Rapid climate changes during the last ice age recorded in coral skeletons and Antarctic rocks

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Greenland ice cores (GRIP and GISP2) recorded signatures of the rapid shifts in the air temperature of 10-15 degree C as short as in a couple of decades during the last ice age. Some of the largest shifts were also coincided with repeated enormous ice curving events in millennial time scales and paleocenographic proxies indicate climate was swung due to this changes. However the timing and the magnitude of this events are remain uncertain and the behavior of the Antarctic ice sheets as was the largest ice reservoir during this timing is still unknown.

Huon Peninsula, Papua New Guinea, is a tectonically unstable, uplifting shoreline ringed by emergent coral terraces. The terraces were formed during episodes of rapid sea-level rise when corals constructed large, discrete coral platforms that were subsequently uplifted. Uranium series ages of four prominent Huon Peninsula last glacial (OIS 3) coral terraces coincide with the timing of major North Atlantic climate reversals at intervals of 6000 to 7000 years between 30,000 years and 60,000 years ago. Terrace elevations, when combined with uplift, indicate 10 to 15 m high sea-level excursions at these times. We attribute the growth of the terraces directly to sea-level rises arising from ice-calving episodes from major North Atlantic ice-sheets and the Antarctic ice-sheet that precipitated extremes of cold climate called Heinrich events. These periods are associated with major discharges of land-based ice and enhanced concentrations of ice-rafted debris in deep-sea cores. Sea-levels at this time were 60 m to 90 m lower than present.

To identify its contribution to this sea-level event, we have studied the Soya coast of Antarctica as well as the Mt. Riiser-Larsen to study the melting history of East Antarctic Ice Sheet (EAIS). Distinct geomorphologic features of raised beach sediments formed during the sea-level highstands in the past were observed and several trenches were made to investigate the internal structure. More than 80 AMS radiocarbon measurements on in-situ fossil mollusks were conducted to constrain the timing of the past highstands. Radiocarbon dating results were clustered in 2 groups showing 2 major highstands during the Holocene and OIS3. Reliability of the dating results is ensuring the quality of the samples including the nature of the tests that are free from secondary younger carbon contamination. We applied step-wise dissolution experiments on those mollusks and successfully replicated the earlier dating results indicating that the samples were free from contamination.

Glacial erratics as well as bedrock samples from Mt. Riiser-Larsen were collected for Cosmogenic Radio Nuclides (CRN) dating. Mt. Riiser-Larsen is useful to study melting history of the ice sheet since it is located near the coast so that the temporal variation in ice thicknesses of the ice margin can be reconstructed using CRN dated glacial deposits obtained from different altitudes. The results of the CRN dating (altitudes between 300 and 700m) are approximately 50ka that is consistent with the TL and radiocarbon age results from the lake sediments in the coastal site. The lake sediments contained till layers separated by lake sediment indicated that the ice sheet was retreated from this area and thus the lake sediment was deposited. The lowest glacial erratics recovered from 290m in altitude show the minimum CRN age of 24ka indicating the timing of the final melting of the ice sheet in this area.

Given that the trimline at the Mt. Riiser-Larsen indicates the maximum height of the most recent episode of expansion of the ice sheet, EAIS in this area experienced 2 distinct events of retreat since about 50ka to the Holocene. This finding is consistent with earlier glacio-hydro-isostastic modeling study using available relative sea-level datasets around the Antarctic continent.