Interactive comment on "Joint interpretation of magnetotelluric, seismic and well-log data in Hontomín (Spain)" by X. Ogaya et al.

Anonymous Referee #1

Received and published: 9 March 2016

this paper present unpublished material, and revisit already available results giving full references to it, concerning the Hontomin CO2 storage pilot project.

The topic is interesting, up to date, the data well presented and discussed. Perhaps the discussion could go further, but as stated by the authors in the discussion, this work is a first step for further joint interpretation.

Please find my detailed comments hereafter.

P1 abstract:

L16: unclear... please rephrase The models correlate well in the surroundings of the CO2 injection area with [the major structural observed related to the presence of faults].

L18 : defining their structural -> geometry ?

L21: The derived velocity model is compared to both the [predicted ? from surrounding wells and seismic] and logged velocity in the injection and monitoring wells

L25: unclear, between what & what ?? The good correlation of the velocity models, one being derived from log base Vp/R relationship demonstrates the reliability of a joint interpretaion, based on petrophysical relationship.

L28: joint interpretation in reservoir characterisation you may write "near surface and reservoir", no ?

P2

L6: pore fluid 'nature'.. L27: magnetotellurics, from [respectively] a structural and petrophysical point of view.... petrophysics is not applied to seismic data ? L28: and [to] compute velocity L29: for [the] first time L29-30: and its correlation ... is used to better characterize etc..

P3 L5: three shallow hydrogeological wells (provide depth range for nfo...) L12: well as the entire target dome structure. This is the first time you write about the reservoir structure, you could indicate before (in intro for instance) it is an anticlinal .. L14: 1) what is briefly the geological reason for velocity inversion You explain P8, but could suggest the answer here..

in fig2, "X-faults" in yellow are almost invisible... could you find another color...

fig 3. a depth given in terms of m.a.s.l. is not depth, but altitude ??

P5 L7: The geoelectrical structure of the F region revealed an important conductive fluid circulation along the fault zone, which was unknown until the MT survey was conducted.

I would suggest first a description of observed resistivity (permute with the next phrase in the text: a conductive zone is observed, and interpreted as due to intense fluid circulation..) In addition, a "Fault zone" of > 1km thickness (in NS direction perpendicular to

the fault direction EW)... is at least a FaultS or multi-Faulted zone...? could you precise a bit..

L18: I think the use of the term "1D resistivity model" is tricky because one could read it as the result of a 1D inversion or the averaging of 3D model in 1D model... whereas it is the cells resistivity along the mesh of the 3D model.. I would sugest to consider rephrasing.. not mandatory, but, could be clearer..

P6: L2 to 5 Interpretation of conductive / resistive zone along fault is only interpreted in terms of fluid circulation... S fault = high flow, E fault: sealed... but, what about clay ? and alteration effect on resistivity signature ? Do you have arguments to neglect the clay effect on the resistivity here ? (perhaps ref to your previous work ?)

Effect of E fault on the higher values of eastern part of the resistivity model... interpreted as a side effect ? I suppose not, else interpretation in terms of velocity model should fail then... So, could you precise what you call E fault effect on the resisitvity ?

L8- L12: I think i understand what you mean, but I propose another way to wirte it: There are 2 ways to detect faults by resistivity: displacment and fluid circulation. If displacement is not sufficient, MT see nothing (but seismic resolution could). If no displacment(or no reflector to indicate displacement) seismic may see nothing but resistivity could still detect wter circulation... You may use this approach to re-phrase L8 to 12 (you use this way later in the discussion chapter paragraph)

P7 L1-4: could you relate ER1 and ER2 to a petrophysical model, and provide reference. That would help to explain why ER1 seems more "physically explainable" but ER2 show a good fit "mathematically a good fitter" with limitation in terms of applicability..

Just a comment: It is hard to compare the fit quality of the 2 relationships, you could have used centered / reduced data, check "gaussian distribution" and validity of relationship to explain the data... I recognize that the fig 7 shows pragmatically the accu-

racy of the models with well data...

L21: are nosier,

P8 L3-4: Thus, we associate the differences between the VR models and the prognosis to the lower resolution of the MT method at that depth: that's the major point ! may be hihlighted in abstract / ccl ..

L12-14: please rephrase This method uses the differences in travel-time of the first-breaks to calculate the [replacement velocity = define please] of a nearsurface layer, based on traveltime inversion (Lawton, 1989). This velocity model is then used to calculate the time-shifts in the [needed ?] to minimise the travel-time difference, usually enhancing considerably the coherence of the reflections.

P9 L6: The static correction model displays the replacement velocities for the first 40 m (Fig. [9] -> 10a).

L8: subsurface (Fig. 10[a] -> b).

The high noise recorded means that the resistivity model R and all the models generated from it have also lower quality in that region. I suppose the black dashed line in fig 10 indicate the wind mill line and low R quality.. shuold write it in the tet and in the fig 10 legend

P10

L3: to the north [to -> of] the South Fault

L15: As commented before, states clearly if this it could be due to artefact of MT imaging or not "Outside this area, the presence of the South and the East faults alter the geoelectrical behaviour of the different layers and produces the major differences observed between the models"

L26: resolution of the MT method is different [than -> from] in the other two techniques

L29: again... "than in those areas where the existence of the South and the East faults strongly alter the geoelectrical behaviour of the different layers."

P11 L13: the [used -> use] of more than one empirical

In the end of the discussion, you state that this work provide a good basis for future work on joint interpretation in the hontomin area, which I fully support.

I think you should emphasize the need for petrological constraint: theoretrical model ? and perhaps sample work varying water saturation, salinity... to refine the relationship R / V

By the way, I did not see written that it is Vp which is considered in this paper.. it is almost evident, but not written..

P12

potential joint "inversion" in the conclusion... joint interp in the discussion... both could be adressed..

And the impact of the aquifer properties in the nearsurface may impact the safety of the stroage, and detectability of diffuse CO2 leakages..

All figures are clear, needed, perhaps axis legends are a bit small.. but it is up to the editor to fix the rule.

All references are cited.

C5