1. 56956-UR8
2. Post-Rift Tectonism on Circum-Atlantic Margins
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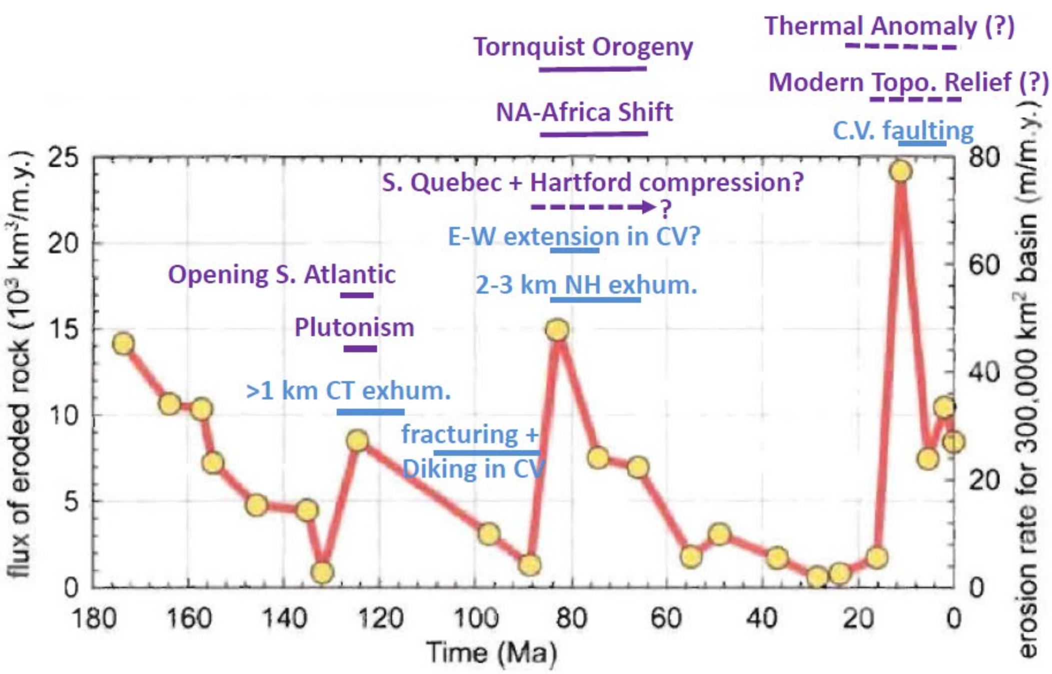
The goal of our research is to identify the spatio-temporal pattern of tectonic rejuvenation in the northeastern U.S. and thus constrain possible mechanisms of uplift. Our work is framed by the sedimentary record in the Baltimore Canyon Trough (BCT), just off the Atlantic coast of New York and New Jersey. This sedimentation record shows three pulses of sediment deposition during the post-rift period, which are interpreted as periods of tectonic uplift and erosion on land. The first episode occurred in Early Cretaceous time (~125 Ma), the next in Late Cretaceous time (~85-65 Ma), and the final episode in the Mio-Pliocene (~15-0 Ma). Our work is attempting to identify the source and cause of these uplift events using a three-pronged approach involving: 1) changes in the provenance of detrital minerals in the Baltimore Canyon Trough, 2) low-temperature thermochronology in onshore drill cores, and 3) U-Pb dating of calcite veins in brittle faults and fractures. The detrital approach will allow us to determine the origin of three sediment pulses, whereas the thermochronology approach will allow us to determine the magnitude and timing of exhumation within potential source regions. Finally, U-Pb dating of calcite veins allows us to establish the timing, and potentially the kinematics of young tectonic events that involved insufficient exhumation to be recorded by thermochronology. The work so far has involved five senior thesis students, 10 summer students, and a handful of part-time student researchers during the semester.

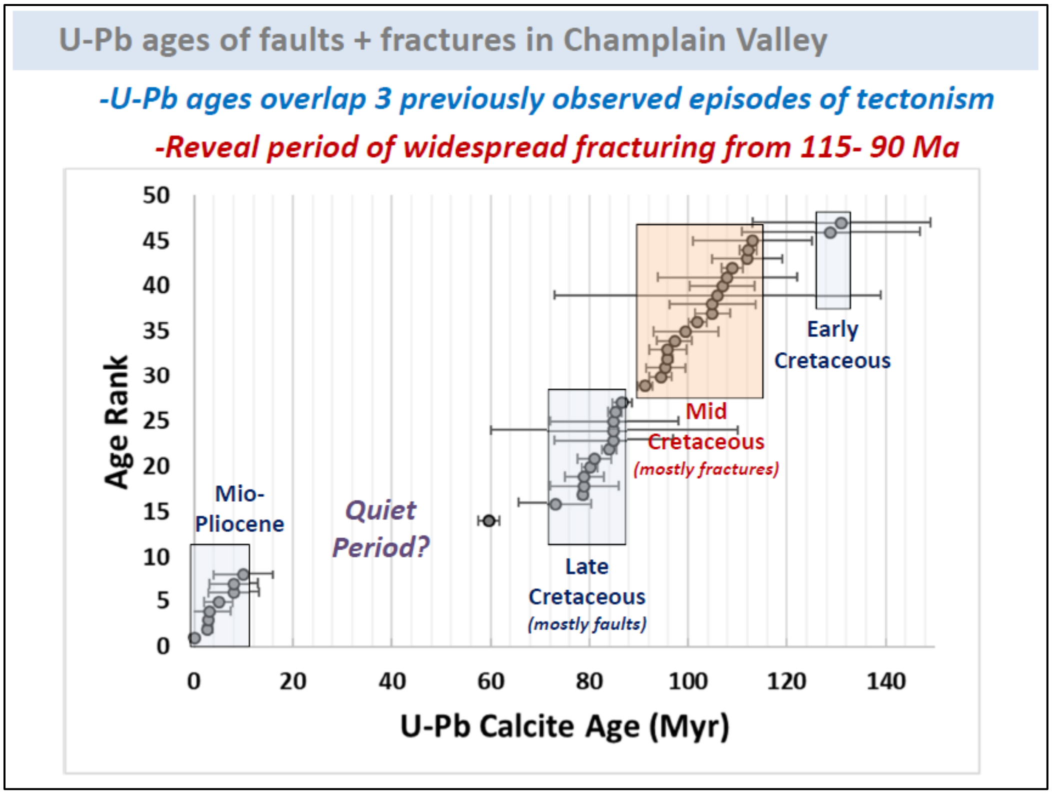
On the detrital side we have completed U-Pb zircon dating of 12 samples from the COST-B2 core (from the BCT), and 11 samples of modern river sediment from across the northeastern U.S.. We have compared these age spectra using maximum likelihood models and also linear mixing models to evaluate which source regions contributed sediment to the BCT at various times. These U-Pb zircon results suggest that the Mio-Pliocene (15-0 Ma) sediment pulse was likely derived from the Adirondack region, and that the Late Cretaceous (85-65 Ma) sediment pulse was most likely derived from the White Mountains of northern New England. Over the last year we have added trace element data into the mixing models, which have allowed us to further discretize the source regions. This has continued to point to northern New England as the source of Mio-Pliocene sediments and has supported a broader source region for the Early Cretaceous sediment pulse.

On the thermochronology side we have obtained samples from three deep drill cores. The first core is the 4700' deep Moodus Deep Core from East Haddam, CT, which has been completely analyzed for apatite U-Th/He (AHe) and apatite fission-track (AFT). Modeling of this data in QTQt demonstrates a period of accelerated exhumation from roughly 135-120 Ma in central Connecticut, roughly synchronous with the first sediment pulse to the BCT. The second core is the 6500' deep Sterling Hill Core from Franklin, NJ, which also shows more than 2 km of exhumation during the Early Cretaceous event, Finally, we have recently obtained samples from a 3000' deep drill core collected from metamorphic basement adjacent to JFK airport on Long Island. A thesis student is currently working on the thermal modeling of this data and we hope to have preliminary intepretations by February of 2020.

The third prong of our work has involved LA-ICPMS dating of calcite from faults and fractures in the Champlain Valley, a zone of Appalachian-aged sedimentary rocks that separates the metamorphic basement blocks of Vermont and New York. We have dated roughly 55 faults and fractures with ages spanning ~130 – 3 Ma (see figure below). These show three groups of ages: 1) a cluster of sub-vertical fracture ages ranging from ~115 – 95 Ma, a group of mostly E-W extensional faults with ages spanning ~ 87 to 70 Ma, and 3) a younger cluster of ages from ~ 10-3 Ma. Preliminary structural interpretation suggests that these ages record several tectonic episodes, including: 1) a period of fracturing and dike intrusion from ~ 115-95 Ma, 2) a period of E-W extension from ~ 85-70 Ma, and 3) a period of E-W extension near 10-3 Ma. These results are important because they present the first direct evidence of Late Cretaceous and Cenozoic tectonism in the northeastern U.S.. Over the last year we have presented these results on several regional field trips and at several invited lectures at universities. We have begun collaborating with Dr. Jean Crespi at the University of Connecticut to use inverse modeling to identify stress regimes for these three periods of deformation. Our hope is to submit this work for publication late in the summer of 2020.

In summary, our first three years have been quite productive and hints of a cohesive story are emerging. Taken in combination with recent papers on the asthenospheric and lithospheric structure of the northeastern U.S., our results suggest several conclusions, which are summarized in the figure below. First, it appears that the sediment pulses to the BCT do correspond in time with tectonic events on land, but these events did not affect all regions equally. The Early Cretaceous event was certainly significant in southern Connecticut and was likely experienced broadly across New England based on the existence of numerous plutons and kimberlites of that age throughout the region. The Late Cretaceous event was likely driven by extensional fault rejuvenation centered in northern New England, where numerous Taconic and Acadian aged faults run north-south. Finally, the Mio-Pliocene event appears to be associated with 'dynamic' regional uplift in response to lithospheric delamination or edge convection. We are sincerely grateful for the support and the extension so that we can continue to refine our results and explore several secondary questions before beginning to publish our results.




U-Pb ages of faults + fractures in Champlain Valley
-U-Pb ages overlap 3 previously observed episodes of tectonism
-Reveal period of widespread fracturing from 115- 90 Ma
Age Rank
U-Pb Calcite Age (Myr)
Mio-
Pliocene
Quiet
Period?
Late
Cretaceous
(mostly faults)
Mid
Cretaceous
(mostly fractures)
Early
Cretaceous
0
5
10
15
20
25
30
35
40
45
50
0
20
40
60
80
100
120
140