Response to Reviewer 1 – Jonathan Turner

We thank the reviewer for their comments (repeated below in black) and provide detailed responses below (in red).

This paper addresses a topic of general societal interest; it is well written, carefully explained, thoughtful. The paper highlights the importance of several fault zone processes which are previously known about but this study provides fresh perspective e.g. the role of uncoupled fluid pressure, coupled fluid pressure (poroelasticity), the frictional properties of fault rocks (gouge, cataclasites), the importance of optimally constraining in situ stress measurements, etc. In fact I think poroelasticity deserves wider discussion here and elsewhere because it may be the key to understanding the unpredictability of induced seismicity.

We are pleased that the ms is considered to be well written, carefully explained and thoughtful.

I have few substantive comments and recommend that this paper be published.

Thank you.

1. It may be a bit too long with a little too much space devoted to explaining the method (or perhaps consider cutting one of the two synthetic case studies).

OK, fair point (also made by Reviewer 2 – Anon). We will delete the Manchester coalfield case study and focus on United Downs deep geothermal for fracture susceptibility and South Wales coalfield shallow geothermal for slip tendency.

2. Rangely oil field, Colorado is another good example to cite of a case study which showed a critical threshold in fluid pressure, above which seismicity was induced and below which it was absent (sorry, I don't have the reference but I think it was in the 1970s).

Good point. We will include this seminal study in our background and/or discussion.

3. The Townend & Zoback dataset is intriguing but in my experience very difficult to apply to development projects. What I mean is that is it hard to demonstrate that critically stressed faults are conductive/transmissive/higher perm, at least in as clearly as the T & Z dataset shows they should be.

Agreed. But tackling this is beyond the scope of our ms.

4. I got confused by the difference between slip tendency and friction coefficient – in words, friction coefficient is the ratio of shear force to tractional force at the moment of failure. So I then thought it's no surprise that your modal slip tendency in the first case study is 0.56 because that's the inverse tan of ~30degree which is an 'average' angle of internal friction for compacted rocks. I would find it useful if this point could be explained in slightly more detail.

Our understanding is that <u>slip tendency</u> is a feature of the stress field and the fault plane orientation (shear stress/normal stress), whereas <u>friction</u> is a rock property (an empirical measurement from laboratory tests). So if slip tendency exceeds friction, then a fault slips; if slip tendency is less than friction, there is no slip.

The friction coefficient will vary for different lithologies, different fault rocks, slip rates, etc. So for <u>recently formed faults in the present day stress field</u>, slip tendency ought to be about 0.6-0.85 (Byerlee). But that does not have to be the case for "old" faults formed under different stress states, not least because the orientation of the present day in situ stress is not the one at the time of faulting (e.g., Carboniferous or Permian in the case of the UK coalfields).