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Ocean iron fertilization by sea-level enhanced mid-ocean ridge volcanism

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Iron fertilization in high-nutrient, low-chlorophyll (HNLC) regions has been proposed to boost phytoplankton growth and enhance oceanic CO_2 sequestration. Dust has long been recognized as a primary external iron source for HNLC waters, but recent discoveries highlight hydrothermal activity along mid-ocean ridges as a significant contributor of iron to the deep ocean. However, it remains unclear if hydrothermal iron directly impacts upper ocean productivity. Pleistocene glacial terminations provide a natural test because previously lower sea level depressurizes mid-ocean ridges, increasing hydrothermal activity and iron emissions. From the eastern equatorial Pacific (EEP), the largest tropical HNLC region, we compare 200,000-year-long records of phytoplankton nutrient consumption (measured by foraminifera-bound $^{15}N/^{14}N$) with hydrothermal iron emissions from the underlying Eastern Pacific Rise (EPR) mid-ocean ridges. Beginning just prior to the last two terminations, increases in EPR hydrothermal activity coincide with higher EEP nutrient consumption, consistent with direct iron fertilization by enhanced ridge volcanism. If corroborated in other HNLC regions such as the Southern Ocean, where flow-topography interactions can more readily deliver hydrothermal iron to surface waters and nutrient utilization has greater impact on atmospheric CO_2, this would imply a new feedback linking climate, sea level, ocean biogeochemistry, and atmospheric CO_2 across glacial cycles.