High-resolution Coral Geodesy in the Solomon Islands

Development of a centennial record of vertical motion at a megathrust using coral $\delta^{13}C$

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TEXAS Geosciences
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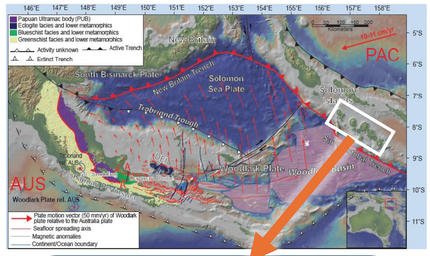
Motivation

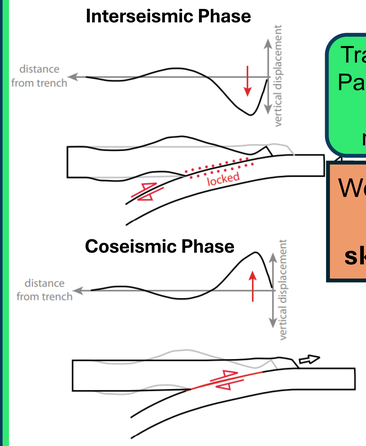
Tectonic Setting



Study area:

Western Solomon Islands

- 2007 Mw 8.1 EQ
- Islands record upper-plate motion near the trench
- Abundance of islands on lower and upper plates / across the hinge-line
- Possible long-term transient uplift
- Abundant coral microatolls



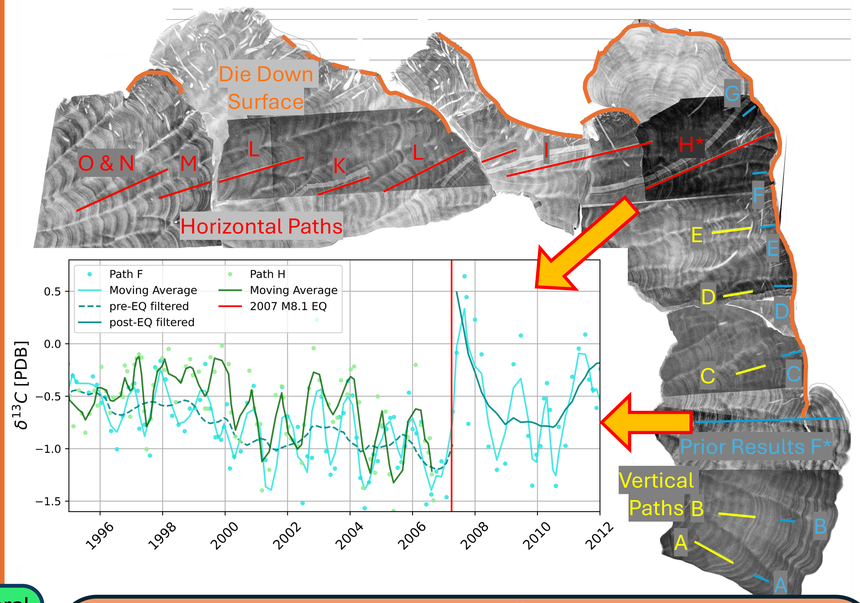
Traditional coral Paleogeodesy is based on morphology

We propose to use **Coral skeletal $\delta^{13}C$**

The Data Gap

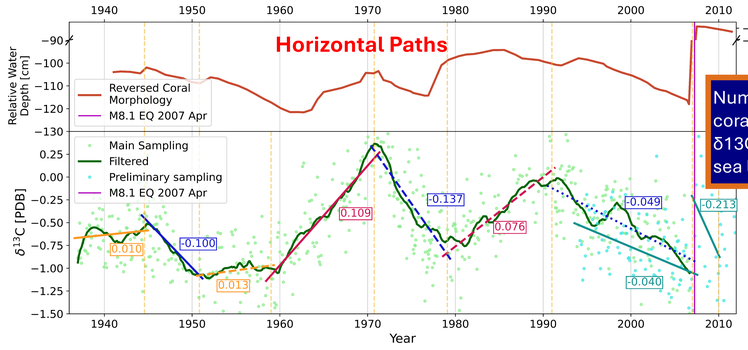
- Only ~30 years of sparse Geodesy.
- Paleogeodesy gives a partial record of tectonics.

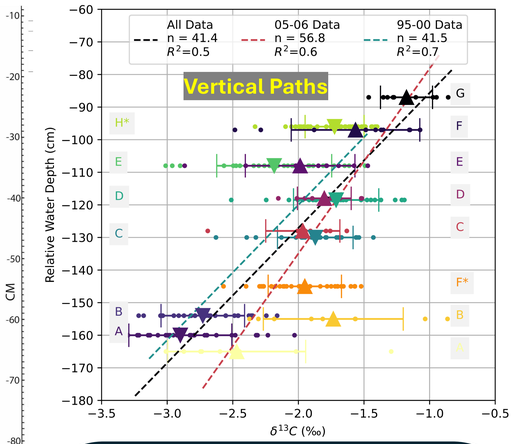
Methods & Results



↑ Horizontal drilling paths recover the temporal $\delta^{13}C$ signal. The two paths shown above (F and H) are in excellent agreement and reveal a prominent positive excursion immediately following the April 2007 Mw 8.1 earthquake, consistent with coseismic uplift & preseismic subsidence.

↓ Extending the record back to 1937 using all eight horizontal paths, the low-pass filtered $\delta^{13}C$ trend closely mirrors the independently derived morphological relative sea-level record (top panel), validating the proxy over the full 70-year baseline. Annotated piecewise slopes quantify apparent vertical displacement rates in each inter-event interval.

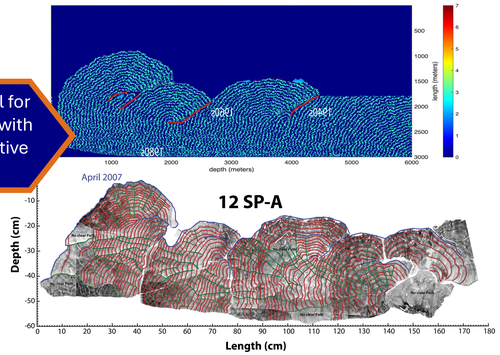




↑ Vertical drilling at known depths provides the spatial calibration. The $\delta^{13}C$–depth relationship is robust (R^2= 0.5–0.7 depending on time window), with sensitivity improving for samples collected during climatically stable periods. This transfer function underpins conversion of the temporal $\delta^{13}C$ record into a quantitative displacement history.

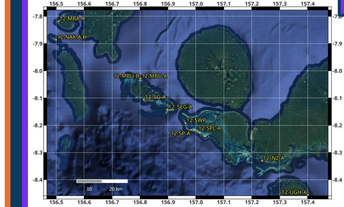
↓ As a forward model validation, the $\delta^{13}C$-derived relative sea-level signal is used as a boundary condition for a numerical coral growth model. The simulated coral morphology (top) reproduces the observed shape of the 12 SP-A slab (bottom), including the die-down surface and lateral growth asymmetry associated with the 2007 coseismic uplift event.

Numerical Model for coral growth fed with δ13C-based relative sea level signal

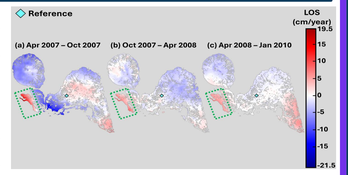


Validation & Next Steps

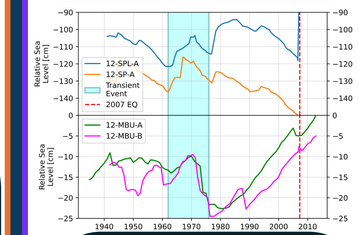
Further Samples

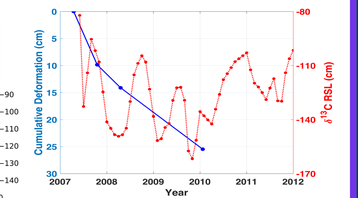


Postseismic Compare with InSAR Kendall et al. (in progress)



Morphology of Adjacent Corals





↑ The MBU corals from North Gizo and the SP corals from Parara Island record opposite directions of displacement for the 2007 Mw 8.1 event, placing the two sites on opposite sides of the coseismic hinge line and confirming that $\delta^{13}C$ stably tracks tectonic deformation. Crucially, both sites record the 1970s transition in the same direction, a spatially coherent, long-wavelength signal that crosses the hinge line and therefore implies a deeper or broader deformation source operating at a scale larger than the 2007 rupture.

↑ Postseismic InSAR (Kendall et al., in progress) constrains the spatial pattern of deformation following the 2007 Mw 8.1 rupture and provides an independent geodetic check on the $\delta^{13}C$-derived coseismic signal. Upcoming NISAR data will extend this comparison into the interseismic period, enabling direct validation of the multi-decadal coral record against modern satellite geodesy.

δ13C of Adjacent Corals