MOANA SIO OBS Instrument Response Issues

7/20/12 Anne Sheehan contacts Jeff and SIO OBSIP about determining instrument response parameters for the MOANA experiment because of a paper in review. Reviewer thinks OBS amplitudes are too low (by factor of 8). The reviewer was led to that conclusion because of 1) much lower spectral values for the single frequency peak on the seafloor than on land, 2) OBS amplitudes from earthquake time series comparison are m8ch smaller than land amplitudes, 3) If assume OBS amplitude is correct it makes the DPG signals way to large

7/20/12 Don Forsyth: In the SCOOBA experiment using SIO 240Ts had to multiply the OBS response by a factor too. They have derived transfer functions between DPGs and OBSs for Rayleigh waves (they are frequency dependent) There was also a small phase shift between the DPGs and verticals.

7/21/12 Gabi Laske 1) I agree with don that the best way to calibrate seismometer is by comparison with normal mode synthetics, preferably in the frequency range 2-8 mHz. Anything higher frequency depends too much on 3-D structure, 2) factors of 2 are possible at the SIO instruments. Factors of 5 are more difficult to explain, 3) the "calibration" between acceleration (seismometer) and pressure (DPG) is frequency-dependent and also depend on the structure beneath the station.

8/2/2012 Gabi and Anne Sheehan compared response files from the same instruments. One of the RESP files was inconsistent with and SIO OBS responses. Gabi will look at the absolute calibrations for each individual seismometer.

Dear Jeff and SIO OBSIP,

We need some help determining instrument response parameters, particularly amplitude, for the SIO OBSIP broadband OBSs used in the New Zealand MOANA experiment. We just received a paper back from review and one of the reviewers thinks our OBS amplitudes are too lo (he/she thinks by a factor of 8).

Here is a summary of some of what we see:

1. noise spectra
reviewer comment, based on noise spectra of OBS vs Land:
"The most likely explanation is the gain for the OBS data is about a factor of 8 too low at 17s period."
"I'm not sure if the seismic responses are completely correct. The most unusual result is the much lower spectral values for the single frequency peak on the seafloor than on land. The energy near 17s period propagates as Rayleigh waves, and one doesn't expect much attenuation at these periods. The Stephen et al. (G3, 2002) observations show the single frequency peak to be nearly identical on land as on the seafloor. In this paper, the single frequency peaks on land are above 10-15 (m/s2)2/Hz) at 17s period (independent of distance from the coast(, while the seafloor data is below 10-16 (m/s2)2/Hz) (independent of water depth). The most likely explanation is the gain for the OBS data is about a factor of 8 too low at 17s period. Adjusting this would bring the spectra together. The pressure spectra in Figure 4 suggest unusually low amplitudes in the microseism peak. "

2. earthquake time series comparison - New Zealand land-MOANA OBS comparison - OBS amplitudes are ~ 4x smaller than land amplitude Some might be due to structure, water, seafloor sediments etc. but I don't think it would be that much, and at all frequencies).
(Geoff Abers reports that using the parameters he got from SIO OBSIP misfit is even larger, factor of 40 or so)

3. we assume the OBS amplitudes are good and use the Rayleigh waves to calibrate the DPGs. So if the OBS amplitudes are off the DPG amplitudes will be off too (we realize DPG is much trickier than OBS, our focus in this message is getting the OBS right).
For the Rayleigh wave calibration, we find a difference of approximately 2 between the transfer function obtained from data (P/a) and the calculated ρH value
(both Justin Ball and Zhaohui Yang have done the Rayleigh wave calibration, independently, and get the same factor of 2)
The resulting corrected DPGs provide tsunami wave amplitudes that are a factor of 6 too BIG compared to modeled amplitudes.
(I'm confused about this - if our OBS amplitude is too low why is our 'corrected' DPG amplitude too high...)

I have cc'd this to Monica Kohler, Geoff Abers, and Anne Trehu since they have all asked me about SIO OBSIP instrument response parameters in the past, and want to be kept in the loop (and obviously I should not be the source of information on SIO OBSIP instrument response).

Hope you can help with this and give us some advice. Thanks very much,

Anne Sheehan

Supporting documents:
MOANA-InstrumentResp-figs.pptx - comparison of land and OBS noise spectra (slides 1-2) and seismograms (slides 3-10), and MOANA-CDPapua OBS info comparison (slides 11 and 12)
RESP.ZU.N30..BHZ, SAC_PZs_N30_BHZ - MOANA instrument info, determined by John Collins in consultation with SIO OBSIP
RESP.NZ.B..BHZ, SAC_PZs_ZN_B_BHZ - Geoff Abers's CDPapua instrument info. Abers used the same SIO OBSIP instruments in the experiment immediately after MOANA. His response values (from SIO OBSIP) are very different from ours, and result in an even larger amplitude mismatch between land and OBS sites. (Comparison of MOANA to CDPapua files shows different calib values, normalization factors, number of zeros).

Anne Sheehan
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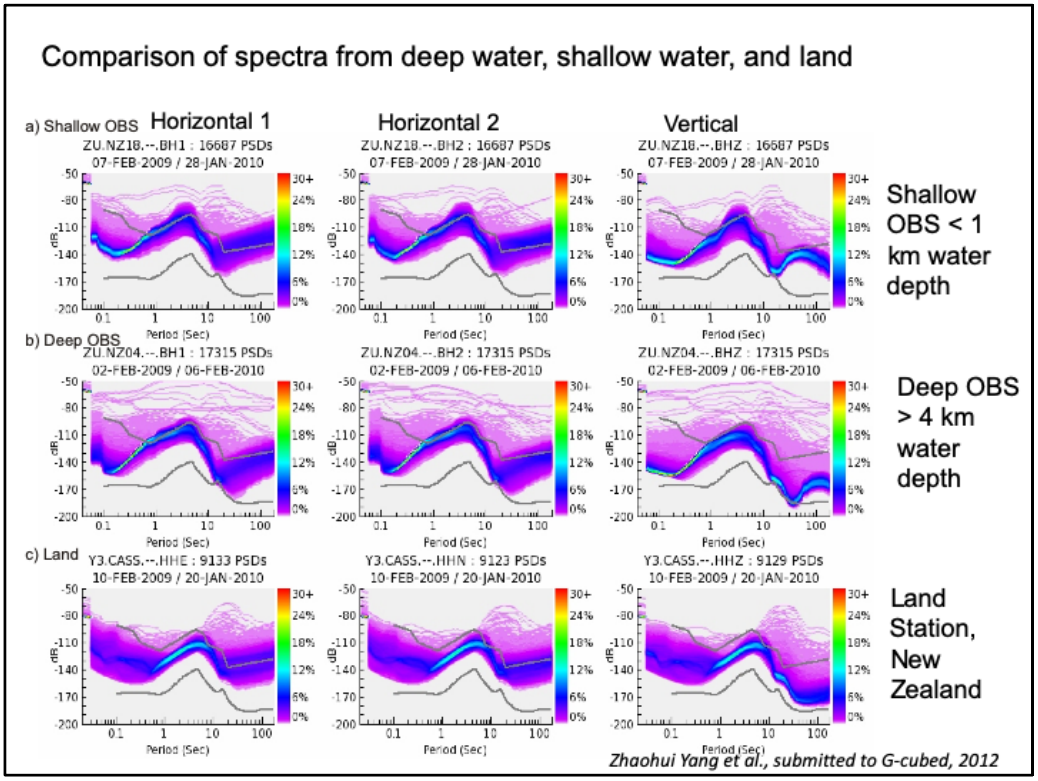
University of Colorado at Boulder



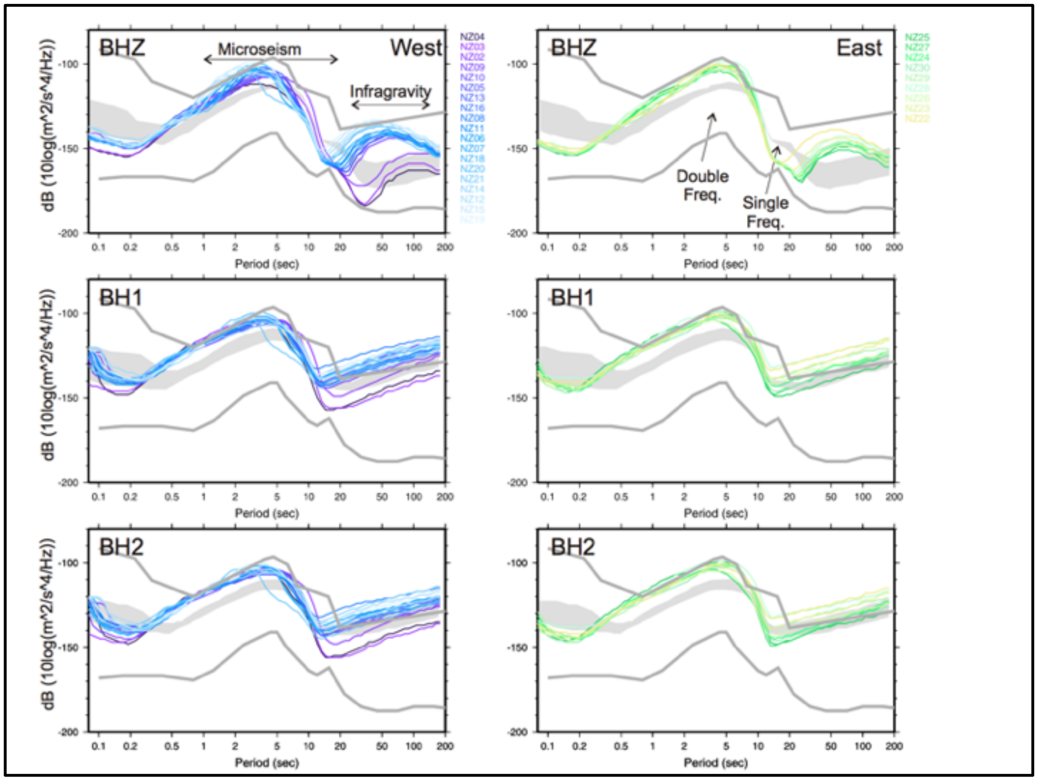
Sample land vs. OBS background noise spectra.

The reviewer is concerned that the single frequency microseism peak is smaller for the OBS than for the land site. They compare to the Stephen et al. 2003 G-cubed article on the OSN pilot experiment.

From the review

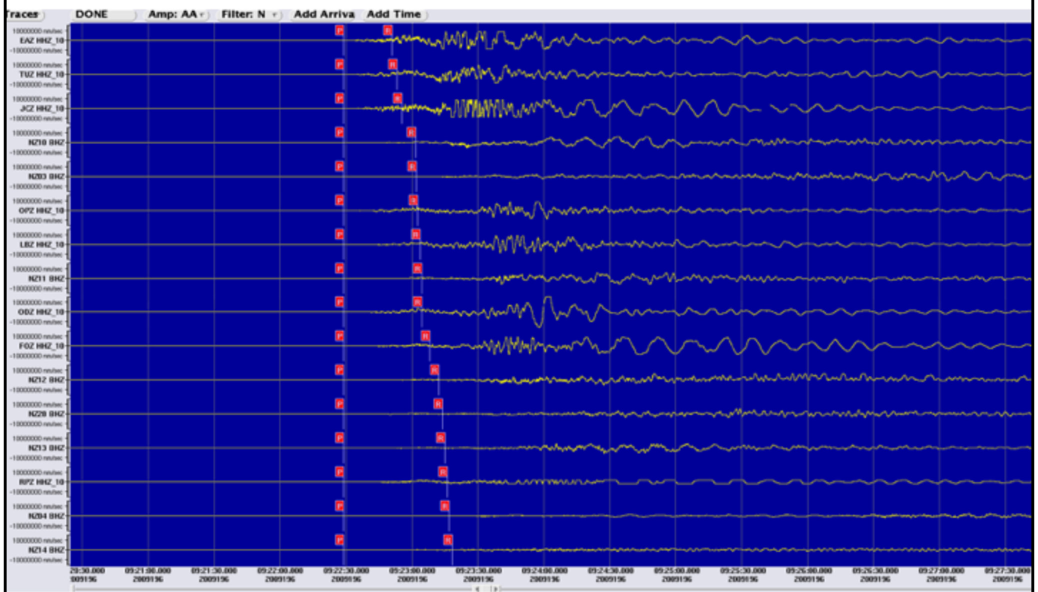
"I'm not sure if the seismic responses are completely correct. The most unusual result is the much lower spectral values for the single frequency peak on the seafloor than on land. The energy near 17s period propagates as Rayleigh waves, and one doesn't expect much attenuation at these periods. The Stephen et al. (G3, 2002) observations show the single frequency peak to be nearly identical on land as on the seafloor. In this paper, the single frequency peaks on land are above 10-15 (m/s2)2/Hz) at 17s period (independent of distance from the coast(, while the seafloor data is below 10-16 (m/s2)2/Hz) (independent of water depth). The most likely explanation is the gain for the OBS data is about a factor of 8 too low at 17s period. Adjusting this would bring the spectra together. The pressure spectra in Figure 4 suggest unusually low amplitudes in the microseism peak. ”

(the land station, CASS, is a temporary Passcal station on the South Island)

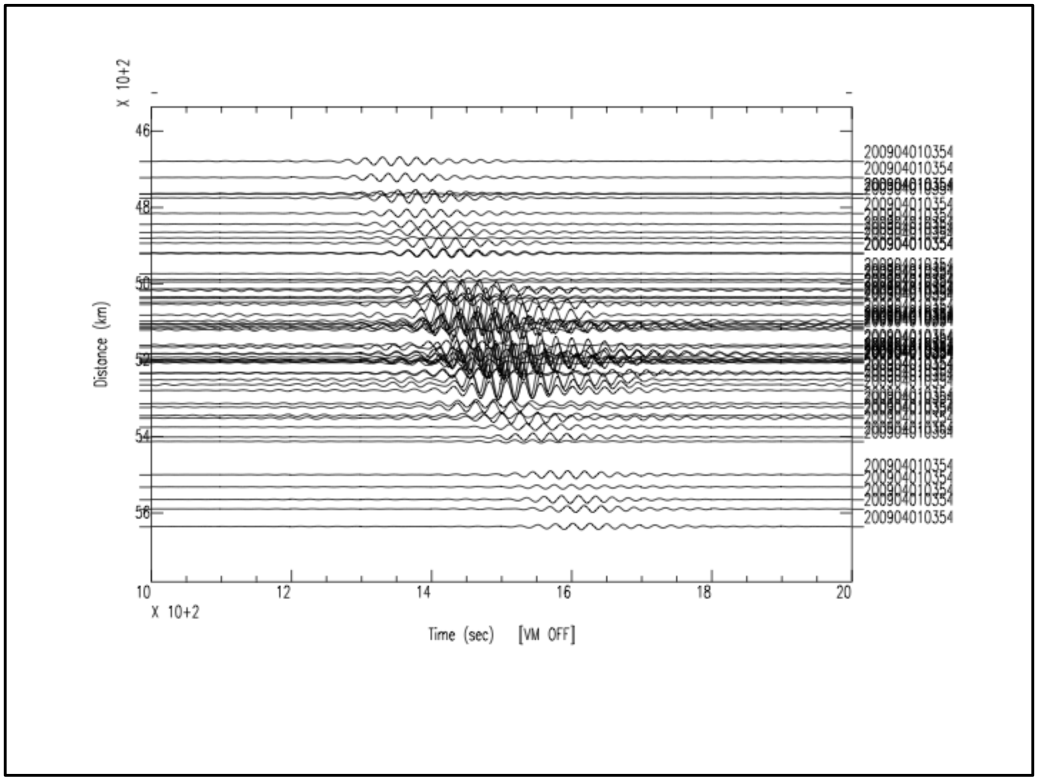


Median values of PDFs for all OBS stations. Left panel is for stations to the west of the South Island of New Zealand, and right panel is for stations to the east of the South Island. Lines are colored according to the site depth (lighter color is shallower). A depth dependence of the peak frequency of infragravity waves is clear. Thick gray lines are the high and low noise model from *Peterson* [1993]. The gray shaded area gives the range of PDF medians for the 4 land stations on the South Island for comparison.

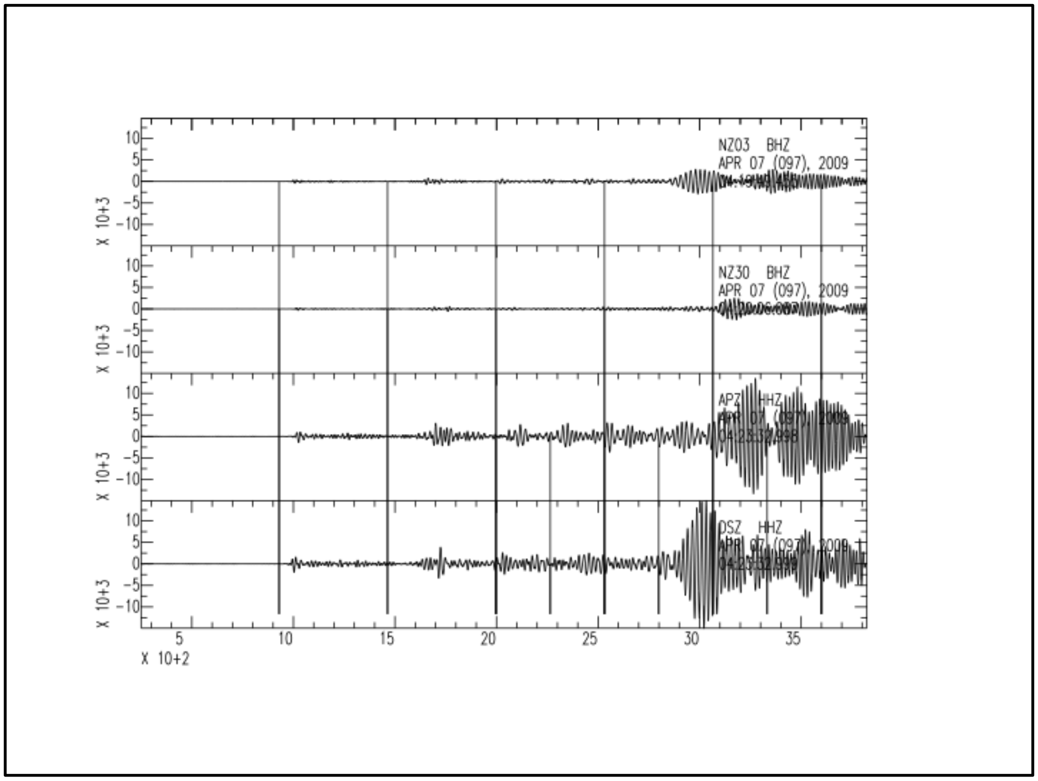
From the review
"I'm not sure if the seismic responses are completely correct. The most unusual result is the much lower spectral values for the single frequency peak on the seafloor than on land. The energy near 17s period propagates as Rayleigh waves, and one doesn't expect much attenuation at these periods. The Stephen et al. (G3, 2002) observations show the single frequency peak to be nearly identical on land as on the seafloor. In this paper, the single frequency peaks on land are above 10-15 (m/s2)2/Hz) at 17s period (independent of distance from the coast(, while the seafloor data is below 10-16 (m/s2)2/Hz) (independent of water depth). The most likely explanation is the gain for the OBS data is about a factor of 8 too low at 17s period.



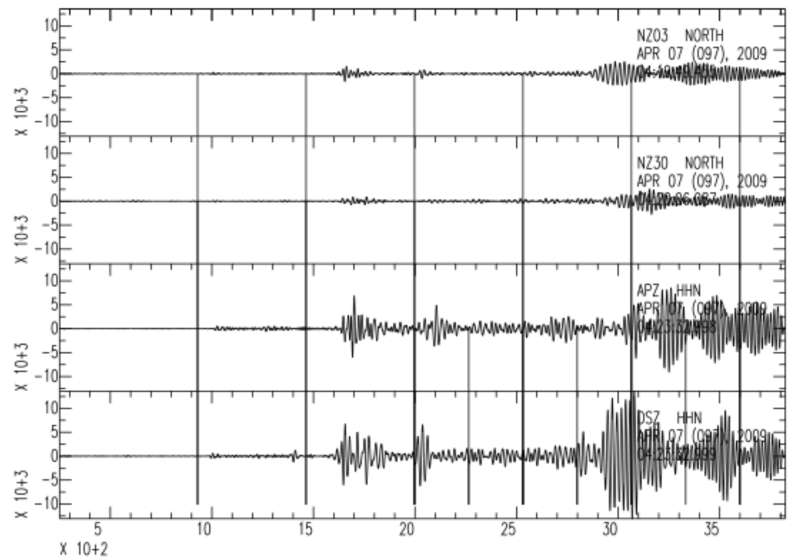
Sample land vs. OBS earthquake seismograms. NZ* are OBS, others are New Zealand Geonet stations. Note that OBS amplitudes seem small compared to land station amplitudes. Is this because of incorrect OBS instrument response?



Another example of small MOANA OBS amplitudes relative to land stations (GeoNet). The attached record section is for a event from the northwest bandpass filtered around 25 second period. The OBS stations (<~5000km and >~5300km) clearly have smaller amplitude compare to the Geonet stations. from Fan-Chi Lin - This can be due to the difference between different instrument responses, but can also due to the structure variation. At 25 second, fast structure offshore can at least partially account for the smaller amplitudes observed by the OBS stations.



MOANA OBS compared with GeoNet
Bandpass 12.5-33.3sec
NZ03 and NZ30 are MOANA OBS
APZ and DSZ are land GeoNent
(from Dan Zietlow)
(these amplitude differences look too significant to me (Anne) to be due to structure)



Bandpass 12.5-33.3sec
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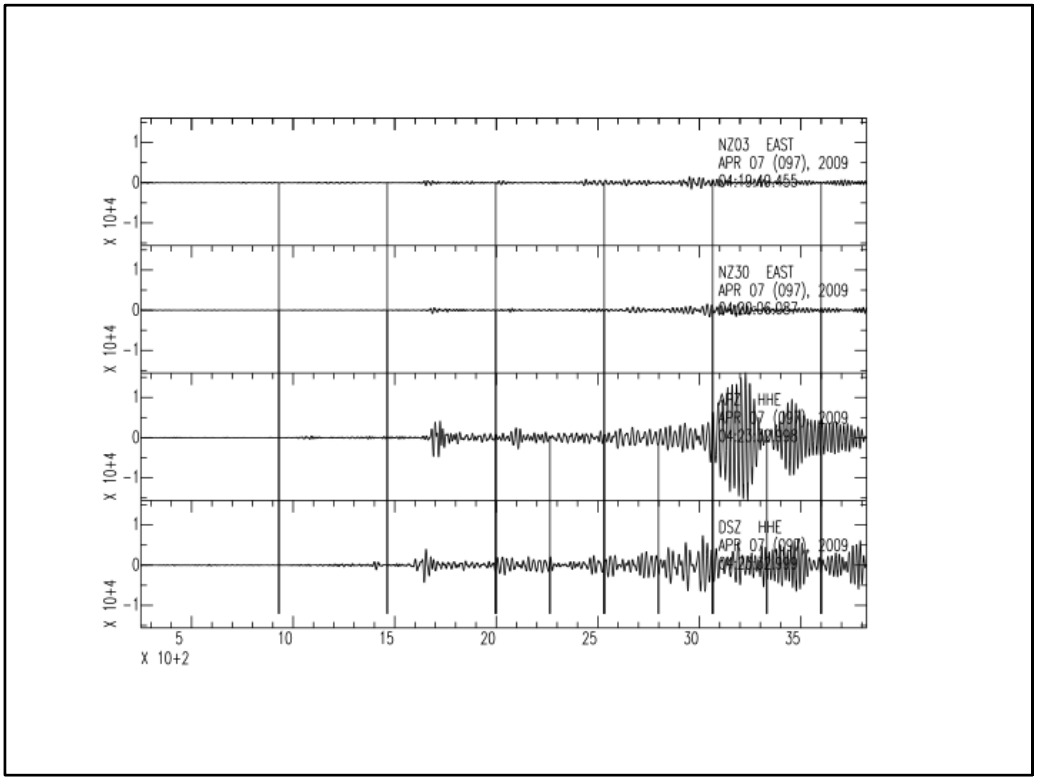

Bandpass 12.5-33.3sec
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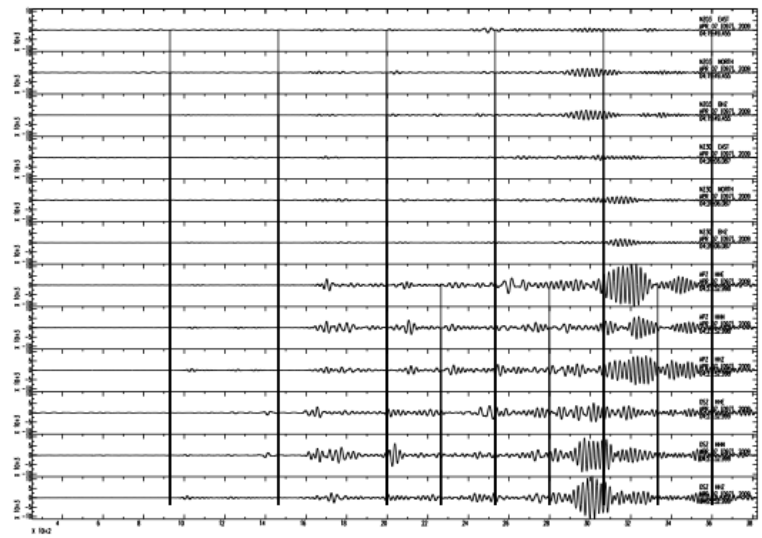
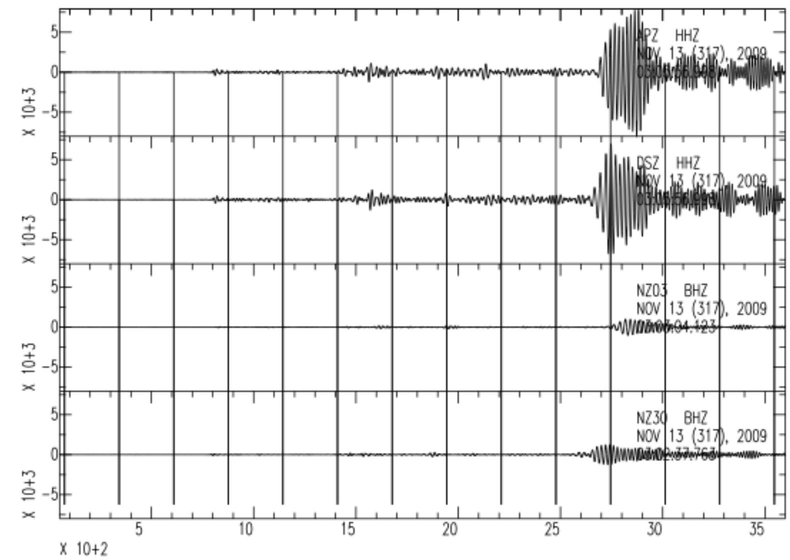
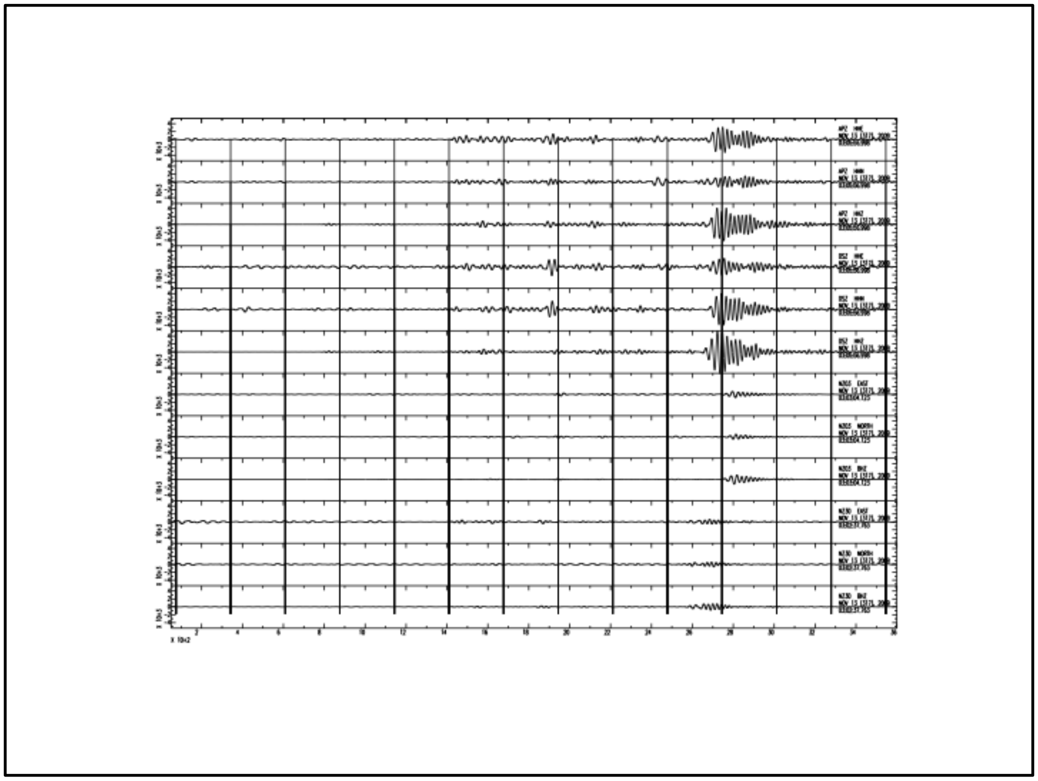


Bandpassed 20-60 seconds



Bandpass 12.5-33.3sec
NZ03 and NZ30 are MOANA OBS
APZ and DSZ are land GeoNent



Bandpass 20-60 seconds

MOANA stage

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NZ01	BHZ	1/31/2009 (031) 0:00:00.00000	4		1			FIR_decimator	8	64000.00000	response/stage
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NZ01	BHZ	1/31/2009 (031) 0:00:00.00000	7		1			FIR_decimator	2	8000.000000	response/stage
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cdp_base_mrg stage

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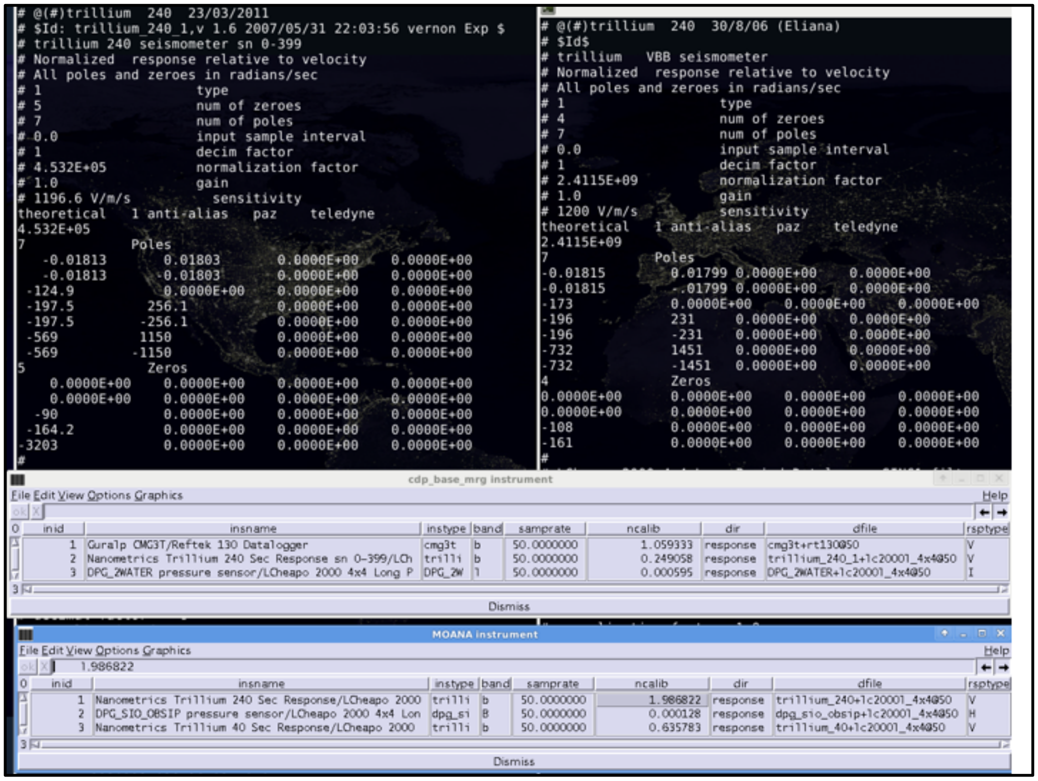
Comparison of MOANA OBS to CDPapua OBS instrument info. CDPapua was immediately after MOANA and used the same SIO OBSIP OBSs.

CDP_preamp.pdf shows a difference in preamp values for MOANA (0.125) vs. cdp_base_mrg (1)

I'm not sure how useful this comparison is, since Geoff's amplitudes have an even bigger mismatch, but here you have it



Comparison of CDPapua (left) to MOANA (right)
OBScompare.png - compares MOANA to CDP OBS instrument response values. Calib values are different MOANA (1.986822), CDP (.249058). Number of zeros in the response is different (CDP 5 zeros, MOANA 4 zeros). normalization factor CDP (4.532E+05) vs. MOANA (2.4115E+09)