Understanding processes that drive plate tectonics is fundamentally important as they are responsible for the development of resource deposits, localization of seismic activity, and dictate long-term evolution of the climate. Subduction zones are destructive tectonic plate boundaries that act as the main driving force for plate tectonics and ocean closure leading to collision of continents. Additionally, subduction zones themselves are directly responsible for mountain building, volcanic activity, as well as fluid and carbon cycling. Thus, it is crucial to investigate subduction zone life cycles from initiation to termination, and how existing subduction zones influence one another or induce new subduction zones due to transmission of far-field stresses, altogether driving plate tectonics that shape the Earth. Studies predominantly utilize modern subduction systems on Earth for understanding their evolutions and interactions. However, presently-active subduction systems inherently do not provide a full record from initiation to termination, nor provide a full illustration of far-field interactions through time. Furthermore, rock records associated with modern subduction systems may be difficult to impossible access, limiting direct investigations into the subduction zone processes.

In this project, we utilize the rock record of the Scandinavian Caledonides as a natural laboratory to investigate subduction zone life cycles and their far-field interactions. The Scandinavian Caledonides is an ancient mountain belt that is well-exposed and highly accessible in Sweden and Norway. Its rock record details the opening of the Iapetus Ocean in the Neoproterozoic and subsequent closure of the ocean starting in the late Cambrian, progressing until final closure and collision of the Baltican and Laurentian continents in the Silurian to Devonian. Records of two late Cambrian subduction zones are preserved within the Scandinavian Caledonides that were responsible for the initial stages of Iapetus Ocean closure, one located along the outer continental margin of Baltica, and the second within the Iapetus Ocean proximal to Laurentia.

Limited recent studies have begun to challenge the current paradigms of these two subduction zones, suggesting drastically different evolutions that would have significant impacts on our understanding how Iapetus Ocean closure progressed. The project aims to critically re-evaluate the histories of these two subduction zones to detail both of their stages of evolution in late Cambrian time and the far-field stress interactions of the two zones that governed closure of the Iapetus Ocean. Rock specimens for the project will be acquired from sample archives and through fieldwork in key regions to provide a comprehensive spatial coverage of the two subduction zone records. Investigation of the rocks will involve a combination of conventional petrographic, geochemical, and geochronological techniques combined with state-of-the-art geochronological and petrological approaches that are essential to extract accurate and detailed magmatic and metamorphic histories from the rocks that comprise the two subduction zone records. Conceptual and numerical models will be developed based on the information extracted from the rocks to examine how the two subduction zones evolved through time and their far-field stress interactions. The project will not only have an impact for re-shaping our understanding of Iapetus Ocean closure recorded in the Scandinavian Caledonides, but will greatly improve our global understanding of subduction zone processes that govern plate tectonics and shape the Earth’s surface and interior.