A preliminary cyclostratigraphic and paleo-environmental analysis of the new high-resolution McMurdo Ice Shelf (ANDRILL) drill core has implications for WAIS history and dynamics

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In the austral summer of 2006-2007 the ANDRILL Program undertook its first drilling project on the McMurdo Ice Shelf in the northwest part of Ross Ice Shelf where it has been pinned by Ross Island for the last ~8ka. The drillsite was situated above a 915m-deep flexural moat basin adjacent to Ross Island that had formed in response to Quaternary volcanic loading of the crust, superimposed on more regional subsidence associated with Neogene extension of the Terror Rift. The drill rig employed a wire-line diamond-bit coring system through a tide-compensated sea-riser, which was kept free from the 85m-thick ice shelf, by a hot-water over-reamer. Multichannel seismic reflection surveys linked the site regionally and indicated a >1km-thick accumulation of sediment that probably spanned the last 5-10Ma. Drilling recovered a 1285m-long core of Late Miocene to Recent age that included cyclic glacial and glacimarine sediment with interbedded volcanic sediments, lava and tuffs contributed from the surrounding alkalic volcanoes of the McMurdo Volcanic Group. Core recovery rate was better than 98%.

A preliminary age model for the upper 600m of core implies the recovered succession is a detailed record spanning the Pliocene through Pleistocene. Facies are attributed to a set of depositional processes and possible range of depositional environments using criteria that include texture, internal structures, contacts, geophysical properties, composition, and paleontological components. The strongly cyclic stratigraphy has three dominant cycle "motifs" reflecting oscillations in glacial proximity. One motif represents environmental changes associated with cold polar ice, another with warmer (polythermal) ice with interglacials being dominated by pelagic diatomites, another warmer (polythermal) ice with interglacials being dominated by glacimarine hemipelagites. Some transitions within and between motifs are very abrupt with rapid facies changes or dislocations; others are more gradual with many physical amalgamations or progressive, logical facies successions.

Repetitive vertical successions of facies bounded by ice contact surfaces show regular fluctuations attributed mainly to changes in WAIS volume. Pleistocene cycles are characterized by a thick interval of subglacial massive diamictites passing up into thin intervals of grounding-line proximal interstratified mudstones, sandstones and volcanic sandstones. Early-Middle Pliocene cycles display subglacial to ice proximal massive and stratified diamictites in their lower parts passing up into proglacial interstratified sandstone and mudstone followed by open water, ice distal mudstone. The Middle to late Pliocene is dominated by strongly cyclic alternations between diamictite and diatomite of probable Milankovitch duration. An ~100m-thick Early-Middle Pliocene interval of diatomite shows no apparent glacial cyclicity and represents an extended period of ice-free conditions.