Anomalous >2000 year old surface ocean ^{14}C: evidence for enhanced bicarbonate flux via Anaerobic Oxidation of Methane ?

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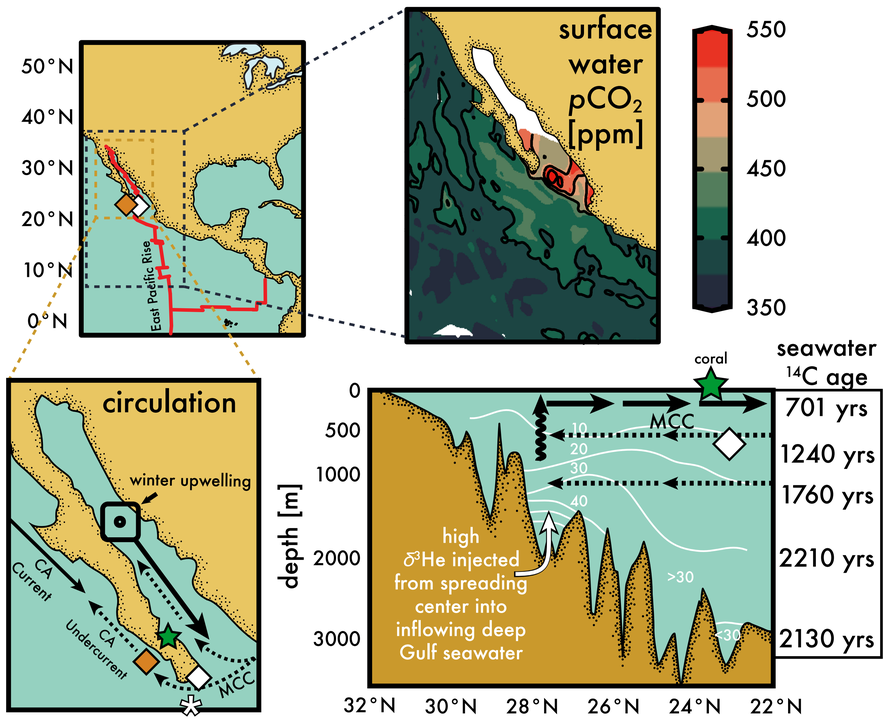
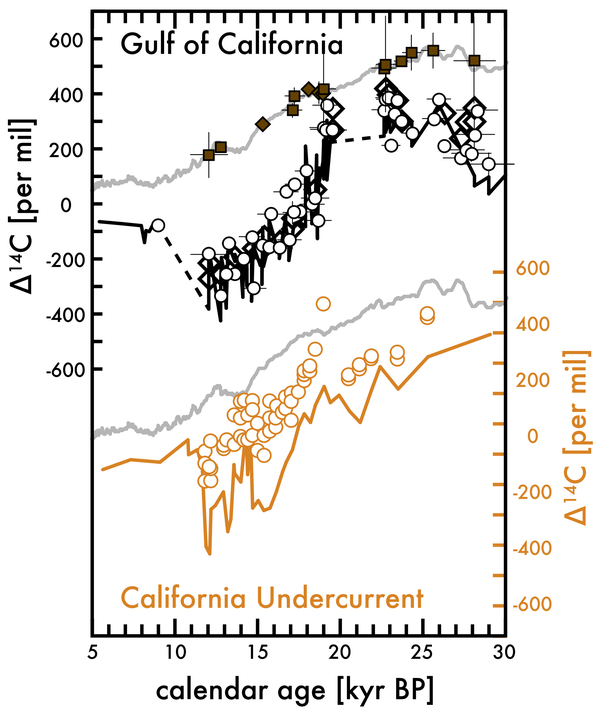
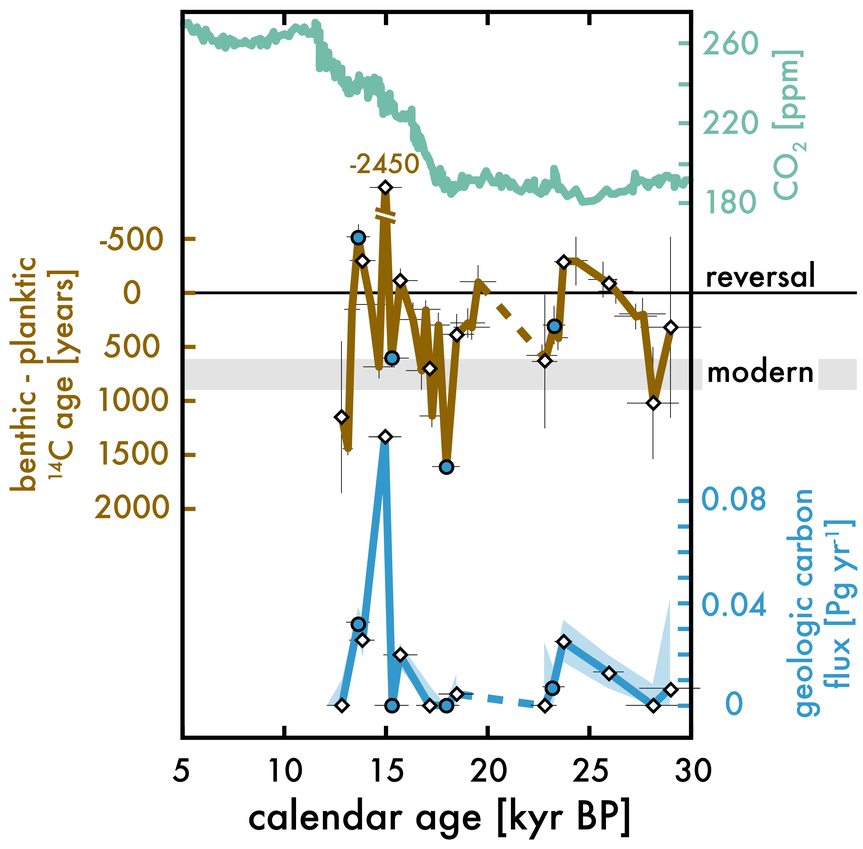


Gulf of California circulation[1] allows us to reconstruct both the inflowing and outflowing seawater geochemistry using benthic vs. planktic foram ^{14}C. Because of this circulation, the addition of geologic carbon predicts an older surface/planktic vs. benthic/deep ^{14}C age.



The small difference between benthic & planktic foram $\Delta^{14}C$ for Gulf of California (upper) vs. the open Pacific[2] (lower) is consistent with the addition of ^{14}C-free geologic carbon to inflowing / deep waters, advected out in Gulf surface waters.



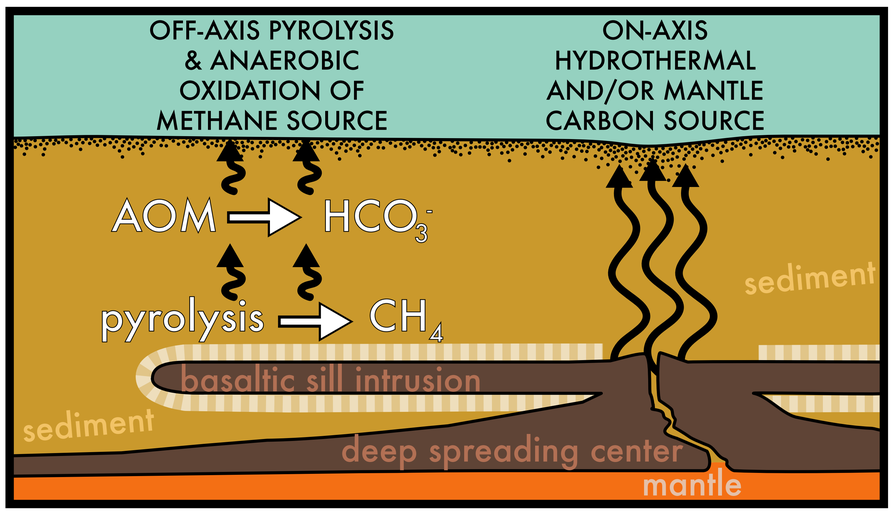
The benthic vs. planktic ^{14}C age from 30 to 10-kyr shows *REVERSALS* (brown) both before and especially during the period of rising pCO_2 (green[3]). Assuming modern overturning, we can estimate the ^{14}C-free C fluxes (blue).

(Samples where bioturbation is minimal[4] or works to attenuate reversals shown as symbols.)

This ^{14}C-free geologic carbon could not have been injected as CO_2 because it would have lowered seawater pH enough to dissolve the carbonate microfossils. Instead,

we suggest the introduction of geologic carbon in the form of partially neutralized, ^{14}C-free bicarbonate.

This could occur via pyrolysis of sediment organic matter to methane[5] (driven by volcanic intrusions) & the anaerobic oxidation of this methane to HCO_3^- (ref 6).



Can we observe these processe today?
Can we further constrain the carbon source(s) in the past?

References: 1 Lavin & Marinone (2003); 2 Marchitto et al. (2007) & Lindsay et al. (2015); 3 Petit et al. (1999); 4 Keigwin (2002); 5 Einsele et al. (1980); 6 Davis & Yarbrough (1966)