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Interactive comment on "Squirt flow due to interfacial water films in hydrate bearing sediments" *by* Kathleen Sell et al.

Anonymous Referee #2

Received and published: 20 November 2017

Dear authors,

I found your paper intriguing and comprehensive; in my understanding, you provide previously published observational evidence from x-ray tomography to support the claim that a thin water film around sand grains embedded in a gas hydrate matrix is a good conceptual model that captures the high attenuation observed in gas hydrate systems.

I believe that the general scope of your paper deserves some attention as squirt flow in hydrates is only recently being considered as the responsible mechanism and Marin-Moreno et al. (2017) is potentially too confusing for scientists to use as it considers the overlap of many mechanisms. So there is definitely a gap in the literature for simple, usable models of the squirt flow of GH and I think your paper is a step towards the right direction. I do however think that the presentation of your work does not do the ideas

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justice and as a result lessens the potential significance it may have. Below are some of my most serious concerns:

1. I am not entirely familiar with imaging techniques when applied to hydrates so I am not aware how the conceptualisation of your model is affected by the imaging. I realise the experimental imaging results are presented elsewhere but I would still like to see a convincing argument about how the thin water film surrounding a quartz grain within a hydrate is indeed a physically plausible configuration rather than an imaging artifact

2. Your single circular grain model presented in Figure 7 is the exact same model proposed by White, J. (1975) which you cite in passing in your introduction. The only difference here is that your sand grain is in place of a second fluid in White's model. This is nowhere mentioned and I firmly believe it should be

3. You claim to numerically solve (1), (2) but you show no meshing and mention no restrictions on your domains (is the circular sand grain obeying a free BC, is it fixed etc?)

4. As I mentioned earlier in comment 2 this model is exactly the same as White's model which has an exact analytic solution. Why does your model of figures 7,14 not have an analytic solution despite the simple domain and, if it does, why are we not seeing it - it is so much easier for someone to replicate your work if they have a formula to use. Does your model agree with White's model if his second fluid becomes really stiff (to the limit of a sand grain)?

5. Although these may be commonplace for people familiar with squirt flow, how do you define "mesoscopic" as a scale here? What are the domains and boundary conditions that go into solving your equations? How does the relative rather than absolute scaling affect the behaviour of your attenuation curves ? What I mean here is that if you fixed the GH square in model 7 to have side = 1 you could see the affect of relative saturation of GH and water rather than inserting absolute values. This would be much more illuminating than your figure 8. This problem is also present when you discuss

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water bridges and your model demonstrates a second peak in the attenuation curves but the reader is left wondering how(if?) does this peak move when the bridge gets longer. There is significant mathematical rigour that is missing from your work which is not in itself always a bad thing but this impedes the impact and significance it may have.

6. You mention shear dispersion in passing indicating that you have numerically calculated it ("it can be calculated in a similar manner simply by changing the boundary conditions") - is the shear dispersion predicted by this model in any way realistic? I feel that it would be beneficial for your work to show the attenuation and dispersion of shear velocity and discuss the success/limitation of your modelling strategy with respect to shear.

And some more minor comments:

-Figure 2 have some labels GH* and I have not been able to see what the * refers to -Figure 3 caption has an unrendered mu character that shows up as a box -P20L5 needs a space between "effect" and "of"

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