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Hydrology and Earth System Sciences Discussions

Interactive comment on "The potential for material processing in hydrological systems – a novel classification approach" *by* C. E. Oldham et al.

Anonymous Referee #2

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Let me start this review by saying that I really like what the authors are trying to do in this work. I am a huge fan and proponent of dimensional analysis and I think the more it penetrates into the way all scientists across disciplines think the better. Perhaps this comes from my traditional fluid dynamics background, where this has had enormous positive impacts. I have always found that hydrology in general could benefit from this and I see ecohydrology as a field where it might be even more important. Despite this enthusiasm though I don't think that the authors in the current manuscript achieve this goal in as effective or correct a manner as they could. I have several comments and criticisms listed below

(1) I personally do not like the current title of this work. It was not until I was immersed

in the paper that I really knew what the purpose of this paper was. Perhaps this is because I am not an ecohydrologist, but even so I think a better title, particularly so that people doing internet searches and the likes can find it, would be helpful.

(2) The notion of timescales, which is key to defining these dimensionless parameters is done in what I find to be a rather roundabout way. If one defines a clear physical system with well defined parameters from the beginning these parameters will naturally emerge from a formal Buckingham Pi theorem application or even an informal dimensional analysis. I think if all these concepts are introduced at the same time it allows for a much more natural flow, rather than introducing additional timescales later on in the paper. The discussion from 2-2.3 is fairly classical dimensional analysis of advection dispersion reaction and something I cover in my undergraduate groundwater hydrology course. The interesting and in my view novel part emerges in 2.4 with the isolation timescale. If the system as a whole were presented to include this at the beginning and then each of the timescales defined based on a conceptual picture, the flow into the discussion of the different regimes would seem more natural to me.

(3) Some of the definitions and discussions seem vague. Again a clearly defined conceptual picture of the system or type of system being studies would really help with this.

(4) The authors correctly talk about some of these parameters having a rich background in chemical engineering. These parameters have penetrated in hydrology and hydrogeology literature over the years. One of the current topics that has received a lot of attention in recent hydrogeology literature is the idea of incomplete mixing (it has been a topic of interest in many many fields and has a rich history). Some of the processes that the authors talk about and aim to delineate are in my opinion precisely that – incomplete mixing of reactants (where the incomplete mixing is forced by hydrologic conditions). I would strongly encourage the authors to look into some of the current work out there. In particular I think the works of Battiato and Tartakovsky would be useful to them (as they sime to create a similar type of delination of regimes as the

authors do, but for reactions in porous media). Additionally some of the recent works of Caroline Gramling & Charles Harvey, David Benson & Mark Meerschaert, Diogo Bolster, Olaf A Cirpka, Charles Werth, to mention a few, on incomplete mixing could be helpful in this regard.

(5) There are also limitations associated with the authors' analysis since they assume that the advection dispersion equation is the correct equation for transport. I don't personally have a problem with that, but there is a lot of evidence from field, laboratory and numerical experiments that better models exist for describing complex hydrologic systems which are heterogeneous and have not just a single characteristic time or length scale associated with each process but perhaps many. Sample models that have had some success include, but are not limited to continuous time random walks, muti-rate mass transfer, fractional dispersion equations. I don't think the authors need to change their model as I think it is fine to define regimes given a specific model, but I do believe that they should highlight that as better models emerge these regime concepts will shift depending on the specific model at hand

(6) I very much like presenting the example section as this elucidates some of the processes to a relevant and important system. However, given some of my concerns above it is not clear to me that the examples fully transmit the information desired.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 10487, 2012.