Kristina L. Butler

Research Statement

Overview.

Mountain building modifies global and regional climate, rearranges drainage systems, and influences changes to biodiversity. The mechanisms which drive orogenesis (e.g. mantle dynamics, climate, crustal shortening) are notoriously challenging to tease apart and therefore the linkages between the causes and effects of mountain building are elusive. Sedimentary basins host time-integrated records of surface processes and elevation, subsidence, exhumation, and climate. I use well-dated sedimentary archives to address the drivers and consequences of mountain building. My research integrates multidisciplinary techniques in sedimentology, geochronology, and geochemistry to test hypotheses regarding the timing and rates of orogenesis and topographic change. My research spans a variety of scales, from single mineral geochemistry, paleoenvironmental interpretation, to basin-scale stratigraphic reconstructions. I focus on three key research themes:

Research Themes & Carleton University Student Projects

1.The initiation and evolution of orogens and their sedimentary basins

Motivation & Implications: Linking earth's surface response to tectonics, mantle dynamics, and climate remains a key challenge in the Earth Sciences (Huntington and Klepeis, 2018). These divergent mechanisms operate across different timescales resulting in distinctive subsidence patterns and exhumation histories. My current work documents the earliest phases of Andean shortening were driven by changing subduction dynamics using the retroarc foreland basin and arc magmatism record of Northern Patagonia, Argentina (Butler et al., 2020; Gianni et al., 2020, Folguera et al., 2020). Future work here will further interrogate this hypothesis by evaluating cooling histories of basement-involved foreland partitioning uplifts and consider the pre-Andean record and the roll structural inheritance might play on Andean mountain building and foreland basin evolution.

Tools: sedimentary facies analysis, sediment accumulation histories, zircon U-Pb geochronology, multiproxy provenance methodologies, low-temperature thermochronology, 2D seismic line interpretation, geological mapping

Related Projects:

(i) Triassic-Jurassic backarc extensional basin development in southern South America during Gondwanan breakup: implications for structural inheritance during Mesozoic-Cenozoic Andean shortening. *Collaborators*: Brian Horton (University of Texas-Austin), Andres Folguera (Universidad de Buenos Aires) *PhD project*

(ii) Multiproxy low-temperature thermochronology of basement uplifts in the Patagonian broken foreland: do changing subduction dynamics drive foreland partitioning? *Collaborators*: Chelsea Mackaman-Lofland (University of Connecticut), Brian Horton (University of Texas-Austin), César Navarrete (Universidad de la Patagonia San Juan Bosco) <u>*PhD project*</u>

(iii) Sedimentology and provenance of the Pennsylvanian Bursum Formation: the incipient Ancestral Rocky Mountains and tectonic evolution of the Orogrande Basin, New Mexico. *Collaborators*: Charlie Kerans (University of Texas-Austin). <u>*Undergraduate thesis project*</u>

2. The drivers and consequences of high topography

Motivation and Implications: Regions of high topography influence global and regional climate and rearrange orogen- and local-scale drainage systems. Debate continues on how high topography is constructed (e.g. protracted crustal shortening, relatively rapid removal of lower crustal lithosphere, climate fluxes). Where preserved, hinterland basins archive surface elevation histories, paleohydrology, and paleoclimate (e.g. Horton, 2012). Currently, I am collaborating with an interdisciplinary team of researchers (stable isotope geochemists and hydrologists) with exclusive access to sediment cores and 2D seismic lines (Albemarle Corporation) in the Salar de Atacama hinterland basin of Northern, Chile.

Tools: sedimentology, geochronology, stable isotope paleoaltimetry

Related Projects:

(i) Paleoelevation reconstruction in hyper-arid settings – integrating sedimentology, geochronology and stable isotope paleoaltimetry in the Salar de Atacama Basin, Chile (22-25˚S). *Collaborators*: Albemarle Corporation, Daniel Ibarra (Brown University), LeeAnn Munk (University of Alaska Anchorage), David Boutt (University of Massachusetts Amherst) <u>*PhD project*</u>

3. Lacustrine depositional systems and their paleoclimate records

Motivation and Implications: Lacustrine systems preserve long and continuous records of climate and surface processes. In closed-basin settings these archives are directly linked to local climate, ecosystems and hydrology. These inherent characteristics make lacustrine depositional records ideal for testing hypothesis regarding how topographic change modifies climate and drainage systems and influences biodiversity. Currently, I am collaborating on interdisciplinary projects in Clayton Valley, Nevada and the Salar de Atacama Chile which host significant lithium brine resources. My roll in this research team is developing basin-scale chronostratigraphic framework, paleoenvironmental interpretations, and assessing diagenesis.

Tools: sediment core facies analysis, geochronology, 2D seismic line interpretation, sandstone, siltstone, carbonate and evaporite thin section petrography, stable isotopes
Related Projects:

(i) Miocene-Pleistocene stratigraphic architecture of Clayton Valley Basin, NV: lithium brine reservoir characterization. Collaborators: Albemarle Corporation, LeeAnn Munk (University of Alaska Anchorage), David Boutt (University of Massachusetts Amherst), Daniel Ibarra (Brown University). <u>M.Sc. project</u>

(ii) Miocene-recent lacustrine sedimentation in a mixed evaporite-siliciclastic system, Salar de Atacama, Chile: wetter-periods punctuate a hyper-arid climate. Collaborators: Albemarle Corporation, LeeAnn Munk (University of Alaska Anchorage), David Boutt (University of Massachusetts Amherst), Daniel Ibarra (Brown University). <u>M.Sc. project</u>