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Climate-ice sheet interactions through the Pliocene-Pleistocene: Preliminary results from Expedition 341 (Gulf of Alaska)

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Since the Pliocene, global climate history is distinguished by the transition into a colder world, dominated by the onset and intensification of major Northern Hemisphere glaciations which have changed in their duration and intensity. It has been argued that cooling in the surface ocean has driven or been conducive to continental ice-sheet growth, whereas alternative proposals consider the influences of progressive sub-glacial erosion and feedbacks to explain changing ice-sheet extent and dynamics, which may occur independently of climate change and/or the potential regional climate impacts of tectonic uplift. At present, isolating climate as the driver of evolving continental ice volume since the Pliocene is hindered by the limited long term data sets which directly link climate changes to evidence for ice-sheet advance/retreat, erosion, and tectonic evolution over million year timescales.

IODP Expedition 341 (May-July 2013) drilled a cross-margin transect from ice-proximal sites on the continental shelf (in the Bering Glacier trough, 248 m water depth) to distal sites in the deep Pacific (c. 4190 m water depth). These include two sites (U1417, U1418) which have both centennial-scale records of Pleistocene glacial cycles and longer-term records extending into the Miocene. Preliminary shipboard analyses indicate that a rich history of climate change, glaciation and tectonics has been recorded, including variable biogenic and terrigenous contributions, and evidence for deposition through pelagic, mass movement and glacial processes. This will allow for a more detailed understanding of the interaction between northeast Pacific palaeoceanography and the history of the northwest Cordilleran ice sheet, neither of which are fully understood given limited data which pre-dates the Last Glacial Maximum. The focus of this research is to target the evidence for past climate change as recorded in evidence for evolving sea surface conditions including sea surface temperatures (SSTs), sea ice, and marine primary productivity through the Pliocene and Pleistocene.

Here we present initial findings from sites U1417 (the most distal site, 4190 m water depth) and U1418 (at 3667 m water depth). We reconstruct SSTs using the alkenone biomarker proxy, the UK37' index, and compare our results with evidence for evolving ice-sheet history as determined through the shipboard-generated lithostratigraphy of the two sites. We consider the interaction between SSTs and primary production by examining the absolute abundance and relative distribution of biomarkers specific to plankton groups (e.g. for haptophytes, diatoms and dinoflagellates). Further investigation of the relationship between these climatic events and the northwest Cordilleran ice sheet advance/retreat history will continue through comparison to emerging data sets on ice-rafting and associated changes to sediment provenance, generated by members of the Expedition 341 Scientific Party.