Geophysical Research Abstracts
Vol. 13, EGU2011-2905, 2011
EGU General Assembly 2011

Geochemical record of the ANDRILL AND-2A drillcore: Miocene sediment provenance and continental weathering in the McMurdo Sound, Ross Sea, Antarctica

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The ANDRILL AND-2A drillcore recovered an 1138 m long record of early Miocene to Holocene glaciomarine strata in a proximal shelf setting from the McMurdo Sound within the Ross Sea, including an expanded interval of the Middle Miocene Climatic Optimum (MMCO) a pronounced warming period documented in global deep-sea records. Here we present a geochemical record for the AND-2A core based on quantitative XRF measurements to characterize (i) the dominant source rock pattern and (ii) the paleoclimate conditions inferred from the degree of chemical weathering.

Hierarchical cluster analysis of the XRF data provides clear evidence for four different clusters within the two dominant lithologies diamicties (D1, D2, D3, D4) and mudstones (M1, M2, M3, M4). Element ratios of these clusters were compared with literature data for potential source rocks from the McMurdo Sound area to identify the major catchment area. For both lithologies the first clusters (D1 and M1) are strongly dominated by igneous rocks from the Granit Harbour Intrusive Complex (GHIC). All other clusters show a stepwise increase in contribution from the McMurdo Volcanic Group (MVG) with increasing cluster number. Based on these results we subdivided the AND-2A core into three main provenance scenarios: the dominance of the MVG below 665 mbsf implies that glaciers overrode early volcanic centres ("proto" Mt. Morning) in the south and transported volcanic material to the AND-2A drill site. In contrast, between ∼665 - 225 mbsf southern glaciers retreated and the sediments are dominated by a local source (GHIC) derived from the Transantarctic Mountains. Above ∼225 mbsf major contribution from the MVG indicating that glaciers from the south eroded and delivered again volcanic material from the surroundings of Mt. Morning to the drillsite.

Chemical weathering indices are appropriate methods to obtain paleoclimate records from sediment cores, especially in polar regimes with a strong contrast between glacial and interglacial periods and low concentration of organic matter. The Chemical Index of Alteration (CIA; Nesbitt and Young, 1982, Nature 299) is one of the widest used proxy to determine the influence of climate changes on the bulk sediment composition and indicate the degree of feldspar weathering. CIA values for the AND-2A core range from 40 to 66 and comprise short intervals with enhanced chemical weathering within the middle Miocene section. In contrast to the global deep sea proxies the CIA indicates also time slices during the early Miocene with a similar degree of chemical weathering compared to the middle Miocene (e.g. ∼1005 mbsf). Based on these results warmer periods with higher degree of chemical weathering are not only restricted to the MMCO but also appear during the early Miocene. Moreover, one of the lowest CIA values (∼44) is located within an ice distal facies at the top of a mudstone interval between ∼822 - 775 mbsf. These could reflect a cold and dry climate with very low precipitation and, thus, less ice expansion. In case of the AND-2A core paleoclimate information seems to be partly decoupled from global climate information derived from deep-sea records.