Reply to the RC1's comment

'The article presents a study on constraints on stress tensor on the monitored seismicity at the Illinois Basin Decatur Project (IBDP), a CO_2 sequestration project effective between 2011 and 2014. The study was encouraged due to the large uncertainty on the stress tensor magnitudes in the Decatur reservoir. Its aim is to refine the stress field estimations by the full stress inversion method from focal mechanisms of microseismic events from two datasets and by considering borehole data: the values of the instantaneous shut-in pressure and the average of vertical stress. From the update of stress tensor, they compute an updated value of the minimum activation pressure at the project site, significantly smaller than the originally estimated threshold pressures for the regional faulting network. The manuscript addresses the importance of the estimation of the minimal activation pressure, one of the main parameters in the design of the injection protocol, and presents a methodology that refines the estimation of the stress tensor.

Overall, the research topic and the proposed methodology are significant. The manuscript is clear, and presents a literature review of the stress estimations of the study case. The methods and results are well explained. Yet, I would encourage the authors to revise the writing of the manuscript. Indeed, the manuscript could benefit from a little upgrade in its writing (there is a lot of repetitions of certain words along the sentences, and the transitions between paragraphs and sections can be quite abrupt).'

Thank you for the positive feedback, we acknowledge the comment regarding the writing style, particularly the word repetitions and transitions. We have revised the manuscript accordingly to improve the clarity and rephrasing repetitive parts for a better readability.

'Minor comments:

in 1. Introduction, there is only one subheading. The subheading might be deleted. In Introduction: The introduction presents stress estimations from previous studies (section 1.1.), but an introduction of the study case (currently in 2.1.) would be expected to be done before.'

We have moved the description of the IBDP site (previous 2.1) to the Introduction as Section 1.1, and accordingly, the previous Section 1.1 (stress state) is now Section 1.2. Section 2 has been revised to contain only the dataset description, and the previous Section 2.2 has been updated accordingly. With this we believe it is better to keep the subheading of 1.1 on line 49 to differentiate it from 1.2 on line 79. We hope these changes enable the reader to orient in the text.

'Lines 90-93: "This is an important constrain on our pore pressure limitation – the pressure that activated induced seismicity cannot significantly exceed this value because we know the injection activated this seismicity and this is the pressure that caused the seismicity to occur

(we can neglect possible thermal effects; selected induced events are far from the injection well)." The sentence is quite long and not very fluid.'

Thank you, we agree the sentence was not clear, we have rewritten it for clarity:

"The average injection pressure provides an important constraint on the pore pressure, as the pore pressure that activated induced seismicity is not expected to significantly exceed this value. We know that the injection triggered these events and the events are far from the injection well. Therefore, thermal effects can be neglected as triggering mechanism. Hence, the most likely triggering mechanism is increased pore pressure on pre-existing faults/fractures."

'Line 115: "We use the fact that this seismicity exists (i.e. the stress state or pore pressure in the reservoir was perturbed to induced seismicity)". What do the authors mean by this?'

We have revised this sentence to clarify it:

"We interpret the occurrence of induced seismicity as evidence that the stress state or pore pressure in the reservoir was sufficiently perturbed to trigger slip. Additionally, we use the source mechanisms of these events to further constrain the stress state in the Decatur Basin."

'Line 119: "small number", how many?'

Thank you for the comment, we have clarified the text to specify the number of events: 39 unique microseismic events in total (23 from dataset1 and 26 from dataset2 with 11 events overlapping between the two datasets).

'Lines 127-… : the bullet points are a bit rough, it could be better to reformulate as paragraphs'

We have restructured the bullet points into two paragraphs to improve the paper style.

'Line 140: "parameters of some seismic events differ from a dataset to the other", how much? Is it questioning the validity of the seismic interpretation of one dataset?'

We are sorry but we cannot find the text ': "parameters of some seismic events differ from a dataset to the other". We quantified the discussion of differences between lines 140 and 145. Partly it may question validity of inverted mechanisms as it is discussed later. We prefer to discuss the validity of the dataset at the Discussion section.

'Lines 150-…: "To determine the pore pressure that caused induced seismicity, we need to know the shear and normal stress on the fault plane, the coefficient of friction and the cohesion on the faults of microseismic events. To determine shear and normal stress on a fault, we need to know the full stress tensor." The two sentences have the same structures and read like a repetition.'

We have rephrased the sentences to avoid repetition and improve readability as:

"To determine the pore pressure responsible for inducing seismicity, it is necessary to know the shear and normal stresses on the fault plane, along with the friction coefficient and cohesion of the faults associated with microseismic events. Calculating the shear and normal stresses on a fault plane requires knowledge of the full stress tensor."

'Line 237: typo in "compute"'

Corrected, thank you.

'Line 240 "the pressure represents the minimum activation pressure, which is the minimum pressure needed to activate the fault". the sentence feels repetitive.'

We have rewritten this sentence to:

"… which corresponds to the minimum pressure required to activate slip on pre-existing faults under the current stress conditions."

'In generally, the colorbars should be wider in the figures, the colors are difficulty distinguishable.'

Thanks for pointing this out, we have increased the width of the colorbars in all relevant figures to enhance visibility.

'In Table 4, one Minimal Activation Pressure Range of All Events is negative. What does it mean for the methodology?'

Thank you for catching this, the negative value means that the fault is unstable in the selected stress field even with 0 MPa pore pressure. This would mean the seismicity would be naturally occurring in the area independently of the injection. This is obviously not correct, hence either ISIP or dISIP is not correct. We explain in the text.

'Line 354: what is "maximum horizontal press magnitude"?'

Thanks for the correction, it was a typo, we have corrected it to 'maximum horizontal stress magnitude'.

'In the manuscript, I would suggest to use the present tense when describing the analyses made by the authors in this study.'

Thank you for pointing this out, we have changed the time tense of the analysis part in this study.