Coseismic deformation associated with the 2007 M_w 8.1 Solomon Islands megathrust rupture

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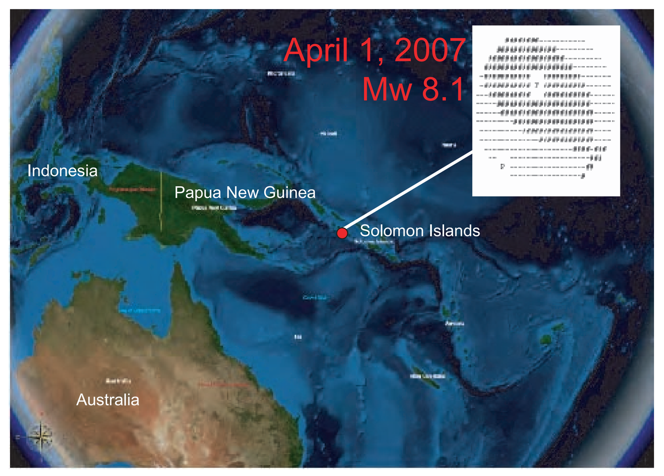
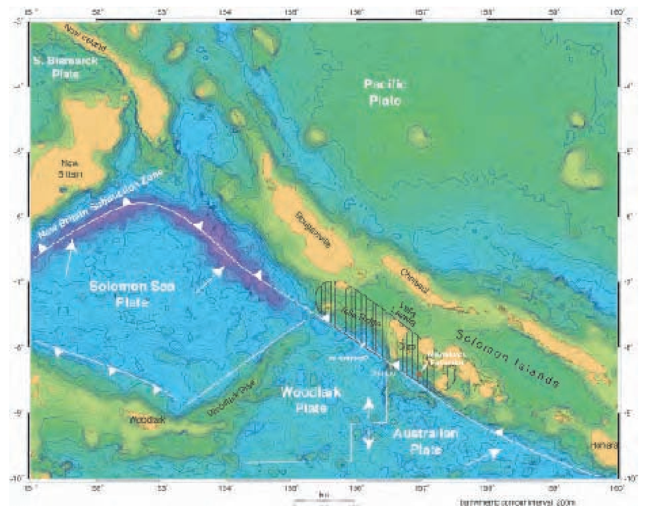
Coral-fringed islands along the Solomon Islands subduction zone record coseismic uplift and subsidence associated with the recent megathrust rupture. The uplift pattern allows us to place primary constraints on the distribution of coseismic slip. This event is interesting because it involved shallow rupture of the megathrust, and slip appears to have reached the trench in places. Also, along-strike structural features appear to have influenced the lateral extent of rupture.



NASA World Wind/NEIC



Eric Geist, USGS

The M_w 8.1 rupture occurred on the Solomon Islands subduction zone (above) where the Woodlark and Australian plates converge with the Pacific plate at ~10 cm/year. We used coral measurements, geomorphic indicators, satellite imagery, and cultural features to quantify uplift and subsidence along the rupture area (right).

Main findings

1. We observed maximum uplift of 2.46 meters near the trench and a subsidence trough of -0.6 meters farther arcward (right). A well-defined hingeline (line of zero change) separates the regions of uplift and subsidence. On the downgoing slab, the island of Simbo subsided up to 0.7 m -- this represents the first set of coseismic uplift and subsidence observations straddling a subduction plate boundary. The total rupture length is over 250 km.

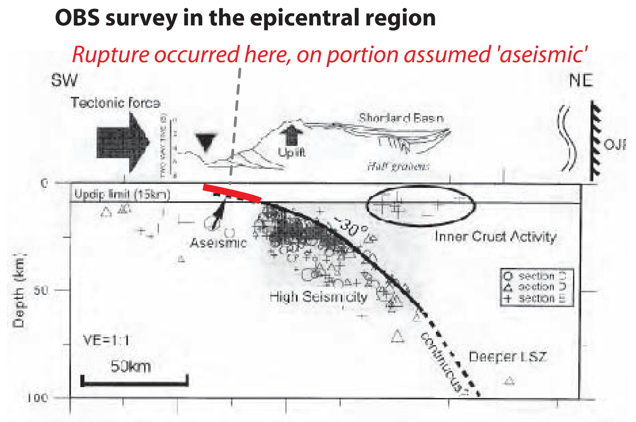
2. Slip was confined to the shallowest portion (<15 km) of the subduction zone, which was previously assumed to be aseismic based on seismicity studies and prevailing notions regarding the seismogenic potential of the shallow portions of megathrusts (below left). In this region of extremely young (<5 Ma) seafloor and thin sediment, the megathrust appears to support velocity-weakening behavior nearly to, or all the way to, the seafloor.

3. Slip reached the deformation front (trench) beneath the island of Ranongga, where the Simbo Ridge transform subducts. Significant slip here is consistent with the idea that subducted topographic highs can function as asperities. Curiously, slip inversions based on teleseismic data (below right) show nearly no slip beneath Ranongga. This may highlight the non-uniqueness of purely teleseismic slip inversions and the utility of geodetic data for mapping slip.

4. Along-strike controls on slip are complex. Rupture began near the edge of Rendova island, then propagated through the triple junction at the subducting Simbo Ridge transform before ending near the Woodlark Rise. Thus it appears that structural features in the upper and lower plates are sufficient, but not necessary, to arrest rupture.

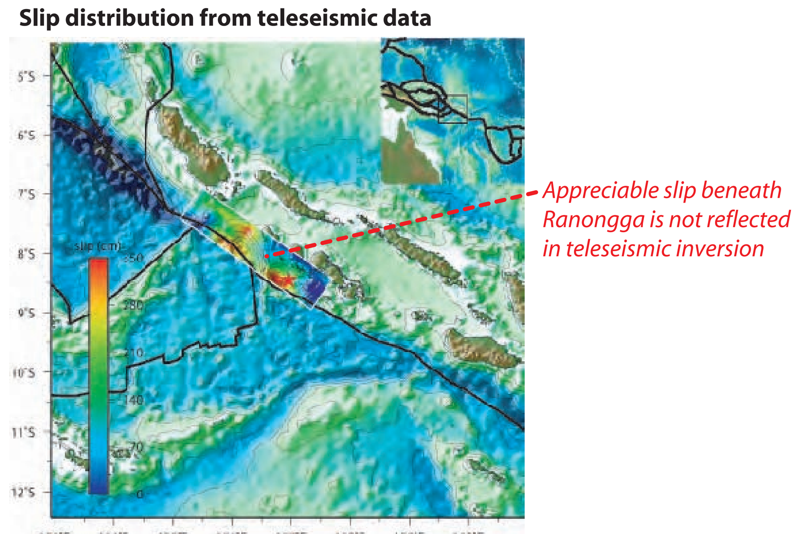
OBS survey in the epicentral region

Rupture occurred here, on portion assumed 'aseismic'



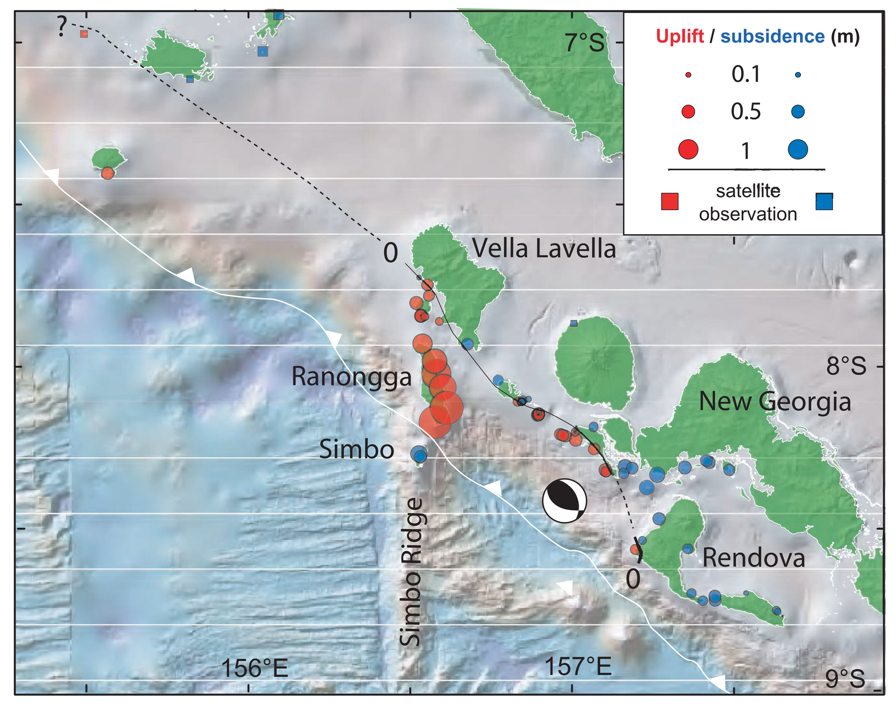
Yoneshima et al., 2005

Slip distribution from teleseismic data

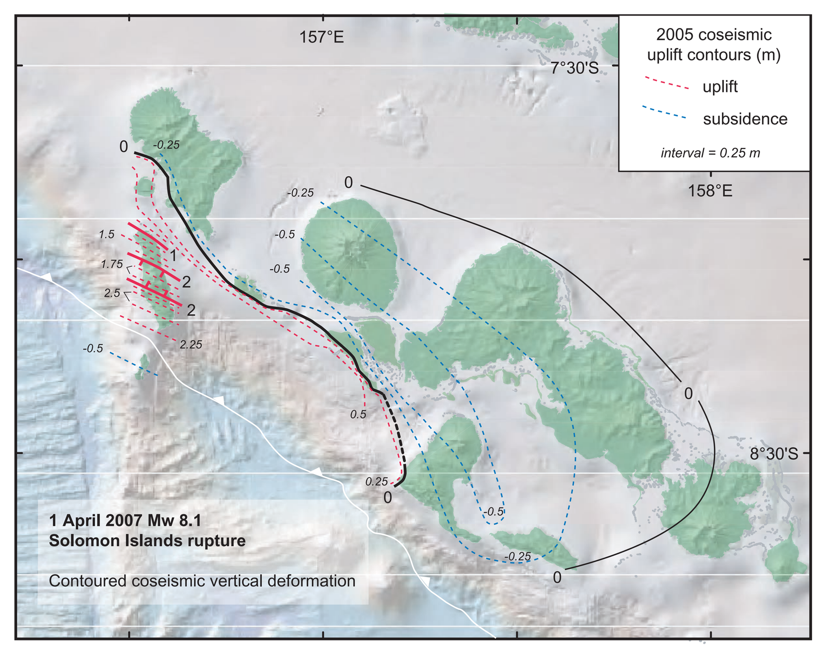


Chen Ji / USGS

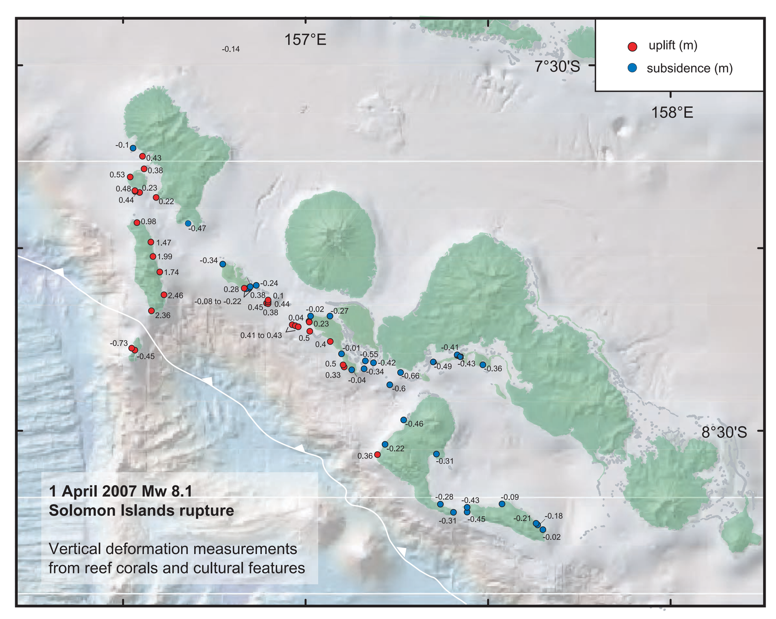
Uplift and subsidence



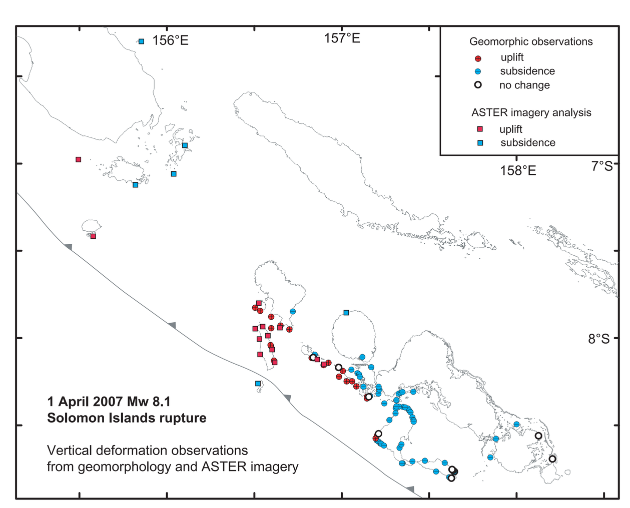
Uplift contours



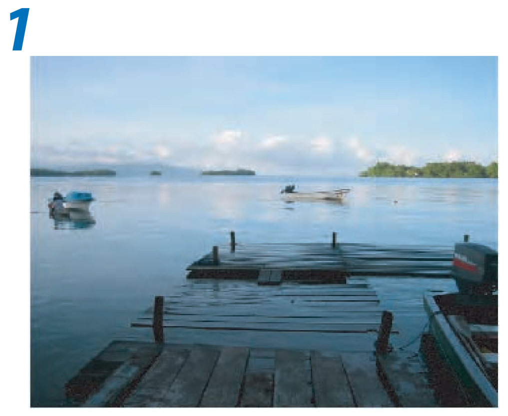
Uplift values



Qualitative uplift observations



1



Dock submerged at high tide near Munda. Subsidence 0.6 m.

2

Massive Porites head just beginning to form a microatoll morphology, near Ghizo. Subsidence 0.34 m.

3

Uplift of 0.23 m near hingeline on Vella Lavella.

Uplift of 0.98 m on northern tip of Ranongga.

4

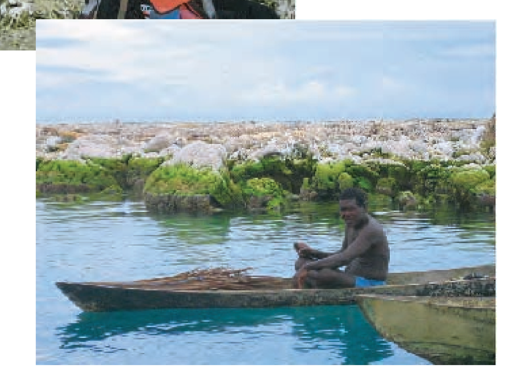
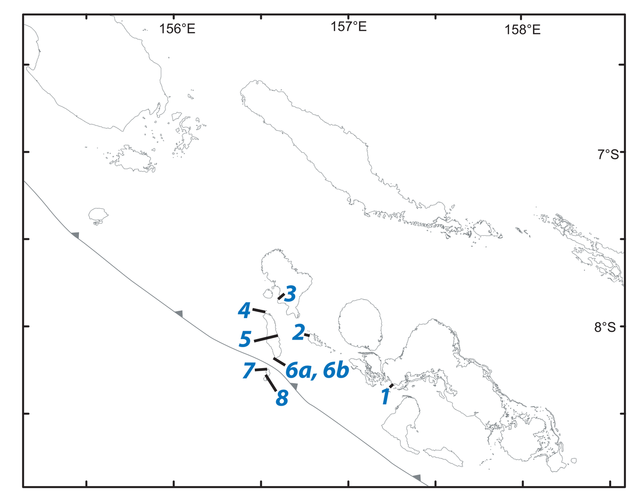


Photo locations



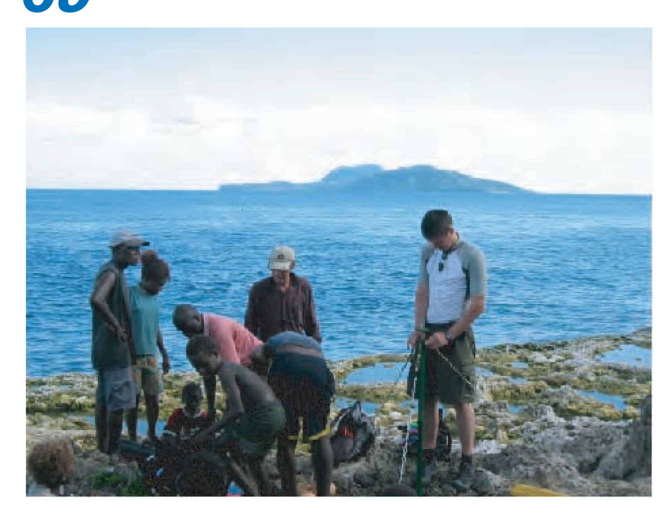
5

Uplift of 1.74 m on central portion of Ranongga.

6a

Uplift of 2.36 m on southern tip of Ranongga.

6b



View across plate boundary from Ranongga (uplifted 2.36 m here) to Simbo, which subsided 0.4-0.7 m.

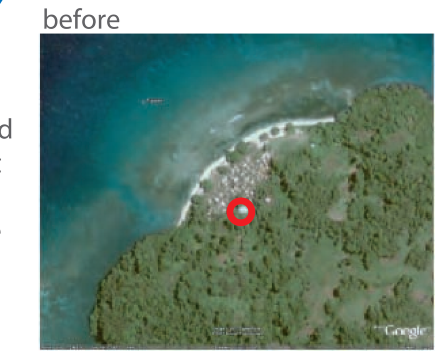
8

Head man points to new high tide strandline on Simbo, where dock is completely inundated during high tide. Subsidence 0.7 m.

7

Coseismic subsidence and proximity to the deformation front caused a devastating tsunami at Tapurai on the northern coast of Simbo. The sole surviving structure is shown circled in red.

before



after

Thanks to NSF for emergency earthquake response funding to Fred Taylor at UT Austin, and to the Tectonics Observatory for covering travel costs for RB.