My research efforts center on determining changes in water column structure and circulation patterns and how they relate to climate evolution, carbon cycling, and the distribution of organisms during transitions into and out of ancient greenhouse climates as well as other intervals of global change. Much of my group's primary data are generated in the stable isotope lab at the University of Missouri that Dr. Cheryl Kelley and I oversee. In addition to specific projects on the Cretaceous/Paleogene and Permo-Triassic boundaries, my current major research themes include:

Ocean circulation patterns

By measuring Nd isotopic ratios in fish debris isolated from well-dated sections spanning a range of depths, we are trying to constrain better the source and circulation patterns of intermediate and deep water masses for the Late Cretaceous. We are currently are focusing on an interval of proposed circulation change around 70 Ma. Staple isotopic measurements coupled with biostratigraphy allow us multiple perspectives on oceanographic conditions and depth transects in the Pacific, Indian, South Atlantic basins are giving us geographic and bathymetric control. Parallel climate modeling experiments lead by Dr. Chris Poulsen (University of Michigan) include a Nd module and oxygen isotopic tracking to test and refine proposed changes in circulation and climate inferred from the geochemical data. Whereas this technique is increasingly being applied by several groups, we think we've only started to realize the potential the approach.

Cretaceous temperature history

Estimating paleotemperatures from foraminiferal $\delta^{18}O$ analyses is a well established technique and has been a major component of paleoclimatological and paleoceanographic studies for the past 30 years. It is a technique with known advantages and known limitations. A significant limitation of the technique in deep time is the susceptibility of calcite to diagenetic overprinting. The contribution we are making to Late Cretaceous foraminiferal $\delta^{18}O$ studies is collecting and analyzing samples from arguably the longest and most complete sequence containing exceptionally well preserved specimens.

Paleozoic paleoceanography

The stability of the P-O bond in phosphates relative to that of the C-O bond in carbonates makes phosphates particularly attractive for paleoclimate studies in lower Paleozoic samples where diagenetic overprints on carbonate $\delta^{18}O$ values are ubiquitous. Because early Paleozoic boundary conditions (geography, biology, solar flux, atmospheric composition) were so much different than either the present or the Cretaceous, examination of this interval provides an intriguing test of the generality of our understanding of Earth systems. These tests, though, require that contemporary conditions can be accurately estimated.

Our work focuses the Late Ordovician glaciation that marks the end of an ~150 my long, early Paleozoic greenhouse interval and that is associated with the second largest mass extinction event of the Phanerozoic. Specifically we are trying to determine when and how cooling toward the Hirnatian glaciation began. We have found that $\delta^{18}O$ values in conodonts were relatively stable for 5 – 10 million years prior to the Late Ordovician glaciation but that the Laurentian seaway experienced resolvable shifts in circulation that correlate with faunal exchange among basins. Ongoing work is focusing on regional to global gradients in $\delta^{18}O$ and $\delta^{13}C$ value and conodont paleoecology.