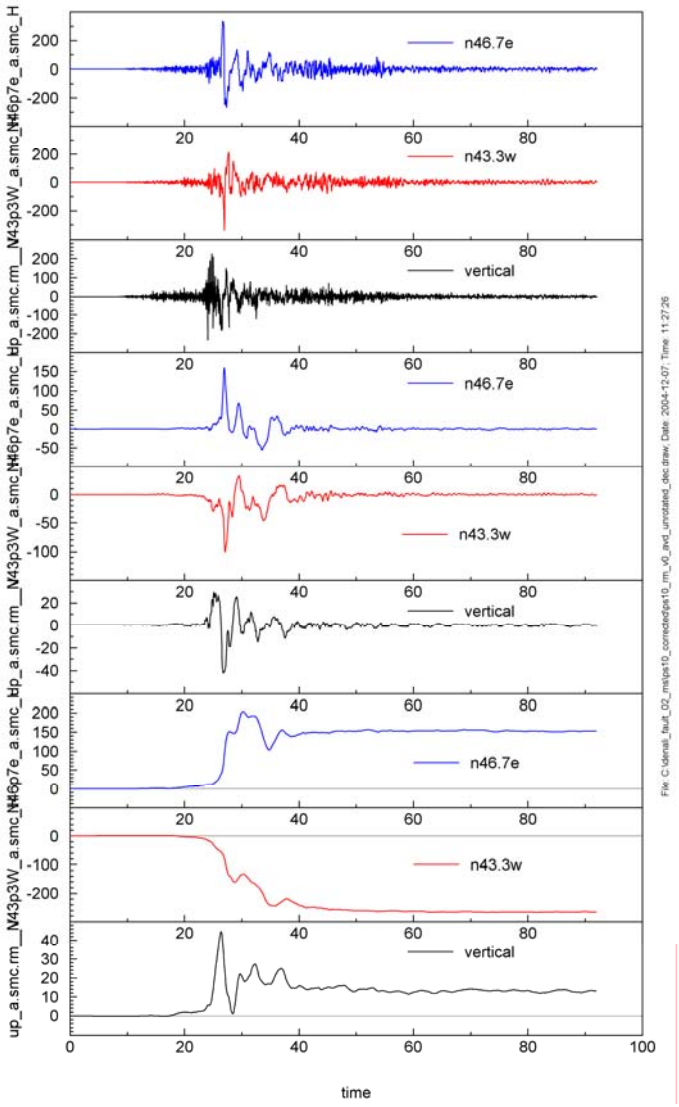
File: C:\peer_nga\database\regarding_pump_station_10_record.pdf

At Workshop 7 Walt Silva asked me about the Pump Station 10 record of the 2002 Denali Fault earthquake. There was some confusion about what version of the record was used in the NGA database. Here is a short history, as I know it, of the record. When first put on the USGS NSMP web site (http://nsmp.wr.usgs.gov/), there was a statement that the hardware low-cut filter was at a very low frequency, on the order of 0.01 Hz . But then it was discovered that the hardware filter was actually about 0.1 Hz. The statement on the web site has been changed to read:

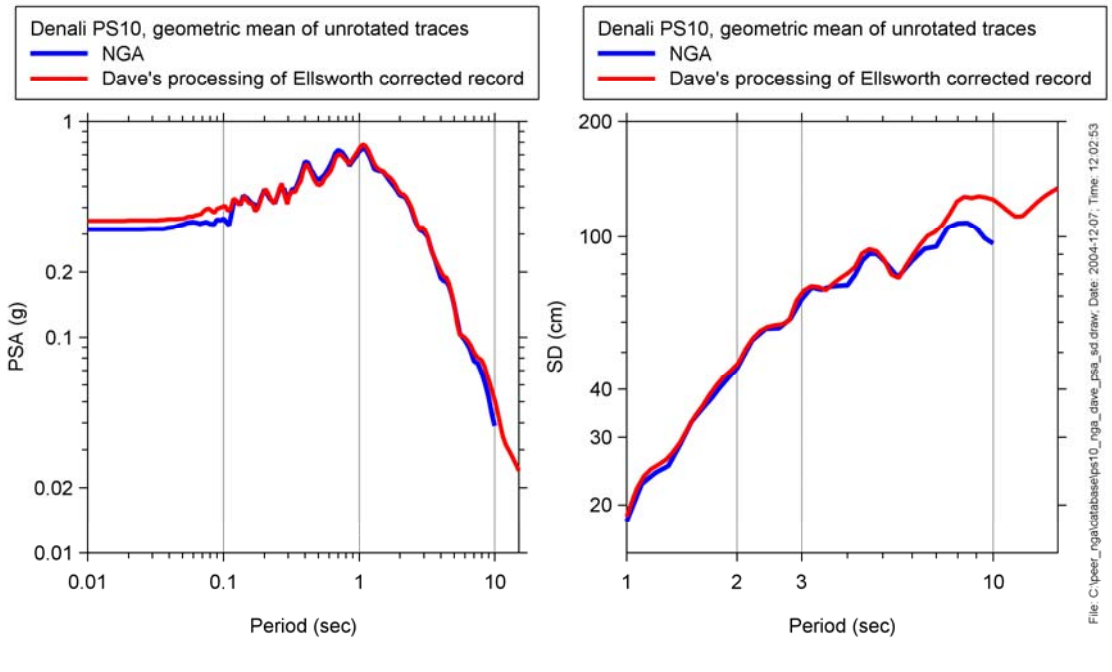
> Revised information about the nominal filter characteristics, as determined from an analysis of a circuit diagram for the filter. **Note in particular that the highpass corner is at 0.1 Hz, not 0.01 Hz** as was indicated in the files originally provided by Alyeska, **and that the highpass and lowpass filters each have 2 poles rather than 1.** Details of the nominal filter characteristics are provided in the headers.
>
> Due to uncertainties in the instrument response, **only uncorrected acceleration time series data are currently being served.** Results from bench tests using components similar to those deployed in the field show deviations from nominal characteristics that could produce variations of up to 20% in displacements determined by double integration of the acceleration time series. The USGS is working with Alyeska to determine more accurate calibrations, and any new information will be released as soon as it is available.

Bill Ellsworth applied a correction for the instrument filter and used this in his recent Earthquake Spectra paper (which is attached). His corrected data can be obtained from ftp://clover.wr.usgs.gov/pub/ehz/PS10/.

I reformatted his corrected version of the data into our standard SMC format, and used the “v0” baseline correction (details are in the headers of the files). Here is a plot of the acceleration, velocity, and displacement for the three components of motion:

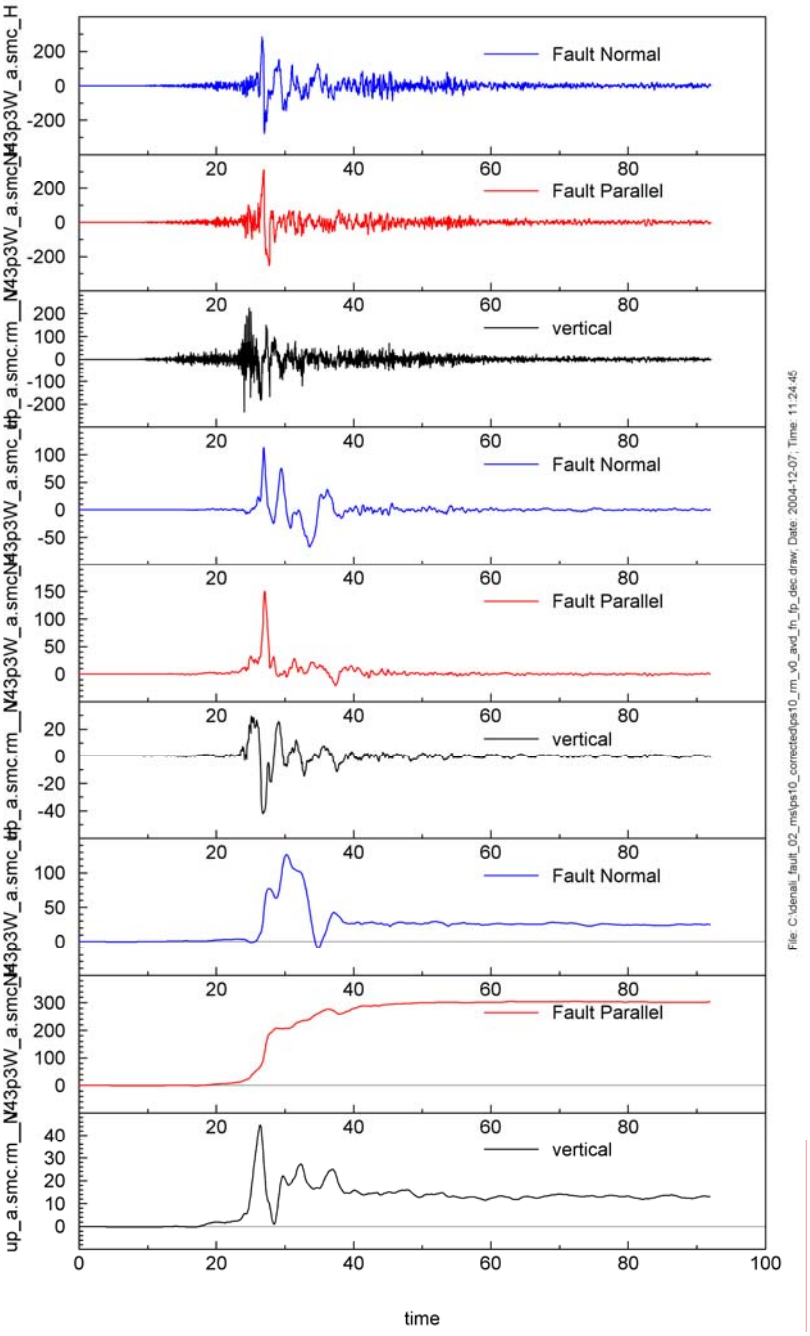


Here is a plot of the geometric mean PSA and SD, compared to the spectrum from the NGA flatfile. As can be seen most readily from the SD plot, there are significant differences between the NGA spectrum and that from the instrument-filter, baseline-corrected data, the latter being higher at short and long periods. Note that the difference at long periods starts at about 6 sec, so it is probably important to replace the spectrum in the flatfile with the new spectrum. The difference is in the direction expected if the NGA values are based on the uncorrected data. The difference at short periods might be due to the use of a causal high-pass filter by NGA. I showed in a previous communication the surprising result that causal filters can affect short period motions, at periods much shorter than the filter corner period.

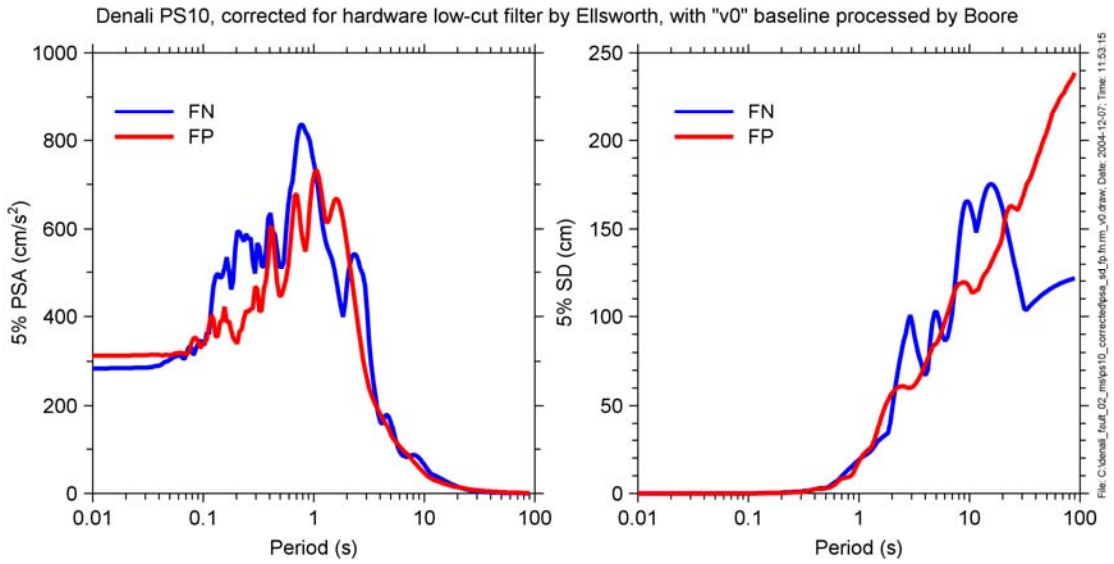


The geometric means of the pga are as follows: NGA: 0.316g; Dave: 0.346g. And for pgv: NGA: 85 cm/s; Dave: 128 cm/s. The difference in pgv might be explained by the use of a 0.1 high-pass filter in the data (or are the filter characteristics in the flatfile simply reporting the hardwired instrument filter? Was an additional filter applied by Walt?)

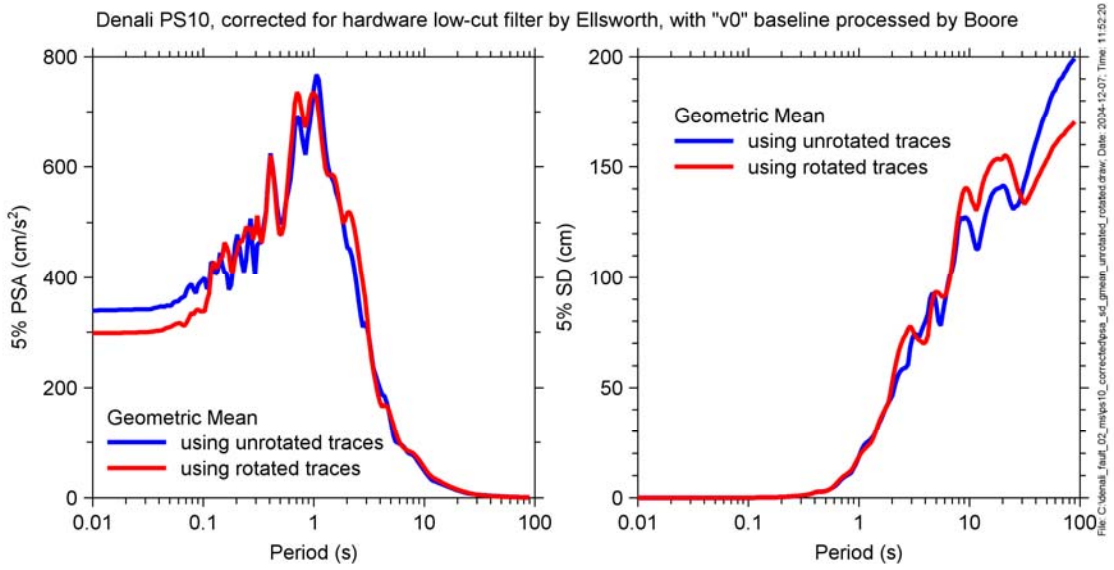
I then rotated the horizontal traces into fault parallel and fault normal (using a fault normal azimuth of 21.62 degrees and again did the “v0” correction.. Here is a plot a plot of the acceleration, velocity, and displacement for the three components of motion:



Here are plots of the PSA and SD spectra for the rotated traces:



An issue not discussed by the group is that geometric means of the two horizontal components is not invariant under rotation. This may become important when the developers are studying fault parallel, fault normal motions. I have not seen a systematic study of the dependence of geometric mean on rotation, and I am not doing that here. All I show below is a comparison of the geometric mean spectra for the unrotated and rotated Pump Station 10 records. Clearly there are differences; are they important for the NGA project?



In summary, the NGA flatfile entries for Pump Station 10 are based on data uncorrected for the hardware instrument filter. Using corrected data leads to differences in the pga, pgv, and pgd values, as well as short- and long-period response spectra. In addition, as a side issue I show that there can be substantial differences in the geometric mean computed from unrotated and rotated horizontal components. This might be important in studies of fault normal and fault parallel motions.