1. 56956-UR8
2. Post-Rift Tectonism on Circum-Atlantic Margins
3. William Amidon, Middlebury College
4. No Co-PI

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 three senior thesis students, 7 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. Next steps will be to undertake trace element analysis on specific mineral phases such as garnet and ilmenite, which have proved to be the most common detrital heavy minerals. This process has been a bit slow over the past year as we attempt to develop the relevant methods and locate the relevant LA-ICPMS standards.

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). Preliminary results suggest 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. We have recently shipped off a complete set of AHe and AFT samples for analysis, which should constrain the longest and most complete record of exhumation in the northeastern U.S.. Finally, we have obtained samples from a 3000' deep drill core collected from metamorphic basement adjacent to JFK airport on Long Island. This sample was obtained and processed over the summer, and preparation of apatite samples is currently in progress.

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 40 faults and fractures with ages spanning ~130 – 3 Ma (see figure below). These show two groups of ages: 1) a broad continuum of ages from ~112 – 70 Ma, 2) a younger cluster of ages from ~ 15-3 Ma. Preliminary structural interpretation suggests that these ages record several tectonic episodes, including: 1) a period of fracturing and dike intrusion from ~ 110-90 Ma, 2) a period of E-W compression from ~ 85-70 Ma, and 3) a period of E-W extension near 5-3 Ma. These results are important because they present the first direct evidence of Late Cretaceous and Cenozoic tectonism in the northeastern U.S.. However, significant additional work is required to document and interpret the kinematics at each site and ultimately the regional tectonic forcing mechanisms.

In summary, our first two 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 compressional fault rejuvenation centered in northern New England, where Taconic and Acadian thrust 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 look forward to filling in additional details next fall.