Radiated energy of $3.0 \leq M \leq 5.0$ earthquakes in rupture patches and rupture barriers on Gofar Transform Fault, East Pacific Rise

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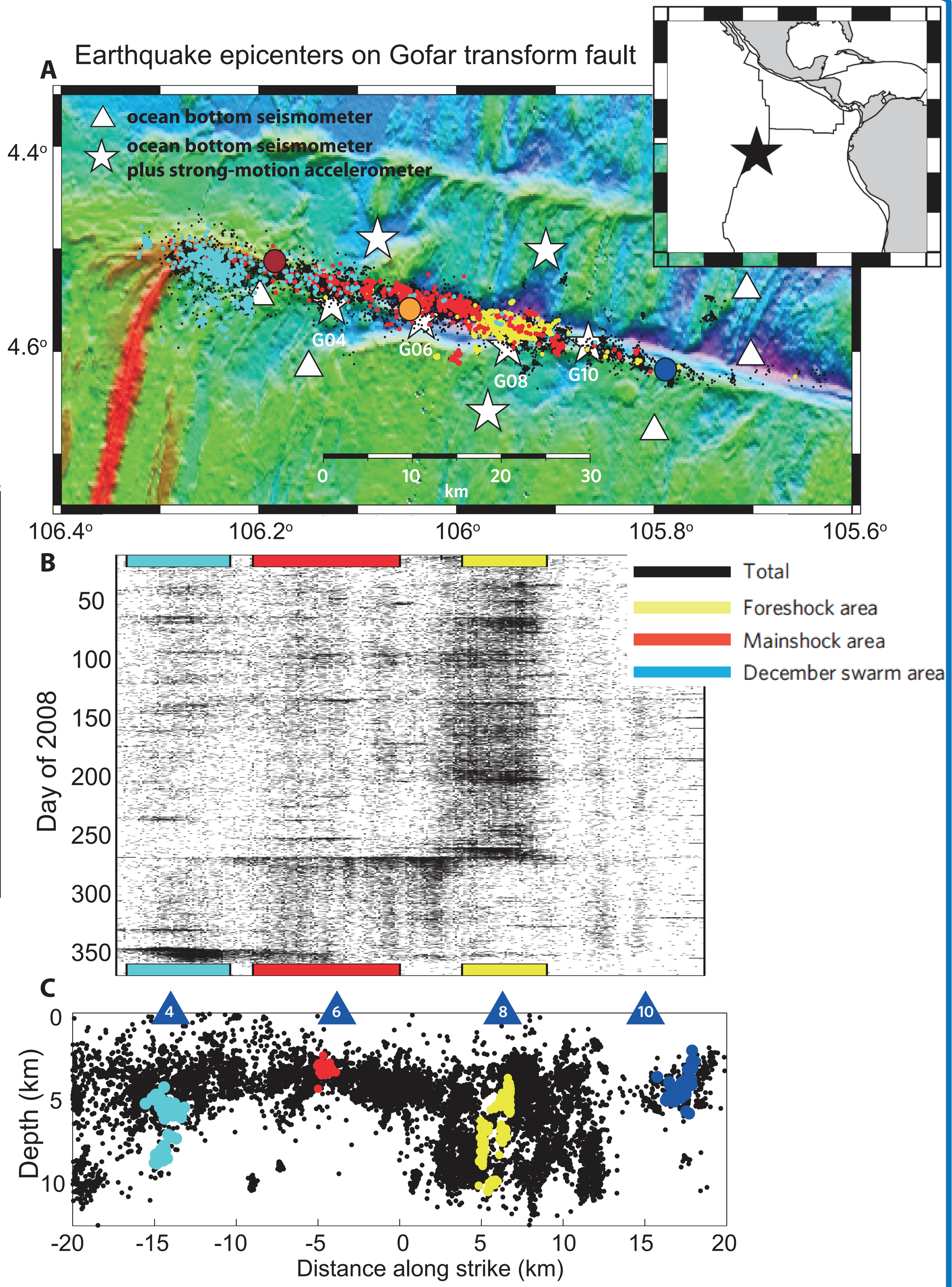
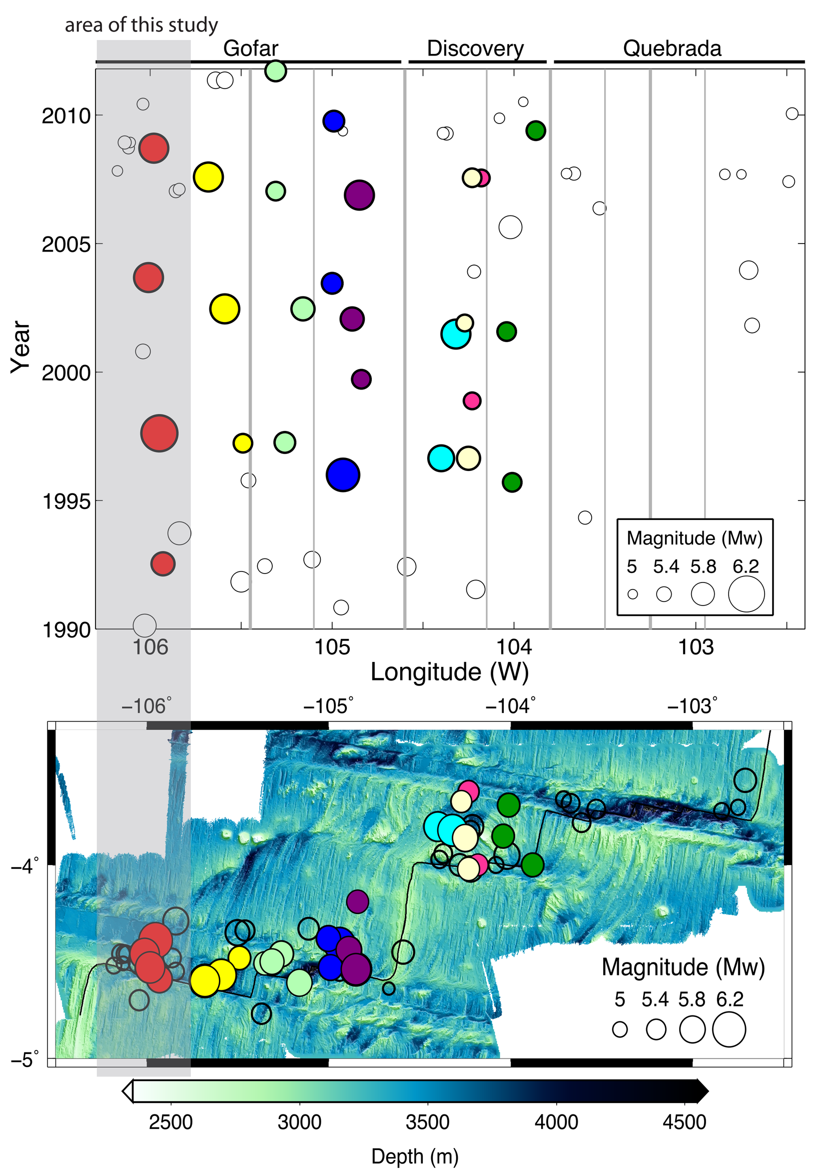
Motivation

On Gofar Transform Fault on the East Pacific Rise, we observe relatively stable rupture patches over four seismic cycles. These rupture patches are separated by M_w 6.0 earthquakes that occur approximately every 5 years. The rupture patches are separated by regions of very low coupling which host swarms of microearthquakes. In 2008, McGuire and coworkers captured the end of a seismic cycle with an ocean bottom seismic array. The dataset includes an extensive foreshock sequence (right, yellow dots), the mainshock and aftershocks (right, red dots), and an earthquake swarm that occurred three months after the mainshock (right, blue dots).



We investigate source parameters of small to intermediate magnitude earthquakes ($3.0 \leq M_w \leq 4.7$) along the Gofar transform fault to assess differences in earthquake properties between rupture patches and rupture barriers.



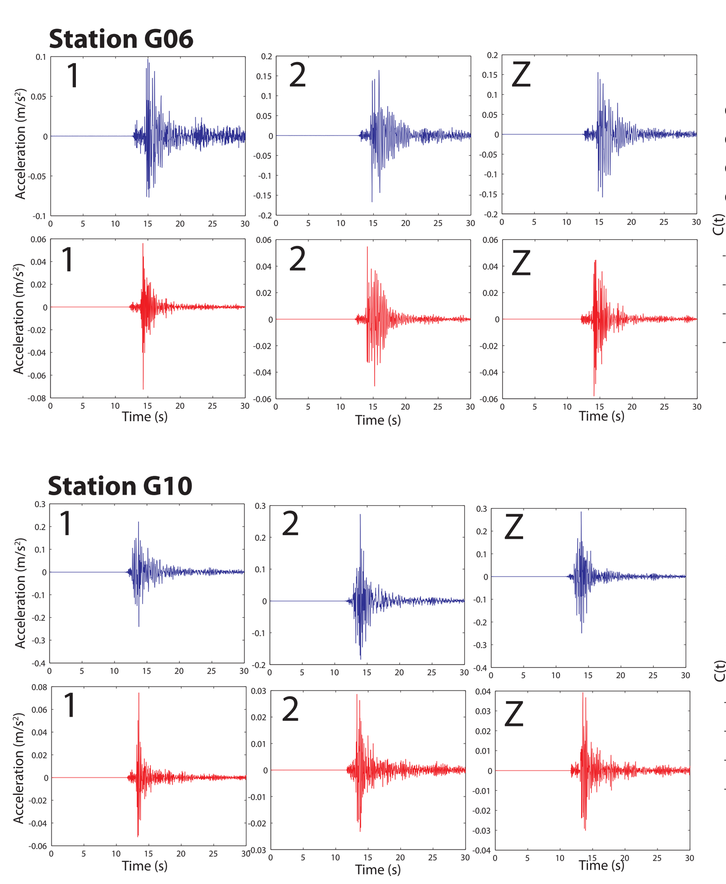
Far right:
A. Locations of over 20,000 earthquakes that occurred along Gofar transform fault from August - December 2008. Ocean bottom seismometers are noted by triangles and stars. The epicentre of the largest (M 5.2) aftershock and the centroids of the 2008 M_w 6.0 and 2007 M_w 6.2 earthquakes are shown as brown, orange, and blue circles, respectively.
B. Earthquake temporal distribution showing the rate of seismicity in the foreshock, mainshock and aftershock, and swarm zones.
C. Along strike variations in earthquake depth in the foreshock, mainshock and aftershock, and swarm zones [*McGuire et al.*, 2012].

Right:
Map and space-time evolution of large earthquakes on the Quebrada, Discovery, and Gofar transform faults (after McGuire 2008). Earthquakes with $M_w > 5.0$ since 1990 are shown as circles at their locations in the Gobal CMT catalog. Events with overlapping rupture areas (defined as relative centroid locations < 5 km, see McGuire 2008) are shown in a constant color. Vertical gray lines show the locations of segment boundaries defined by intra-transform spreading centers [*McGuire e. al.*, 2012].

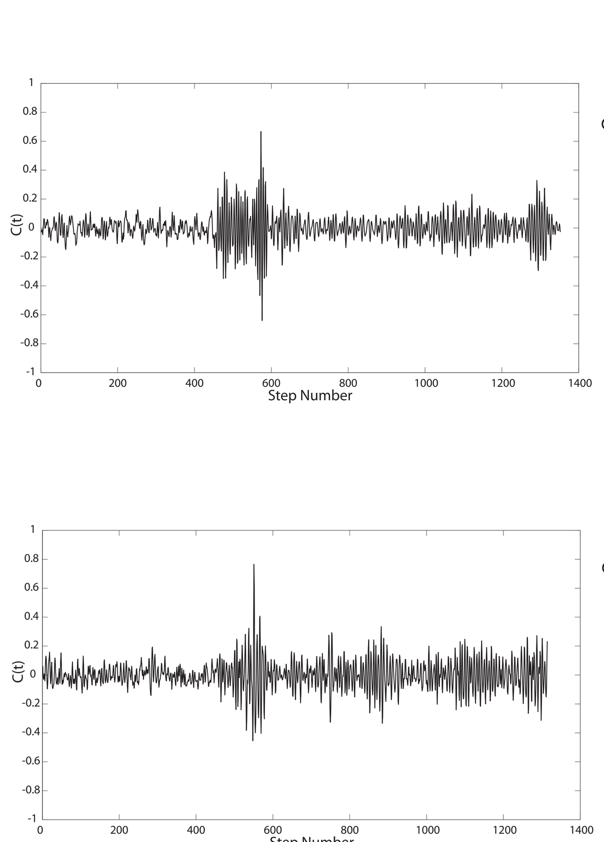
Methods and Discussion

We calculate radiated seismic energy using an omega-squared source model, where the corner frequency is derived from an empirical Green's function (EGF) technique. We follow the method of *Viegas et al.*, [2010] to find good EGF pairs and compare the results of stacking "high-quality" spectral ratios (as defined by the variance in the fit to the corner frequencies of both events) to stacking all station, component data.

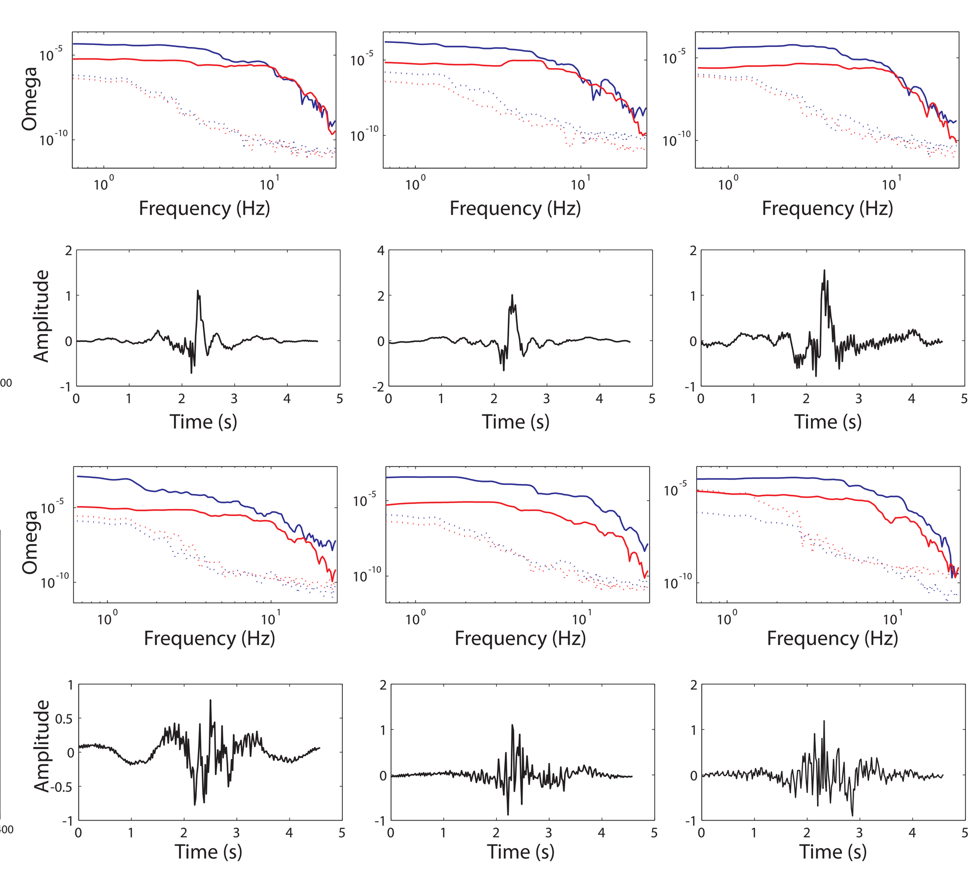
Three component acceleration waveforms for a potential EGF pair recorded by stations G06 and G10 are shown below. The events occurred in the foreshock zone and are M 4.0 (blue) and M 3.0 (red).



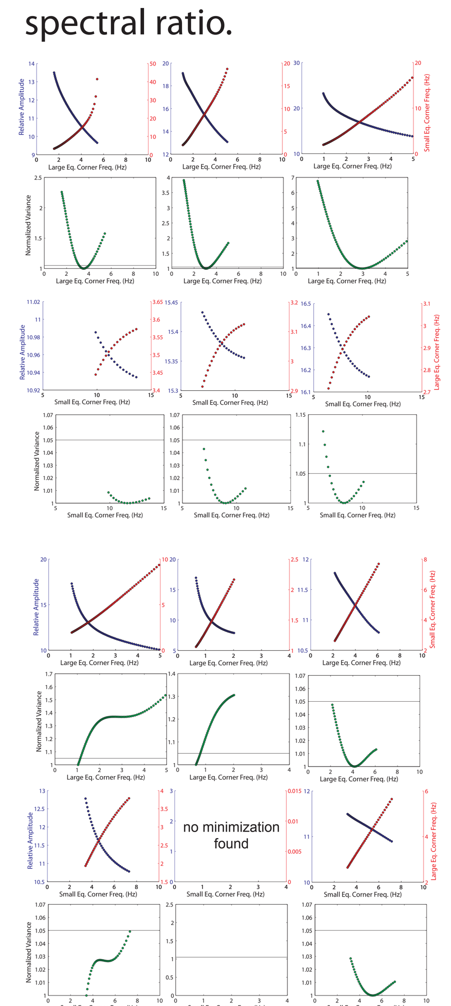
Step 1. Apply a match filter to ensure a suitable EGF pair. We use a match filter technique described by *Yang et al.*, [2009] and select pairs with a cross- correlation coefficient ≥ 0.6.



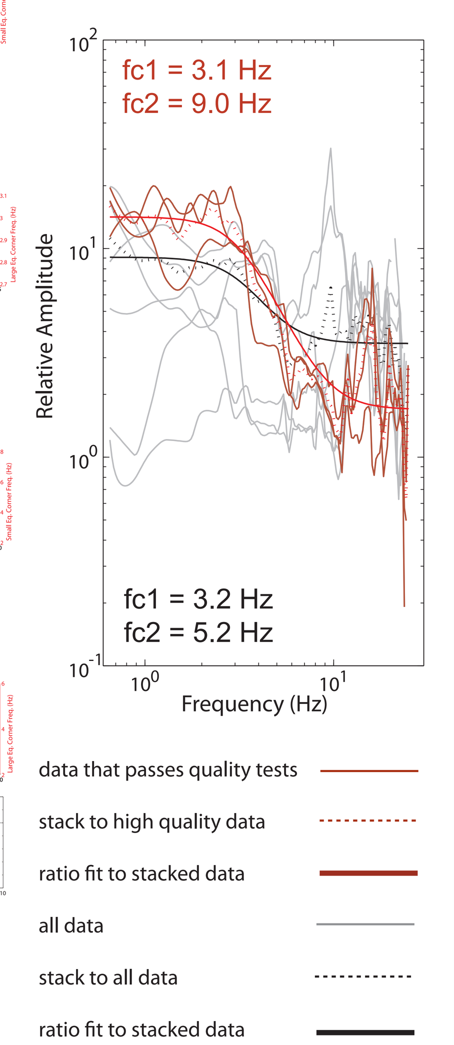
Step 2. Use the multitaper technique of *Prieto et al.*, [2009] to obtain the displacement spectra and use data with a S/N > 3. Top: Displacement spectra (solid line) and pre-event noise (dashed). Bottom: Source time function from acceleration spectral ratio



Step 3. Assess the quality of the fit to the Brune model and the observed spectral ratio.



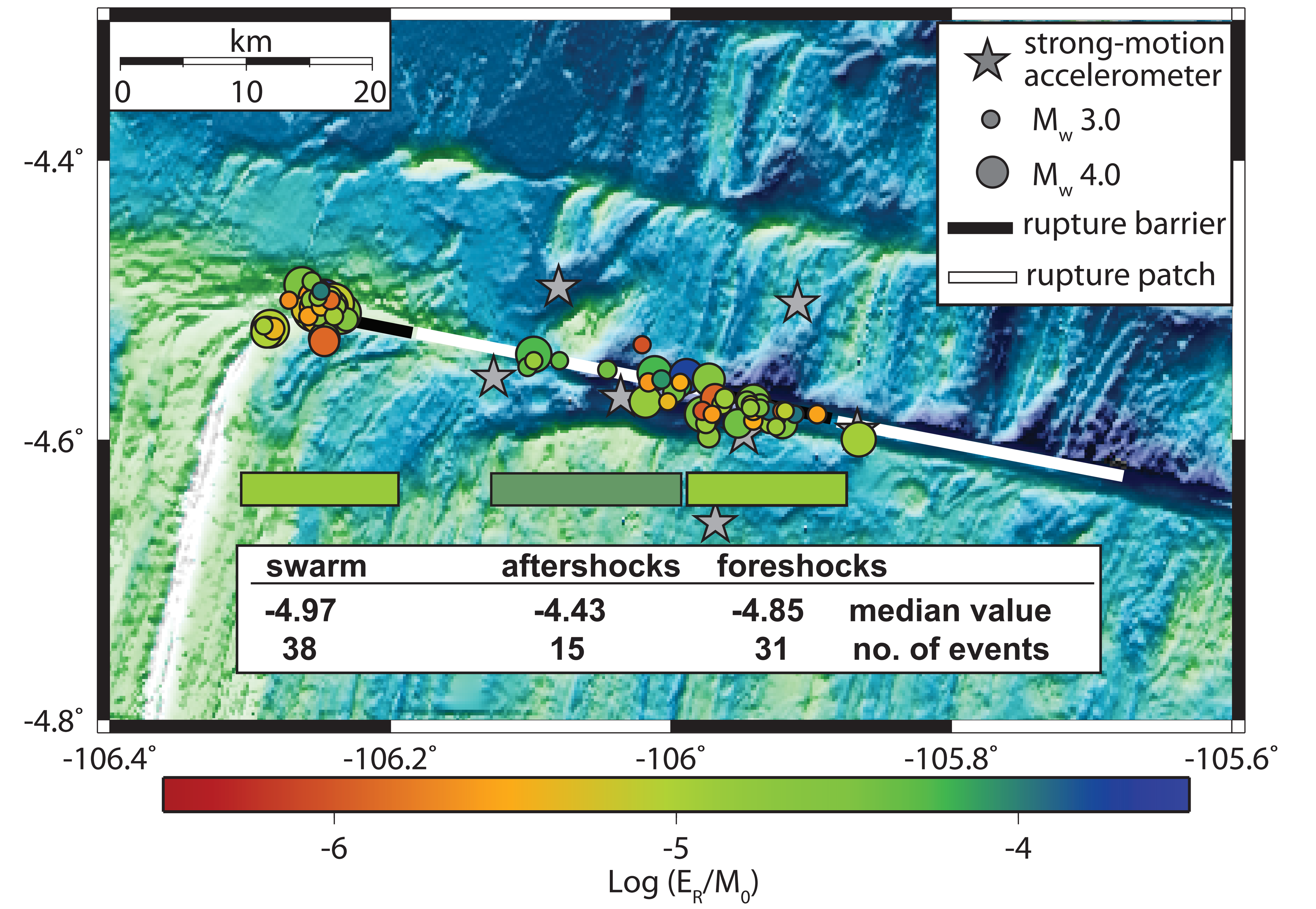
Step 4. Stack ratios that pass our quality tests and compare with results from stacking all station, component data.



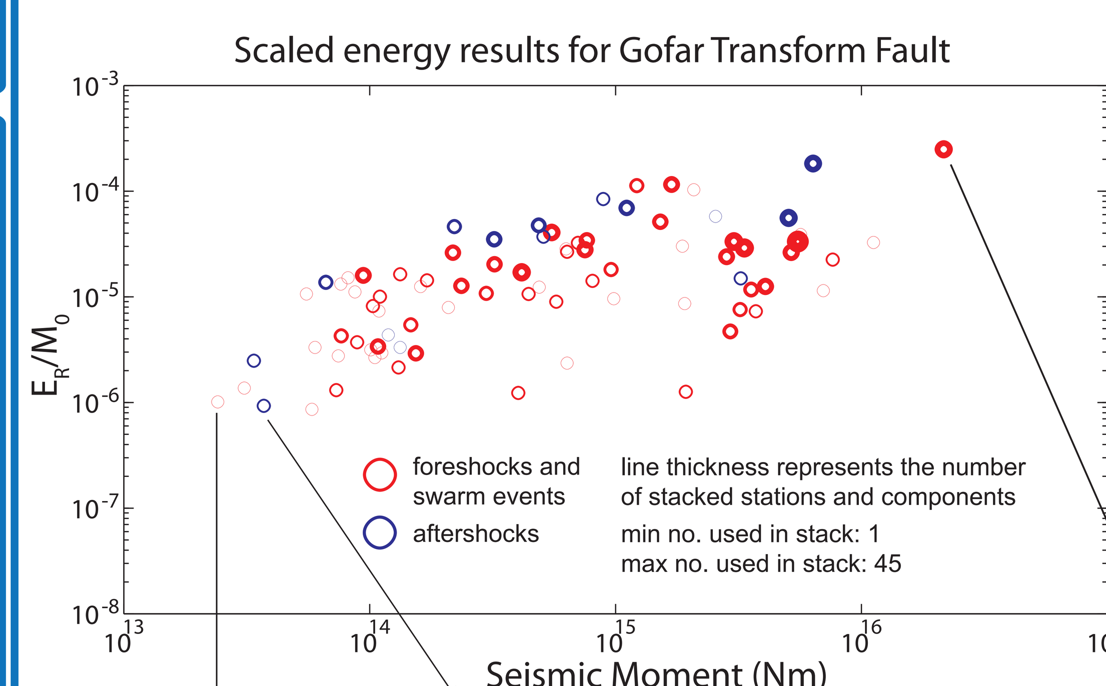
Stack or not to stack?

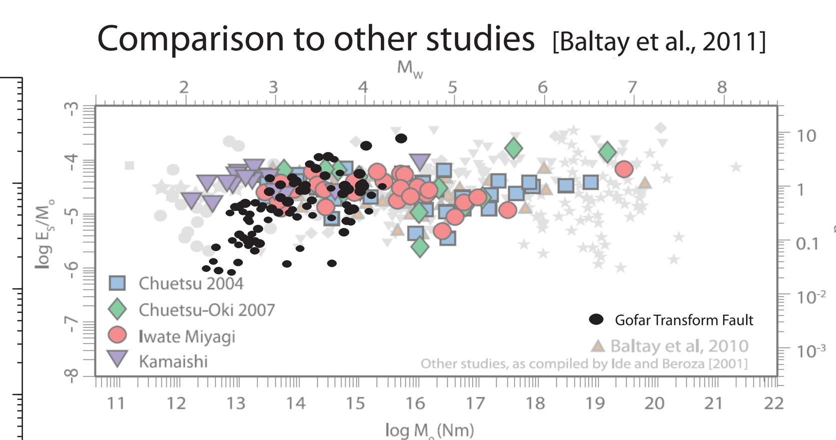
Due to noise and resonance in the OBS data, most of our results come from one station. Often, only one component from one station passes our quality tests. The question of how to deal with limited spectral data arises. Is only one "high-quality" ratio enough for robust results? Should all data be stacked? What other quality tests should be performed?

Results

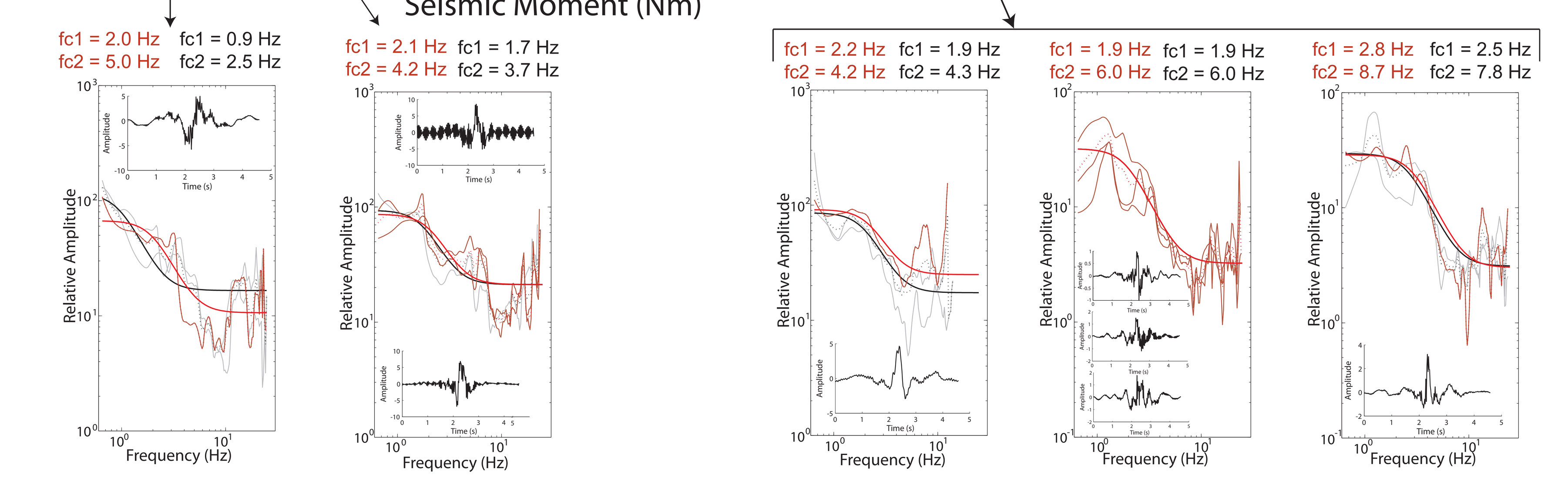


Results for 85 events in the foreshock, aftershock, and swarm zones along Gofar transform fault show log scaled energy values between -6.1 and -3.6 with median values for each zone as shown above. A median scaled energy increase of ~10% in the aftershock zone as compared to the foreshock and swam zones suggests systematic differences in the rupture process of $3.0 \leq M_w \leq 4.7$ earthquakes in rupture patches and rupture barriers along Gofar transform fault.





Scaled energy results from Gofar transform fault and comparison to other studies. Stacked spectral ratios and source time functions for three outliners are shown below.



While our results appear to show a slight trend to non-constant scaling, most outlying values result from stacking only one or two ratios. See Discussion section.

References

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