Some aspects of seismic risks in Acoculco

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1) Objective

This presentation concerns some relevant aspects that could affect seismic risk in Acoculco, namely the apparent faults system and the presence of softer surface soil layers. Faults can affect the travel of seismic waves, especially from local events, modifying the seismic field through nonlinear geometric reflections, and eventually mechanic interaction with different soils, producing motion amplification. Surface soil layers with mechanical characteristics lower than those of the underlying soil can produce local amplification of the seismic motion at frequencies depending on the geometric/mechanical properties of the soils.

2) Methodological approach

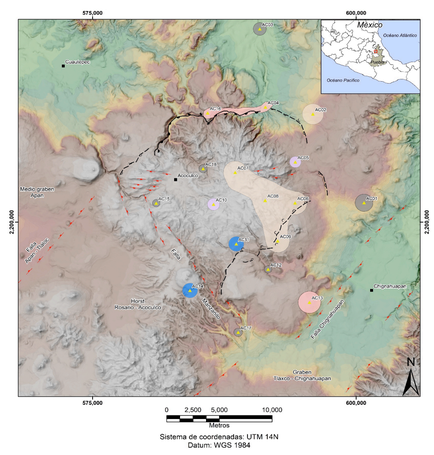

Figure 1. Seismic stations' location in Acoculco geothermal site.

Seismic data have been provided by Marco Calò, (UNAM). They consist in continuous recording for 10 days from 16 seismic stations deployed in the Acoculco area, Figure 1. Data are analysed as they are, without any processing.

It has been chosen to consider two days, 80 and 87, for which it seems that there is only noise, separately, and the seismic events present in the records of the days 81,82, 83, 85 and 86. The mean Fourier spectra and HVSR, Horizontal to Vertical Spectral Ratios, for the two days, are computed over a time window of 5 minutes due to the relevant presence of very low frequencies, while for earthquakes they are computed over the whole length. Spectra have been smoothed with a moving triangular function 1 Hz long.
Spectral ratios can help to discriminate amplifications from stratigraphic origin from others.

3) Seismic data analysis

Noise records, Figure 2, show very low amplitude and frequency content. Figure 3, is dominated by frequencies, ~ 0.13 Hz, typical of ocean waves, whose wavelength is probably too high to interest the eventually present soil deposits that could give stratigraphic amplification of the motion. The rest of frequency content, lower amplitudes, shows a shape of one or more peaks surmounted by a ripple, that resemble that originated by echoes/reflection, around 3 Hz in Figure 3. Spectral ratios, Figure 4, exceeds the standard value 2 for a range of frequencies, 4-9 Hz, that does not justify the attribution of this effect to stratigraphic amplification but could be related to reflections effects.
Analogous considerations can be done for earthquake records, Figure 5, 6 and 7, that show a more rich frequency content.

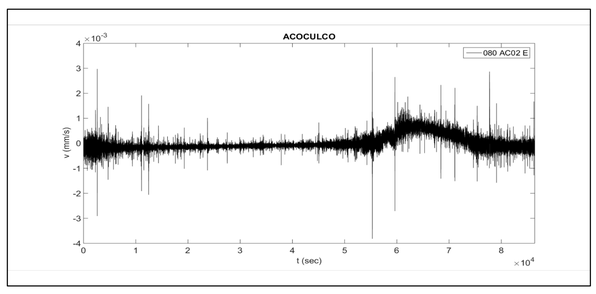

Figure 2. Example of noise record, day 080 station AC02.

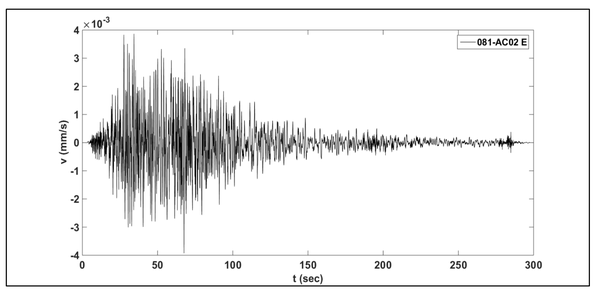

Figure 5. Earthquake record, day 081 station AC02.

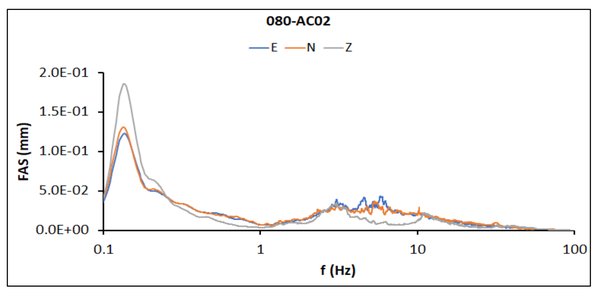

Figure 3. Fourier spectra of noise record day 080 station AC02.

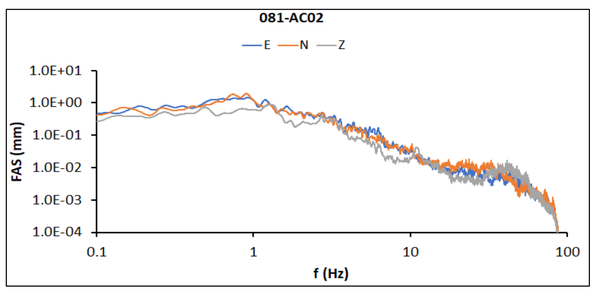

Figure 6. Fourier spectra of earthquake record day 081 station AC02.

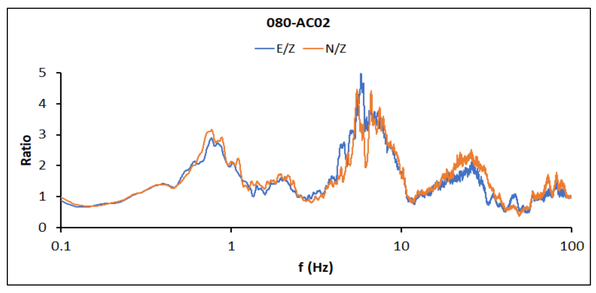

Figure 4. Noise spectral ratios, day 080 station AC02.

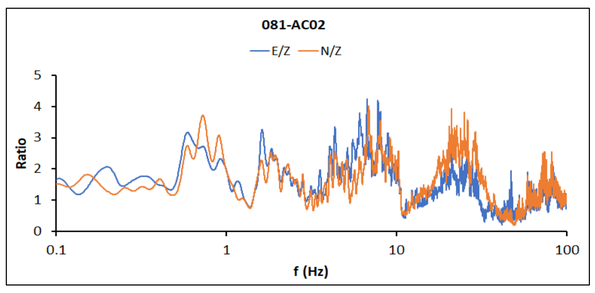

Figure 7. Earthquake spectral ratios, day 081 station AC02

4) Discussion

The observation can be synthesized as follow:

1. Amplitude of the motion is very low, both for noise and earthquakes.
2. The frequency content is limited, very limited for noise.
3. Because of points 1 and 2 it is possible that local soil effects could not have been activated.
4. Fourier spectra of the noise records show the possibility that complex reflection are present, as expected from the geology of the site.
5. Use of HVSR technique show that amplification of the horizontal motion occurs mainly in wide frequency range, at frequencies up to 30 Hz, so that it cannot be attributed to the presence of surface soil layer/s. In some cases, narrow peaks that could be attributed to stratigraphic effects are present, but peaks in the horizontal components are not apparent.
6. For some stations, vertical spectra are higher than the horizontal ones in the high portion of the spectra.

5) Conclusions

In Acoculco geothermal site, locally generated earthquakes travel through discontinuous media rich of faults with relevant lateral discontinuities that can modify the seismic field in the sense of producing refractions/reflections capable to shift the frequency content of seismic motion to higher frequencies and then to higher peak values.

In some station it is evident the possibility of stratigraphic amplification of seismic motion.

The dense seismic network to be installed in Acoculco should give information also on the variability of the seismic motion along the surface and should take in account the local geology and the closeness to faults. Installation of downhole instrumentation is strongly advised specially in proximity of faults.

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