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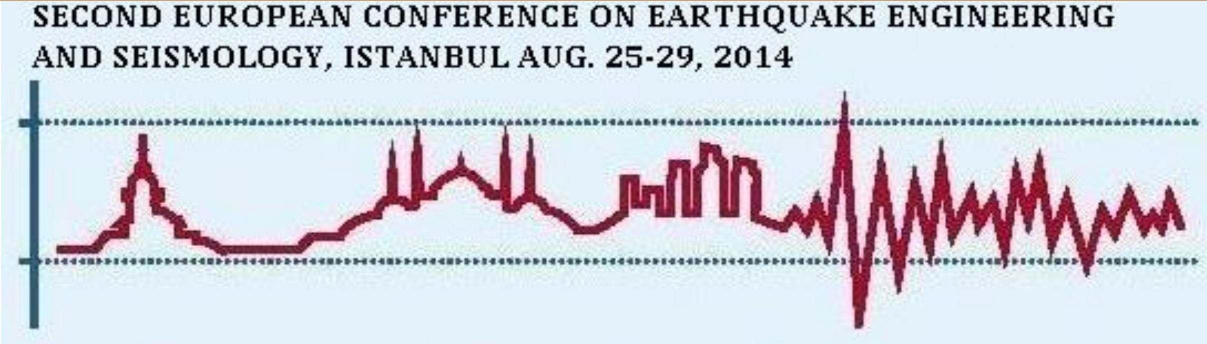

TELESEISMIC MODERATE EARTHQUAKE DEPTH ESTIMATIONS AND SOURCE ANALYSIS OF DEEP INTRAPLATE EARTHQUAKES TO IMAGE THE SPATIAL VARIATIONS OF THE GUERRERO SUBDUCTION (MEXICO).

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Great earthquakes often occur in subduction areas at the boundary between two strongly locked and coupled plates. Thus, understanding strain accumulations, slip distributions and coupling ratios of these subduction interfaces are some of the most important issues in seismology. Moreover, slow slip silent earthquakes (SSE) have recently been discovered. The question of the origin of these slow slip events is still debated as coupling maps and SSE locations are showing significant spatial variations on the subduction interfaces (*Radiguet et al., 2012*). Constraining the subduction geometry is thus crucial to understand the cause of theses variations. We here focus on imaging the Guerrero subduction zone, where some of the world's largest SSE have been observed. The study of the Wadati-Benioff zone and hypocentre locations (*Pardo & Suarez, 1995*) yields an idea of the subduction geometry but is limited by uncertainties in the depth estimation. Another method is to use receiver function analysis (*Pérez-Campos et al., 2008; Kim et al., 2010*). A drawback for this approach is the scarce stations coverage in the Guerrero region and the question about the lateral variation of the geometry that remains open.

To assess this issue, we have conducted an exhaustive analysis of the depth distribution, based on the ISC catalog. We show that focal mechanisms of intraplate deep earthquakes (mainly thrust events) can lead to bias in the hypocenter estimations. They generate sP waves which can be wrongly interpreted as more common pP waves. Trade-offs between depth and origin time can also introduce important uncertainties and lead to misinterpretations of the Wadati-Benioff location zone.

We use two methods to deal with these possible errors. First, we use the ISC-locator for 140 recent earthquakes with magnitude above 4.5 to relocate the events. This new location algorithm (*Bondar & Storchak, 2011*) accounts for correlated error structure, and uses all IASPEI standard phases to obtain more accurate event locations. (*Bondar & Storchak, 2011*) demonstrate that this new algorithm, through the use of later phases and testing for depth resolution, considerably clusters event locations more tightly. In the Guerrero area, this new tool shows a clear trend: a diminution of the ISC bulletin focal depths and a better spatial coherency between these depths (Figure 1).

In parallel, we have then developed a completely automatic depth estimation procedure to avoid effect and bias due to possible non-coherent phase pickings (which can vary from an institute to another, as these pickings are dependent on the noise level, the frequency band used, source effects, crustal propagation effects and the analysts' interpretations). This procedure is applied for the same list of

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earthquakes used for the ISC locator relocalization. The method consists in a modification of the Cepstral analysis from *Letort et al. (2014)* and *Bonner et al (2002)*, which aims to detect the surface reflected (pP and sP) waves in a signal at teleseismic distances (30-90°). We filtered all spectra between 0.8 Hz and 2.5 Hz, which is the frequency band of interest for earthquakes of magnitudes of around 4–5 in this area. Then, the Cepstral analysis (basically, inverse transform of the logarithm of the power spectrum) is applied to each beam of selected arrays and for each station (22 station/arrays have been selected for this study). For each station, we keep the main Cepstrum peaks, we assume these peaks to be the P–pP delay detections, and we convert these time delays to a depth probability function using the velocity IASP91 model. These time delays are also associated with sP arrivals that yield different depth probability curves. Then, we automatically find the final depth as the best match between the pP and sP equivalent depth curves from the different azimuths. The results show great similarity with the ISC Locator results and show an important number of sP phase detections in North America, consistent with thrust events. In Figure 1, we can notice the improvement of both methods compared with the ISC classical bulletin.

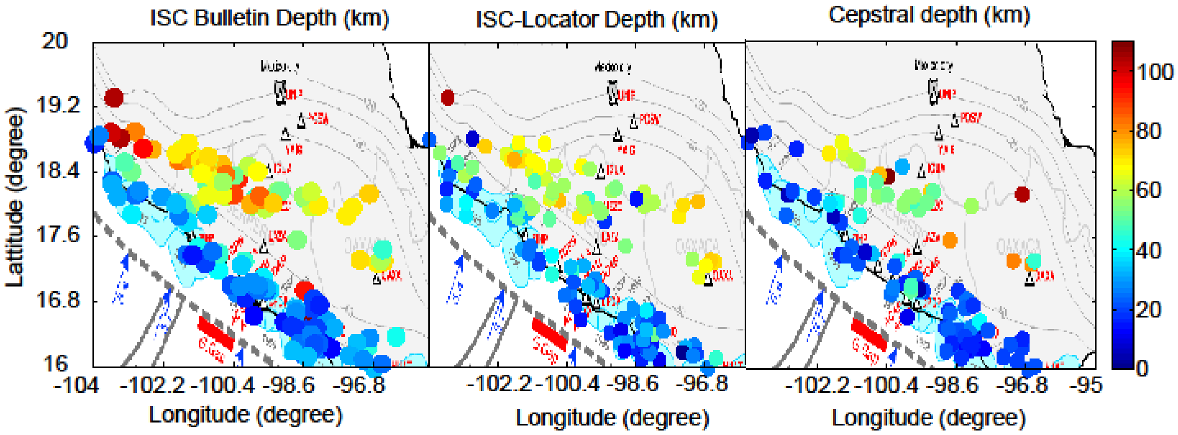

Figure 1: Earthquake depths in the Guerrero area for the 140 selected events for the ISC Bulletin, the ISC-locator relocalization and for the Cepstral depth estimation.

Then, we have analyzed and modeled teleseismic waves due to 14 deep recent earthquakes in the subducting plate, which are reflected on the subduction interface (*p(sub)P* and *s(sub)P*, see Figure 2), following an original approach of *Song et al. (2009).* This approach gives us a punctual estimation of the depth of the interface above the focal hypocenter. We have tested different crustal models and proved that the waves are well sensitive to the depth of the interface (Figure 2). Analysis of synthetics has also shown that introducing a low velocity layer at the plate boundary in the crustal model, as proposed by *Song et al. (2009),* better explain the data. However, we are less sensitive to the width of this low velocity layer and the fits are almost similar with a fixed interface depth and different layer widths varying between 1 and 10km. The depth interface estimations are shown to have weak dependencies from focal mechanism determination errors for North America arrays (ILAR, YKA). One great interest of this approach is that such teleseismic wave analysis is independent of the regional station coverage needed for the classical receiver function analysis.

Finally, combining the ISC catalog with the new improved depth distribution using automatic cepstral analysis and the ISC Locator relocalization, we propose an image of the subduction boundaries by interpolation between the punctual interface depth estimations obtained from the simultaneous crust & focal mechanism inversions. The results confirm the presence of a relatively flat area in the deep part of the subduction at around 40km, which is coherent with previous subduction geometry studies and with the function receiver analysis (*Pardo & Suarez, 1995; Pérez-Campos et al. 2008; Kim et al. 2011; Song et al. ,2009).* Our results show a clear symmetry around the receiver line, which confirms results of amount of slip found by *Radiguet et al. (2011),* where the inversion process is based on a symmetric geometry. We also propose a deeper part of the interface in the Oaxaca region (at around 50km) that is less constrained due to the lack of moderate seismicity in this area.

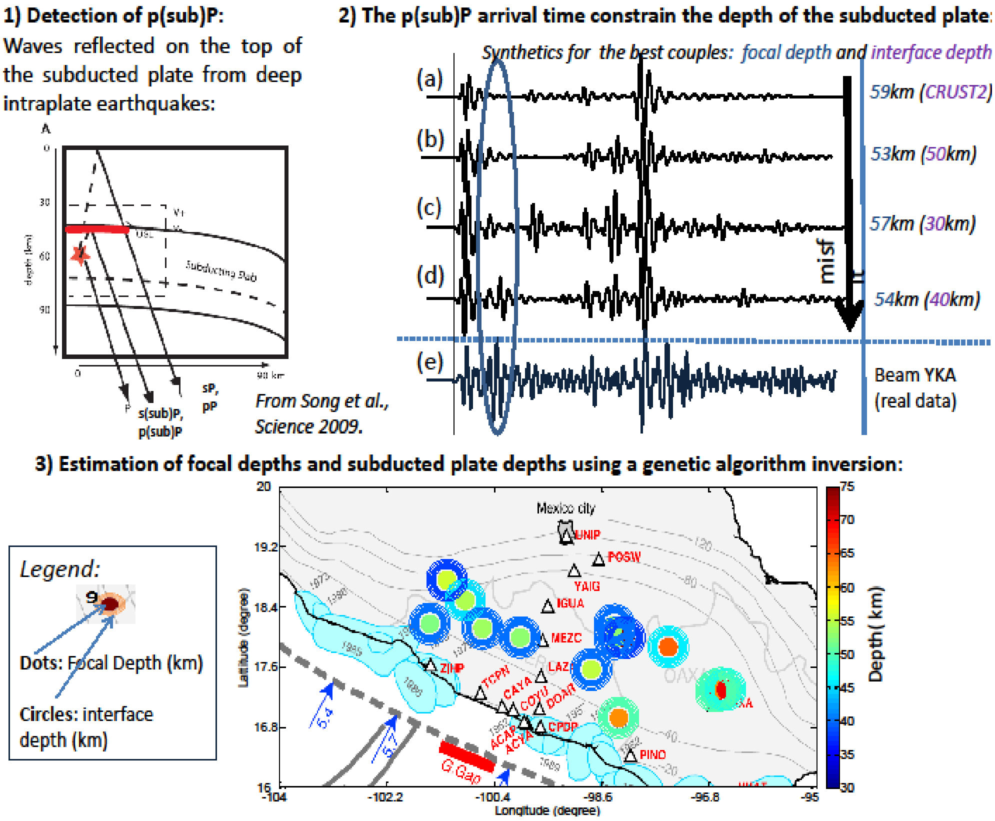

Figure2: (1) Figures from Song et al. (2009) which show the reflected waves. (2) Synthetic example on a thrut event proving that the interface depth play a role on the telesesimic signal phase arrivals. (3) Punctual Interface depth estimation by inversion of interface depth and focal mechanism.

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