Spectromicroscopy of marine colloids: scanning transmission X-ray microscopy (STXM) and synchrotron infrared nano-spectroscopy (SINS)

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In the Southern Ocean, a critical region of carbon sequestration to the deep ocean, primary productivity is limited by iron (Fe). Nanoparticulate Fe sourced from West Antarctic Peninsula (WAP) sediments, in the colloidal size fraction, may represent a key Fe input. Our goal is to understand the mobility and bioavailability of Fe released from these sediments. To achieve this goal, we propose to measure the chemical speciation of Fe released from the sediments along the WAP in a highly mobile and potentially bioavailable colloidal size class. Colloids are an operationally defined size fraction with diameters between 0.003 μm and 0.2 μm. While colloids have traditionally been included in the "dissolved" fraction (i.e. < 0.2 μm), they are small solid phase particles. Colloids are known to represent 10 to 90% of open ocean Fe with an average of 50% below the chlorophyll maximum (Fitzsimmons et al. 2015). In this project, we are developing sample collection, handling, and analysis approaches for spectromicroscopy. We are using scanning transmission X-ray microscopy (STXM), X-ray absorption spectroscopy (XAS), synchrotron infrared nano-spectroscopy (SINS), and midinfrared (IR) spectroscopy to measure the chemistry of colloids. The colloidal fraction will push the limits of current capabilities of the STXM and SINS instruments in terms of spatial resolution. However, there no other analytical methods currently available to answer these important colloid-specific, chemical speciation questions. We aim to use colloid morphology, composition, and speciation to understand the mobility and bioavailability potential of the this important oceanic Fe pool.

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