The characteristic of source spectra and stress drop of earthquakes in the Bucaramanga nest

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Spectra analysis is helpful to understand earthquake rupture processes and estimate source parameters like stress drop. Obtaining real source spectra and source time function isn't easy, because the station recordings contain path effect and we usually can't get precise path information. Empirical Green's function (EGF) method is a popular way to cancel out the path effect, main two of which are the stacking spectra method (Prieto et al, 2006) and the spectral ratio method (Viegas et al, 2010; Imanishi et al, 2006). In our study, we apply the latter with multitaper spectral analysis method (Prieto et al, 2009) to calculate relative source spectra and relative source time function. Target event and EGFs must have similar focal mechanism and be collocated, so we combine correlation coefficient of wave at all stations and focal mechanism similarity to select proper EGFs.

The Bucaramanga nest has very high seismicity, so it's suitable to calculate source spectra by using EGF method. We calculate the source spectra and source time function of about 1540 earthquakes (3-5.7ml, 135-160km depth) at Bucaramanga nest in Colombia. Simultaneously we also estimate corner frequency by fitting spectral source model (Brune, 1970; Boatwright, 1980) and stress drop using simple model (Eshelby, 1957) of earthquakes with multiple station recordings or EGFs. We obtain about 30000 events data with 12 stations from National Seismological Network of Colombia (RSNC).

The result show that the source spectra of most earthquakes fitted well by omega-square model are smooth, and the source spectra of some have obvious 'holes' near corner frequency, and the source time function of a few earthquakes appear two separate peaks. The first kind of earthquakes are style of self-arresting ruptures (Xu et al. 2015), which can be autonomously arrested by itself without any outside interference. Abercrombie (2014) and Wen et al. (2018) both researched the second kind of earthquakes and Wen think that this kind of earthquakes are style of the runaway ruptures including subshear and supershear ruptures. The last kind of earthquakes maybe be caused by simultaneous slip on two close rupture zone. Stress drop appear to slightly increase with depth and are very high (assuming rupture velocity/s wave velocity is 0.9). We also investigate the high-frequency falloff n, usually 2, of Brune model and Boatwright model by fitting all spectra, and find that the best value of n for Boatwright model is 2 and for Brune model is 3.5.