Solid Earth Discussions

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Comment on se-2021-54

Anonymous Referee #2

Referee comment on "Deformation-enhanced diagenesis and bacterial proliferation in the Nankai accretionary prism" by Vincent Famin et al., Solid Earth Discuss., https://doi.org/10.5194/se-2021-54-RC2, 2021

Overall quality

The authors link diagenetic reactions to microbial activity in deformation structures and suggest that these processes may play a role in large-scale faulting at subduction zones. In particular, they suggest that deformation enhances microbial activity and that this might localize illitization and supply fluids to major faults in accretionary wedges. This model provides an alternative to shear heating as the primary mechanism to account for illitization.

The work presented here is very detailed and the findings are thought provoking. The issue of fluid budgets and sources/sinks in accretionary wedges remains a critical line of research. The suggestion of what might be described as a coupled biogenic-kinematic mechanism to liberate fluids in a somewhat distributed manner is a nice alternative to shear heating to account for illite crystallinity observations adjacent to more mature fault zones in the wedge. It adds important constraints to the way we view cause and effect in these settings. I find the work to be a helpful contribution.

Specific comments

The finding presented are quite compelling. The changes in chemistry and mineralogy between mm-scale deformation structures and matrix are suggestive of fundamental processes that seem to link biology and strain localization. The number of samples that have provided the key findings is very limited, reflecting the exacting work and the very small supply of core material. A broader discussion of the context would highlight additional implications that might be worthwhile to motivate work aimed at reproducing the findings and scaling up the applicability. A couple are presented here for consideration.

- Site C0001 is in the footwall of a megasplay fault that is crosscut by a slope basin or mass-transport deposit. It is also in the hangingwall of other out-of-sequence thrust faults. The structural setting of the 3.5-5.5 Ma sediments examined could be mechanically connected to either or both of these structures, but the constraints provided in the manuscript suggest that the structures were formed prior to the emplacement of these faults. Is the timing well constrained?
- If the dewatering is exclusively burial-related (consistent with the fact that the shear zones record normal motion), the link to more mature faults is more of a stretch. Is it possible that the structures are synchronous with the nearby out-of-sequence thrusts?

These overarching questions connect to the implications that start on Line 328, specifically the potential relation between structures of the kind the authors nicely characterize and larger faults. The timing questions are thus critical. Given how much interest there is on accretionary prisms, and on the spectrum of time scales over which seismic energy is released, the following specific questions might be worth consideration. For example, if the dewatering structures are tectonic (not simply products of burial) over what timeframes can the authors bracket them to have been active? Are they "one-time" features related to a single seismic event on the megathrust or the more proximal megasplays? Alternatively, are they formed over many seismic cycles, or perhaps even during the inter-seismic phase as fault zone coupling evolves? Are they crosscut by structures with known kinematics that help narrow the timing? Some of the structures are themselves normal sense shear zones. I realize that these questions are challenging. I ask because I wonder whether the fluids produced by the processes described might have been supplied to structures up dip, down dip or even along strike? If these structures immediately precede the development of throughgoing faults, do they shed light on process-zone evolution? If they are coeval with throughgoing faults, do they help us understand feedbacks between damage zones and faults? An entirely different implication/question: could these structures be signatures of aseismic processes such as tremor?

These questions require timing constraints that are very difficult, if not impossible. Given that the "plumbing of accretionary prisms" remains a hot topic, as the authors rightly note, providing the larger context would elevate the significance of the findings, motivating additional innovative work of this sort. In the Discussion section, the authors agree with prior work that these deformation structures are in effect byproducts of dewatering. Is it possible that volume fluxes can be estimated so that we have a better sense of the scale? Getting word out about the findings strikes me as important because as more core from similar settings is collected, the community might prioritize this kind of work so that we can begin evaluating the true scales over which these processes operate. The potential feedbacks between biogenic and tectonic processes are quite provocative. If the structures are well constrained to pre-date the megasplays, then the implications for fault evolution are more tenuous and my many questions are not so helpful.

Technical corrections

Line 157: “Petrographic” might be more appropriate than “Petrologic” here given that much of what follows is derived from thin-section work it seems.

Line 265: The topic has received “much attention.” This might be crisper than “a large attention…”

Line 339: The sentence that starts “This dual biogenic...” is confusing.