Evidence of Diminished WAIS and Open Interior Seaway, from Distinctive Dropstones in Amundsen Sea that Originated in the Ellsworth Mountains

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IODP Expedition 379 to the Amundsen Sea continental rise recovered latest Miocene-Holocene sediments from two sites on a drift in water depths >3900m. Sediments that are dominated by clay and silty clay host pebbles and cobbles of ice-rafted detritus (IRD) (Gohl et al. 2021, doi: 10.14379/iodp.proc.379.2021). Cobble-sized dropstones also appear as fall-in, in the top of cores recovered from sediments >5.3 Ma. The principle means to deposit abundant IRD and sparse dropstones in deep sea sediment is through melting of icebergs released by Antarctic ice-sheet calving events. We use petrological and age characteristics of clasts from the Exp379 sites to fingerprint their bedrock provenance to extend knowledge of subglacial bedrock, and with the intention to illuminate changes in icesheet extent between 7 – 3 Ma that lend credence to forecasts of extensive future change.

Mapped onshore geology shows pronounced distinctions in bedrock age between tectonic provinces of West or East Antarctica (e.g. Jordan et al. 2020). Therefore we use geochronology and thermochronology of clasts and minerals for tracing their provenance, and ascertain whether IRD deposited at 379 drillsites originated from proximal or distal Antarctic sources. We here report zircon and apatite U-Pb dates from several sand samples and dropstones taken from latest Miocene, early Pliocene, and Plio-Pleistocene-boundary sediments. Additional Hf isotope data, and apatite fission track and 40Ar/39Ar Kfeldspar ages for some of the same samples help to strengthen provenance interpretations.

The study revealed three distinct zircon age populations at ca. 100, 175, and 250 Ma. Using Kolmogorov-Smirnov (K-S) statistical tests to compare our new igneous and detrital zircon (DZ) U-Pb results with previously published data, we found strong similarities to West Antarctic bedrock, but low correspondence to prospective sources in East Antarctica, implying a role for icebergs calved from the West Antarctic Ice Sheet (WAIS). The ~100 Ma age resembles plutonic ages from Marie Byrd Land and islands in Pine Island Bay. The ~250 and 175 Ma populations match published mineral dates from shelf sediments in the eastern Amundsen Sea Embayment as well as granite ages from the Antarctic Peninsula and the Ellsworth-Whitmore Mountains (EWM). The different derivation of coarse sediment sources requires changes in iceberg origin, likely the result of changes in WAIS extent during deglaciation.

One unique Exp379 dropstone is green quartzite containing mostly 500-625 Ma detrital zircons. In appearance and dominant U-Pb age population, it resembles a sandstone dropstone recovered from Exp382 U1536 in the Scotia Sea (Hemming et al. 2020, GSA abstract). K-S tests yield high values ($P \geq 0.6$), suggesting a common provenance for both dropstones recovered from late Miocene to Pliocene sediments, despite the 3270 km distance separating the sites. Comparisons to published data, in progress, narrow the group of potential on-land sources to exposures in the EWM or isolated ranges at far south latitudes in the Antarctic interior. If both dropstones originated from the same source area, they signify that dramatic shifts in the WAIS grounding line position do occur, along with periodic opening of a seaway connecting Amundsen and Weddell Seas.