

Interactive comment on “Fault reactivation by gas injection at an underground gas storage off the east coast of Spain” by Antonio Villaseñor et al.

Anonymous Referee #2

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Review, Solid Earth, se-2019-113 Villaseñor, A., et al. “Fault reactivation by gas injection at an underground gas storage off the east coast of Spain”

The paper provides a seismological discussion on an interesting case of triggered seismicity in Europe, occurring in 2013 offshore Spain. The sequence was studied by a number of previous publications and reports. However, beside a general agreement on the relatively shallow hypocenters and strike-slip dominated mechanisms, accurate depth and fault geometry remain to a certain extent debated. Given the interest of the sequence and its relevant in the field of induced seismicity, this study appears to be justified.

Target of the study are basically on one side dispersion curves and velocity models, to improve Green’s function and data modeling up to higher frequencies, and on the other

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side a contribution to the estimate of focal depths and focal mechanisms (or moment tensors).

I think this is an interesting manuscript, but requires some moderate improvement. I provide below my major comments:

Main comments:

1. Uncertainties

In order to provide new insights into a sequence which was discussed by previous papers, I think authors should not only provide a new result (depth, location or mechanism) but also some uncertainties. The estimation of uncertainties is discussed indeed in the first sections, dedicated to the assessment of dispersion curves and velocity models, but they are not used to derive a uncertainties on derived parameters, such as the depth.

2. Network asymmetry

Both depth estimation, location and hypocenters suffer in this region by the asymmetric distribution of the stations. In this study, some new data have been taken into account (e.g. upon the Topoiberia project), but the azimuthal coverage remain strongly unbalanced. This may have a strong influence on the location accuracy, and some works suggested that the distribution plotted e.g. in Fig. 1b, may be partially attributed to the network geometry. The azimuthal coverage may also affect the depth, because of an inaccurate epicentral location. Has this been verified? Finally, it surely affects the focal mechanisms estimation. All these effects are not discusses.

3. Data used for MT inversion

Furthermore, authors use the same velocity model for all stations. While this may be proper for onshore stations, I doubt this is accurate for stations on Balearic islands. It is unclear whether these stations have been used or not, as they appear in Fig. 1 but not in Fig. 4. Using them will surely improve the coverage, and improve the moment

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tensor inversion result, but possibly a different velocity model should be used. Fig.4c should show some waveform fit there.

4. Velocity models

Since a lot of velocity models are discussed, they should be included in the document, as table or in the e-supplement. Having them available is need for the reproducibility of results

5. High frequency waveform modeling

The high-frequency waveform comparison is very interesting and in my opinion the most interesting and novel part of the work. However, too little is said on how data were processed. Please, provide accurate information on how you process and fit data. The velocity of the structure is so far poorly resolved, especially at shallow depths. This can strongly affect the high frequency synthetic waveforms and thus your inference. How sensitive is the method to such velocity model uncertainties? You only show the fit for the “best” depth, but a reader has no idea what are the uncertainties... Could you plot the fit for perturbed depths as well? Next question is why only one station was used, since there are two of them at local distances. The analysis should be shown with both.

6. Minor comments:

L. 76: quantify “low frequencies”

Fig. 1: figure misses axis labels

Fig. 4: plots (or labels) should be enlarged, as labels are too small to be readable

Fig. 5: improve figure quality, it seems inadequate for the journal. There are no axes nor labels in plot c. If you add (too small) numbers in panel (a), they should refer to some events in the Figure or its caption.

Fig. 6 should show ALCN and ALCX

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