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West Antarctic Ice Sheet dynamics controlled export production in the Pacific Southern Ocean over the last 500,000 years

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The increased supply of the micronutrient iron (Fe) promotes primary and export production in the Fe-limited Southern Ocean, thus acting as a dynamic sink of atmospheric CO_2 that has amplified past natural climate variations. This mechanism critically relies on the partial dissolution of the lithogenic particle input. However, the influence of lithogenic particle composition (and Fe solubility) on Southern Ocean export production in the large Antarctic Zone (AZ) is largely unconstrained for the Pleistocene glacial cycles. Here, we present a comprehensive dataset of glacial-interglacial particle fluxes and composition in the remote Southeast Pacific AZ covering the last 500,000 years. The high fluxes and compositional range of lithogenic material can only be explained by glaciomarine sediment input sourced from West Antarctica. Importantly, higher solubility of the lithogenic input corresponds with enhanced export production, implying that the primary production in large parts of the South Pacific AZ was closely coupled to West Antarctic Ice Sheet (WAIS) dynamics. These processes contributed to atmospheric CO_2 reductions on orbital to millennial time scales, suggesting that the WAIS retreat and bedrock erosion will affect Southern Ocean biogeochemical cycles and reduce the input of bioavailable Fe in the future.