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Microbial respiration of fossil carbon beneath Antarctica

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Chemical and biological reactions in waters beneath the Antarctic ice sheet may directly impact the atmospheric carbon budget by recycling large stores of organic matter sequestered in subglacial sediments. Yet limited access to the Antarctic ice-bed interface leads to uncertainty in the geographic extent of carbon dioxide production beneath the ice sheet, and whether mobilized carbon is neutralized through rock weathering before it can escape to the atmosphere. Here we present stable oxygen and carbon isotope data measured in a continent-wide suite of carbonate samples that precipitate in Antarctic subglacial waters. Carbonate forming waters beneath East Antarctic ice sheet (EAIS) consistently exhibit $\delta^{13}C$ compositions as low as -23.5 ‰, pointing to geographically widespread conversion of fossil subglacial organic matter sequestered in sediments and rocks into carbon dioxide through microbial respiration. Precipitate $\delta^{13}C$ values are correlated with a proxy for the ratio of alkalinity to calcium (P/Ca), providing evidence for varying degrees of carbon neutralization in Antarctic subglacial environments. The $\delta^{13}C$ values of subglacial waters also scale with strontium isotopic composition and geographic location, indicating that bedrock type exerts significant control in the degree of carbon neutralization through silicate weathering. These results suggest that the Antarctic subglacial environment can potentially source carbon to the atmosphere, but the magnitude of released carbon is limited by silicate weathering efficiency.