TO Bownbag Seminar
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Does sea level influence mid-ocean ridge magmatism on Milankovitch timescales?

Abstract:
Magma production at mid-ocean ridges is driven by sea floor spreading and decompression melting of the upper mantle. In the special case of Iceland, mantle melting may have been amplified by ice sheet retreat during the last deglaciation, yielding anomalously high rates of subaerial volcanism. For the remainder of the global mid-ocean ridge system, I hypothesize that the ocean plays an analogous role, with lowering of sea level during glacial maxima producing greater magma flux to ridge crests. Published estimates of sea level variability can be used to model the effect of oceanic hydrostatic pressure on decompression melting beneath mid-ocean ridges. Peaks in magma flux occur after sea level drops rapidly, including the Marine Isotope Stage (MIS) 5/4 and 3/2 transitions. The minimum in simulated flux occurs during the mid-Holocene, due to the rapid sea level rise at the MIS 2/1 boundary. The model results are highly sensitive to melt migration rate; rates of ~1 m/yr produce very small signals, while those >5 m/yr yield substantial anomalies. In the latter case, sea level-driven magma flux varies by 15-100% relative to the long-term average, with the largest effect occurring at slow-spreading ridges. Simulated melt pulses lag sea level by 5-10 kyr due to slow melt extraction velocities.

Evidence for anomalous melt flux may exist in the topography of the oceanic crust and archives of hydrothermal activity. Archives of hydrothermal records are probably the best focus because they have the resolution and age control necessary to address glacial-interglacial timescales. Sedimentary time series of hydrothermal particle flux, oceanic Os isotopic ratio, and oceanic radiocarbon may serve as proxies for magma-flux variations at mid-ocean ridges. Although well-dated records are rare, preliminary data from the Pacific and Atlantic suggest hydrothermal metal flux was elevated during MIS 2 and 4, consistent with modeling results. Similarly, large seawater radiocarbon anomalies at intermediate depths during the last deglaciation may have been driven by 14C-depleted carbon associated with magma degassing.