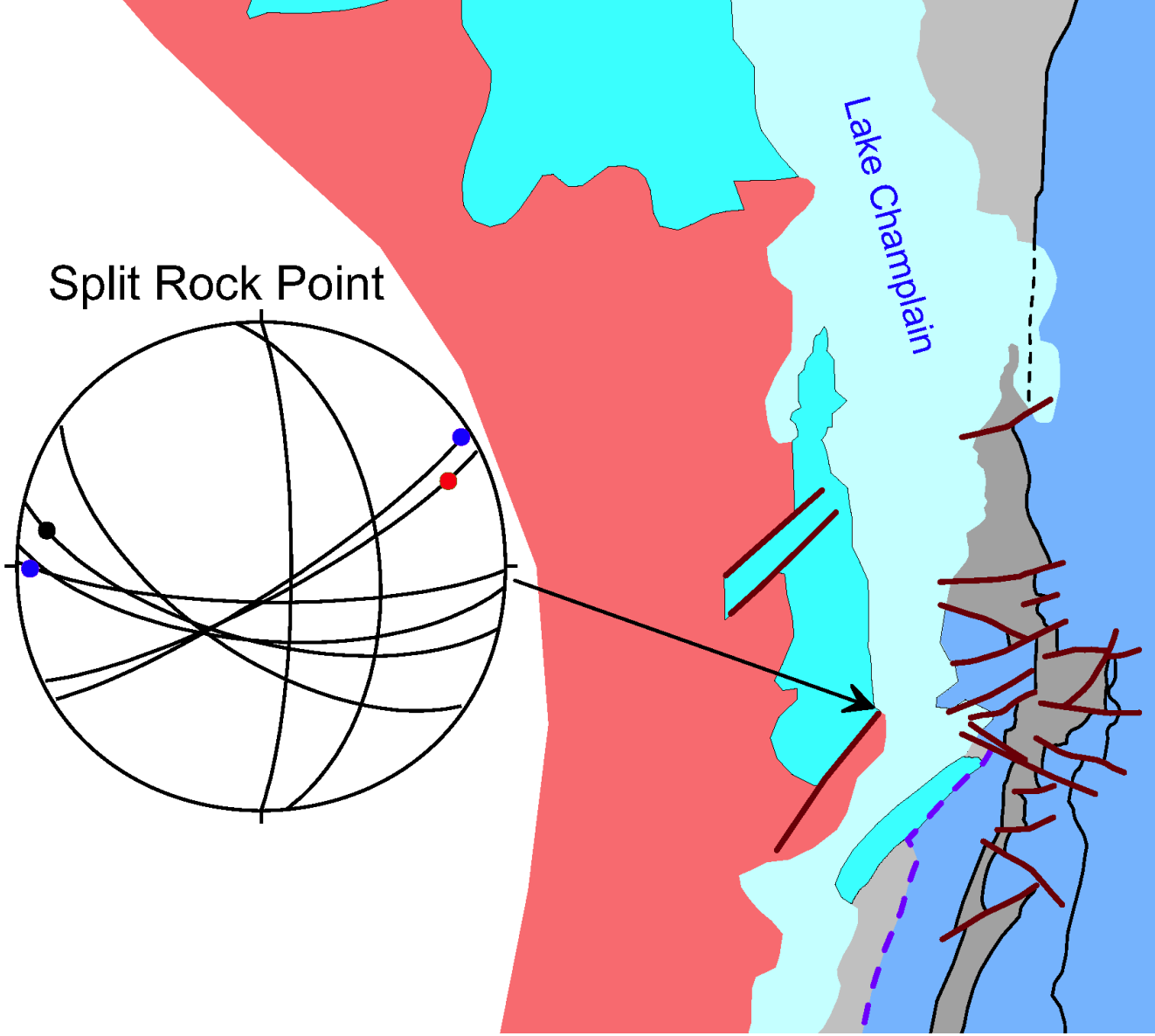

Chuctanunda Creek
Manny Corners Quarry
Canajoharie
Amsterdam
Canajoharie

Sinistral slip sense are more abundant than dextral; both are pure strike-slip

Strikes of the two are in most cases less that 20 deg. apart, and not consistently arranged


South
NY Capital District
North
Homogenization Temperature (°C)
300
280
260
240
220
200
180
160
140
120
100
80
N
N
N
N
L
R
L
R
L
L
Strike-slip vein
Thrust slip vein
Normal slip vein
Thin line - range of inclusion Th data
Thick line - multiple Th data points within 10° span
The strike-slip veins have lower Th than most of the normal-sense vein inclusions but all except Poestenkill Falls sample are located significantly to the west of the thrust belt
RVW - Catskill
Route 151
Poestenkill Falls
Manny Corners Q.
Chuctanunda Creek
Route 7
Battenkill River
Mettawee River
West Haven
Burlington
Swanton





At Split Rock Point, strike-slip veins are mostly dextral, by contrast, but the same mixture with sinistral occurs

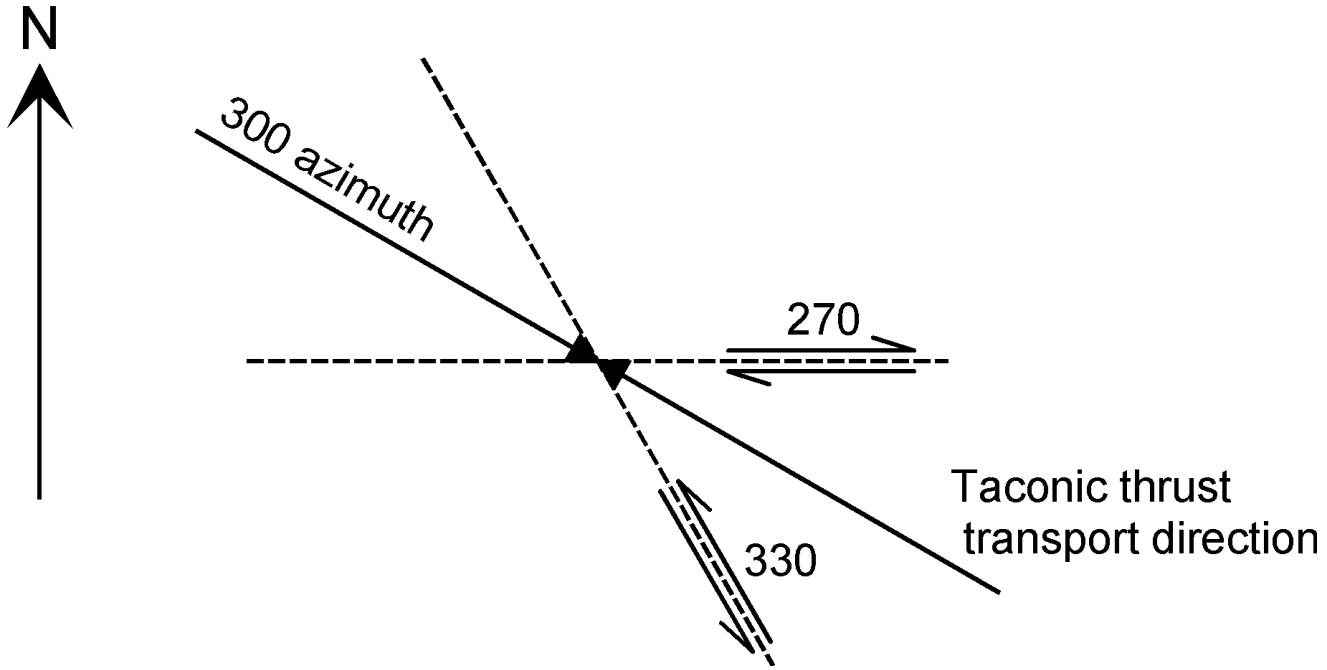
The major fault here must have (probably earlier) normal fault offset (?from outer-slope “flexural” faulting)

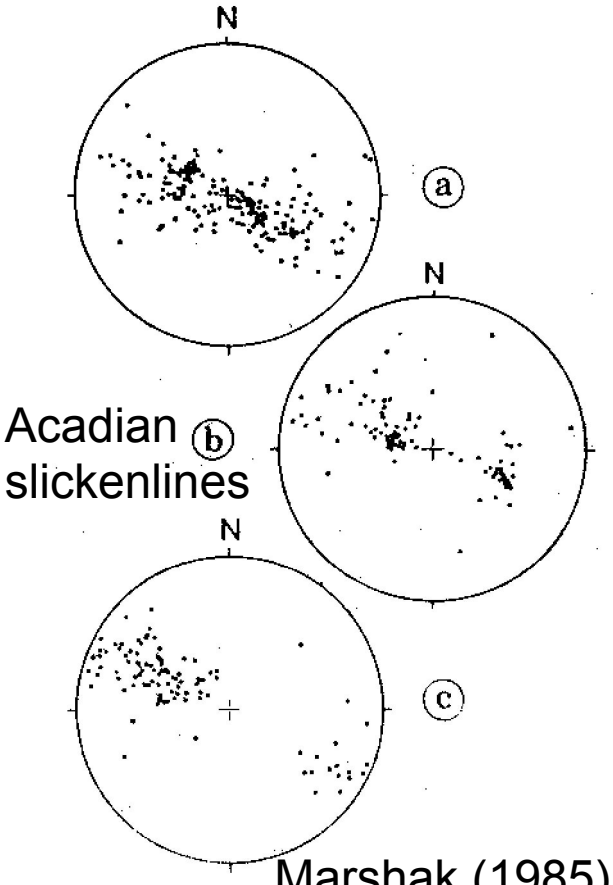
The strike-slip cross-faults are not:

-- conjugate faults related to Taconic shortening (sinistral are wrong slip sense)

-- conjugate faults related to Acadian shortening (ditto, and no such faults seen in Devonian)

-- Alleghenian strike-slip faults (known to be NNE-trending dextral,
and later E-W trending dextral faults (Chedabucto F.) in NE US and Canada)



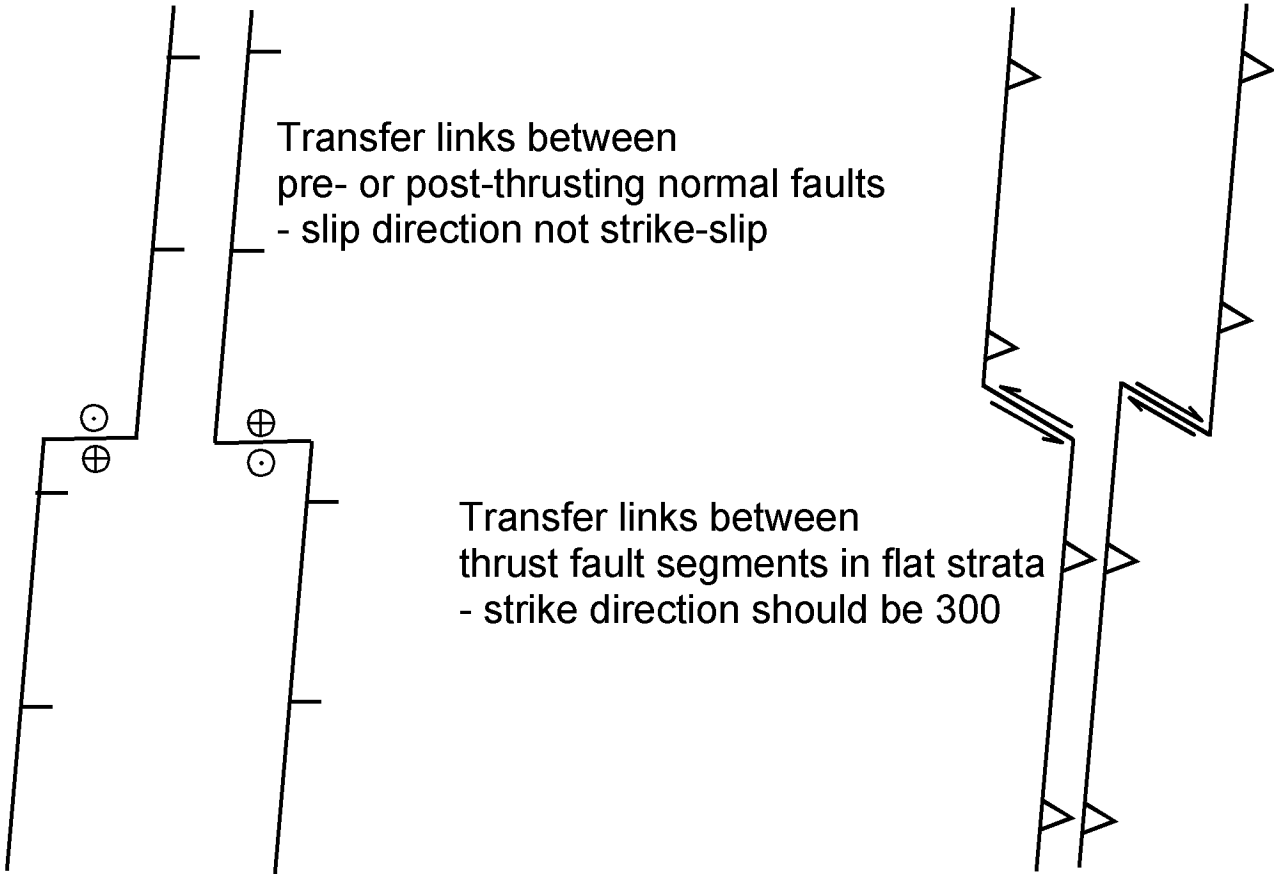


Marshak (1985)

-- transfer faults for Taconic or Acadian thrusting
(strike is significantly different from known 300 trend of thrusts in both events here)

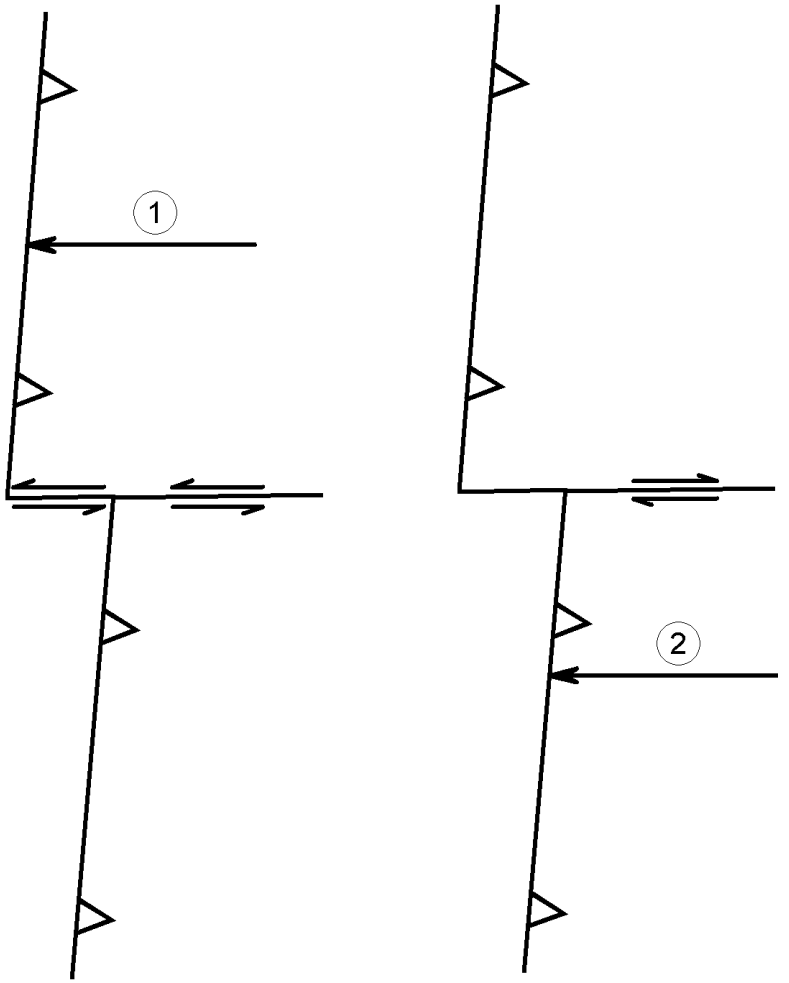
-- transfer faults for Taconic outer-trench slope “flexural” normal faults
(movement is strike-slip, not parallel with normal fault displacement)

-- transfer faults for Taconic post-thrust normal faults
(ditto)

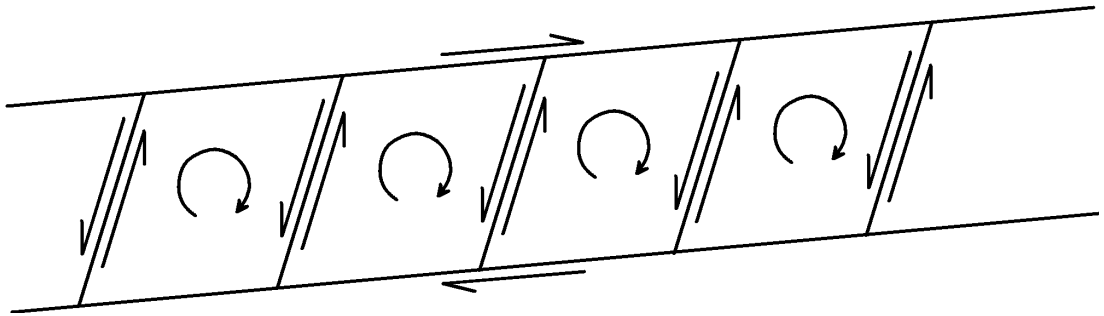


Origin as thrust segment-bounding faults?
(problem of inappropriate transport direction)

(Unless thrust direction changed substantially in very last part of Taconic thrust event)

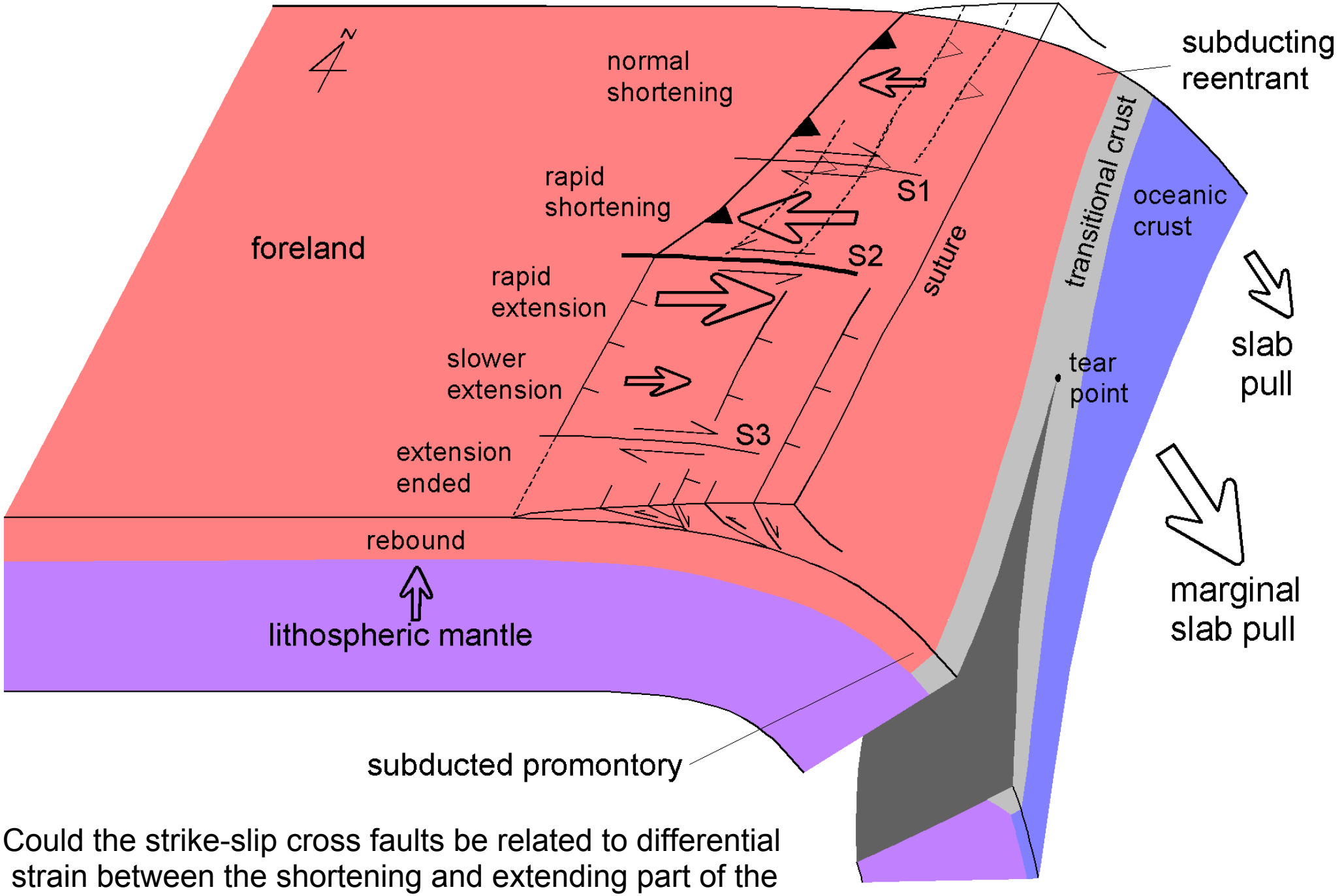


? - secondary rotation of blocks
(angle between fractures of opposing slip too small)



So.....unless they are “far-field” faults from a collisional event at another margin of Laurentia
(?Ouachita, possibly?)

We suggest another possibility.....



Could the strike-slip cross faults be related to differential strain between the shortening and extending part of the western orogen margin, caused by the slab tear-off?
Or/and differential strain within the shortening area, or the extensional area?