Research Experience and Future Directions

Plate tectonics and the supercontinent cycle fundamentally influence the landscape and climate of the Earth's surface. What physical processes govern how continental crust is built, broken apart, and destroyed? These three processes, orogenesis, continental rifting, and subduction, rely on the formation of ductile shear zones at mid- to lower crustal depths (> 10-15 km) to accommodate contractional and extensional strain of continental crust. The timing and role of ductile fabric formation in the continental crust is crucial to understand structural inheritance during continental break up and assemblage. My research integrates multiple techniques to investigate the age of mylonitic fabrics in continental crust and how/when continental blocks accommodate strain. The temporal differentiation of mylonitic (ductile) fabrics is particularly important in regions that have experienced multiple or polyphase tectonic events with similar kinematics and direction, where structures and fabrics cannot be differentiated by their orientation or metamorphic facies alone. My work combines geo- and thermochronology with structural geology and petrology to provide more holistic tectonic histories of mid-crustal blocks. Most of my research has focused on metamorphic core complexes and fold-thrust belts, but I look forward to applying this methodology to a variety of tectonic settings, including Archean cratons and ancient orogens.

Past and On-Going Research

Extensional Dynamics in the Southern U.S. Basin & Range

My doctoral research at UT-Austin has focused primarily on ductile fabrics exposed in the Maria fold-thrust belt (MFTB) and the Colorado River extensional corridor (CREC) of southeast California and west-central Arizona. The CREC consists of Miocene-age detachment faults that exhumed mid-crustal blocks previously deformed during the Cretaceous-Paleocene MFTB formed during the Laramide Orogeny. I apply high-temperature thermochronology (apatite and titanite U-Pb), low-temperature thermochronology (apatite and zircon (U-Th)/He), and microstructural characterization (EBSD and microtextural characterization), to constrain the temperatures and timing of ductile/mylonitic fabric development.

Laramide Extension in the Maria fold-thrust belt: Using apatite U-Pb geochronology of single-grains and within thin-section, I have constrained top-NE extensional fabrics in the MFTB as Late Cretaceous-early Paleocene in age, confirming a strong component of orogenic collapse during the Laramide Orogeny that was not overprinted by Miocene core complex formation in the region. This project has involved close collaboration outside of UT-Austin, including John Singleton at Colorado State University and Michael Wells at the University of Nevada-Las Vegas.

Cretaceous and Miocene mylonitization in the Colorado River extensional corridor: In my doctoral research, my next goal is to analyze the age mylonitic fabrics and exhumation within core complexes of the CREC, such as the footwall of the Whipple, Chemehuevi, and Riverside detachment faults. First, ductile fabric formation can be constrained with a combination of apatite U-Pb cooling ages, syn-kinematic titanite U-Pb crystallization ages, and zircon U-Pb geochronology of cross-cutting, non-deformed intrusions. Low-temperature (U-Th)/He thermochronology will allow me to date the exhumation of the footwall blocks that contain these ductile fabrics in the CREC. Field work for this project involved an undergraduate from UT-

Austin who gained valuable field experience collecting structural data and the collection of geochronologic samples along geologically significant traverses.

Geochemistry and petrology of pre-Peach Spring supereruption mafic lavas: My research experience in the CREC began during my undergraduate years when I participated in the first-year of the Before and After a Supereruption NSF-REU program through Vanderbilt and Mercyhurst Universities. This REU enabled me to spend two field seasons in the CREC and develop an individual research project on the chemistry of pre-Peach Spring Tuff supereruption mafic lavas in northwest Arizona, part of the ignimbrite flare-up that preceded large-magnitude crustal extension in the region. Working with Calvin Miller at Vanderbilt University, I learned how to apply MELTS temperature modeling, characterize pre-supereruption lavas with trace element and whole rock chemistry, and document the volcanostratigraphy of the southern Black Mountains. After the REU finished, I continued to process my data and develop a geologic story—allowing me to finish the project as my senior honors thesis at the College of William & Mary.

Extension and exhumation in the Southern Cyclades, Greece

I began working in the southern Greek Cycladic islands during my M.S. at UT-Austin and throughout the project I have collaborated closely with Eirini Poulaki (another MS and then PhD student at UT-Austin) and Kostis Soukis at the National and Kapodistrian University of Athens. This work has spanned over 500 Myrs of history preserved in the Ios metamorphic core complex.

Permian mylonitization and Coeval Miocene exhumation of the Ios MCC: Using apatite U-Pb geochronology and constraining the temperatures of mylonitic deformation with EBSD and microtextural characterization, my research has shown that there are Permian-age high-temperature fabrics exposed in the Miocene-aged Ios metamorphic core complex. This importantly contradicts previous assertions that all fabrics exposed in the Cyclades are the result of either Eocene subduction or of Miocene exhumation and suggests that, at least in the basement rocks, Permian extension and exhumation imparted a strong fabric that was not strongly overprinted by subsequent deformation.

My work in the southern Cyclades continued by examining the nature of the contact between the basement and its metasedimentary cover. By using low-temperature thermochronology, I was able to show that there is no difference in the timing of exhumation between the two units, which contrasts with previous interpretations that the contact represents a detachment fault responsible for exhumation of core complexes in the southern Cyclades.

Tectono-magmatic evolution of the Cycladic Basement: My M.S. research focused on the age of the Cycladic Basement granitoids and the tectonostratigraphy of Basement metasedimentary rocks. By robustly dating the age and constraining the age relationships preserved in the Basement rocks, this work helped develop an updated paleogeography in the eastern Mediterranean region and was published in *Tectonics*.

Future Research Plans

While much of my research has focused in Cenozoic extensional terranes/orogens, the methods are applicable to the spectrum of tectonic settings. For example, the age of mid-lower crustal suturing of peri-Gondwanan terranes with Laurentia in the Appalachian Orogen remains contentious, as the Appalachians are an ancient orogen where only the metamorphic core remains.