

Reviewer 1 Comments

For author and editor

Review of “Potential for Continental Scientific Drilling to Inform Fault Mechanics and Earthquake Science” by Cochran et al.

This is an opinion article that outlines how fault zone drilling and monitoring can elucidate how earthquakes start, propagate, and stop. This is a long-standing grand challenge in solid earth science, and the paper nicely summarizes the outstanding knowledge gaps. The paper especially highlights how new technology and instrumentation such as DAS and directional drilling have made this a timely problem to try addressing again.

The one drawback to the paper that I see is that the problem of catching a quake in late interseismic/precursory slip/coseismic phases have not been mentioned at all. This is a problem of timing that the new technology does not address. Also, I think the paper would benefit from suggestions of potential target faults. Finally, many of the knowledge gaps that could be addressed by drilling listed here were discussed at the SEISMS meeting in 2017 (Savage et al., 2017). Seeing as half the authors of this paper were either conveners or speakers at that meeting, it seems like that paper should be cited.

Savage, H. M., J. D. Kirkpatrick, J.J. Mori, E.E. Brodsky, W. L. Ellsworth, Brett M. Carpenter, Xiaowei Chen, Frédéric Cappa, and Yasuyuki Kano, 2017. Scientific Exploration of Induced Seismicity and Stress (SEISMS). *Scientific Drilling*, 23, 57-63.

Reviewer 2 Comments (Round 1)

For author and editor

“Potential for Continental Scientific Drilling to Inform Fault Mechanics and Earthquake Science” is an opinion article about near-future opportunities that will lead to advancements in earthquake science through scientific drilling. This is a useful article that communicates the products of a workshop.

While reading, it took me until I was almost finished to understand that the authors are really focused on fiber optic sensing. I recommend the authors edit the abstract and introduction to be a bit more direct about what the most immediate observational opportunities are and the big questions that can be addressed by them. I also suggest then being more clear in Section 1 about how future opportunities build on or are an advancement on the past fault drilling (e.g., why now?). Below are a few specific points that would clarify the manuscript for me, and I do not believe any require major effort.

1. My reading of this article is that fiber optic borehole sensors along a series of boreholes will allow for 4-D stress state estimation and (potentially) nucleation processes. This is the clearest measurement $\Downarrow$ advancement link made. I suggest being more upfront about this be ‘the technology advancement’ including in the abstract and introduction. If the authors disagree, it would be helpful for other such links to be clearly explained.

2. L 209 The authors call for borehole “instrumentation” in the near field to estimate stress and heterogeneity. It is unclear to me if they are still only referring to fiber optics or if there are other borehole instrument (seismometers??) that they envision. Please provide more specificity about instrumentation.
3. These applications seem to require multiple boreholes per fault. Are there advancements in drilling technology that make this easier/more feasible than in the past? If so, that would be helpful to explain. The drilling projects in section 1 were quite costly and complex.
4. There is a section explaining the importance of fluids, a long known complicated factor in earthquake processes (L 158--). However, there is no information on what measurements/observations could be made and how they will answer specific questions regarding fluids. I recommend either moving this to the end after the stronger connections have been made and/or providing more information to justify its placement.

Minor comments/typos

L 166: “fault strength **and** mineral stability, and **are** ...”

L171 fix “provide can capture”

L 174: perhaps change to primary slip zone?

For editor only

I suggest minor revisions for this opinion article.

Reviewer 2 Comments (Round 2)

For author and editor

The authors have addressed my comments and I recommend publication.