Antarctic Weathering during the middle Miocene Climatic Optimum and Climate Transition

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The middle Miocene Climatic Optimum (MCO; ~17–15 Ma) stands out as an interval of global warmth and ice sheet retreat in Antarctica, superimposed on the long-term cooling trend and ice volume growth of the Cenozoic. A return to cooler conditions and renewed expansion of the Antarctic ice sheet during the middle Miocene Climate Transition (MMCT; ~14-15 Ma) is associated with decreasing CO_2 levels and deepening of the CCD, processes linked to chemical weathering of Earth's continents. The Antarctic region records the most pronounced variations in climate during these transitions; however, the evolution of the ice sheet and associated weathering patterns on the continent during this time are currently concealed under the ice.

Pb isotopes of continental weathering products preserved in deep sea sediments record past variations in weathering that are related to climate change. During incongruent chemical weathering of bedrock, radiogenic Pb is preferential released to the dissolved phase, producing weathering solutions with more radiogenic isotopic values than weathered parent material. The isotopic value of the solution, preserved in the seawater record from Fe-Mn oxide coatings on bulk marine sediment, and the offset between the solution and parent material, preserved in detrital sediment fractions, increases with the intensity of incongruent weathering.

Data from Ocean Drilling Program site 744 on Kerguelen Plateau and sites 689 and 690 on Maud Rise reveal increased $^{206}Pb/^{204}Pb$ seawater values and increased offsets between seawater and detrital values during the MCO, and decreased values and offsets during the MMCT. Our data suggest enhanced chemical weathering accompanied the reduced ice volume and high atmospheric CO_2 during the MCO, which may have contributed to the drawdown of CO_2 as well as deepening of the CCD. Reduced atmospheric CO_2, increased ice volume and a proposed transition from a wet-based to a more cold-based ice sheet may have contributed to reduced weathering during the MMCT.