Enhanced silicate weathering of tropical shelf sediments exposed during glacial lowstands: a sink for atmospheric CO_2

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Atmospheric CO_2 and global climate are closely coupled. Since 800 ka CO_2 concentrations have been up to 50% higher during interglacial compared to glacial periods. Because of its dependence on temperature, humidity, and erosion rates, chemical weathering of exposed silicate minerals was suggested to have dampened these cyclic variations of atmospheric composition. Cooler and drier conditions and lower non-glacial erosion rates suppressed in situ chemical weathering rates during glacial periods. However, using systematic variations in major element geochemistry, Sr-Nd isotopes and clay mineral records from Ocean Drilling Program Sites 1143 and 1144 in the South China Sea spanning the last 1.1 Ma, we show that sediment deposited during glacial periods was more weathered than sediment delivered during interglacials. We attribute this to subaerial exposure and weathering of unconsolidated shelf sediments during glacial sealevel lowstands. Our estimates suggest that enhanced silicate weathering of tropical shelf sediments exposed during glacial lowstands can account for ~9% of the carbon dioxide removed from the atmosphere during the glacial and thus represent a significant part of the observed glacial-interglacial variation of ~80 ppmv. As a result, if similar magnitudes can be identified in other tropical shelf-slope systems, the effects of increased sediment exposure and subsequent silicate weathering during lowstands could have potentially enhanced the drawdown of atmospheric CO_2 during cold stages of the Quaternary. This in turn would have caused an intensification of glacial cycles.