Using Sediment Provenance to Study Ice Streams in the Weddell Sea Embayment of Antarctica

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Abstract

The geochemical and geochronological fingerprint of rock debris eroded and carried by ice streams may be used to identify the provenance of iceberg-rafted debris (IRD) in the marine sediment record. During deglacial times it has been shown that there is an increase in IRD accumulation in marine sediments underlying the western limb of the Weddell Gyre. We seek to find the provenance of this IRD, identify the ice streams contributing to the IRD load, and interpret the geographic sequence of ice sheet retreat in the Weddell Sea embayment for the last three deglaciations.

In December 2014 we conducted fieldwork to collect samples of rock and sediment debris carried by three of the major ice streams draining the Weddell Sea embayment: the Foundation Ice Stream, the Academy Glacier, and the Recovery Glacier. We sampled both modern moraines at the edges of the ice streams and older till on hillsides next to the ice streams. In addition to rocks representing the geology of local outcrops, we found that each of the three ice streams carries a characteristic set of erratic lithologies from further upstream, giving clues to the geology hidden under the ice sheet. Downstream, subglacial till and proximal glaciomarine sediment from existing core sites located at the edge of the Filchner and Ronne Ice Shelves, collected on past expeditions of the RV Polarstern, characterize the geochemical and geochronological fingerprint along ice flow lines extending from the ice streams. Finally, two deep-water RV Polarstern sites contain a continuous record of IRD sourced from the set of Weddell embayment ice streams over the last few glacial cycles.

Here we present $^{40}Ar/^{39}Ar$ hornblende and biotite thermochronological data from individual mineral grains, K-Ar, Nd and Sr isotopes from the silt and clay fraction, and U-Pb zircon geochronology from the onshore tills and offshore sediments. Using this data we will discuss provenance matching between the IRD and the ice streams, and the possibilities for using provenance to understand ice sheet dynamics over the course of glacial cycles.

Keywords: Weddell Sea embayment, deglaciations, ice streams, sediment provenance