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Hydrology and Earth System Sciences Discussions

Interactive comment on "Experimental and theoretical memory diffusion of water in sand" *by* G. Iaffaldano et al.

Anonymous Referee #2

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General comments: The paper presents a model and experimental verification of a "memory model" for the diffusion of water through sand particles and natural rearrangement of sand particles as a function of time. This involves a modification of traditional Fickian laws, resulting in a model which allows representation of variables within these equations as a weighted mean of its past value. Thus it allows quantification of changes in (permeability) as a function of time. Further the model does not discriminate between processes as it utilizes changes in flux data. The arguments are clearly and adequately presented. The paper is suitable for publication and makes a nice contribution to the scientific literature.

Specific comments: This concept and derivation are useful as it is likely they have numerous "real-world" applications. As the authors point out, classic theories fail to reproduce changes in diffusivity and flux that often (always?) occur during the transport

of solutions through media. This paper does provide a way to quantify, rather than ignore, such changes.

As a reviewer, I am not particularly well-qualified to verify the authors' mathematical calculations, and must assume in this discussion that they are correct.

The experimental configuration, however, seems sound for accomplishing the desired test. From an experimental point-of-view, the observations of decreasing flux as a function of time are incredibly common and it is very likely that such observations are a result of real physical (and chemical) phenomena. I would suggest, however, that sometimes increasing flux is observed, and would query an explanation for this observation.

How do the authors think their results were influenced by non-natural repacking of sediments in comparison to natural packing of sediments? Some of these observations may be a result of a physical configuration of the sediments repacked by humans; which may or may not have direct comparison to sediments originally packed by natural sedimentological processes. This question does not have bearing on the utility of this model, since many repacked sediments are utilized in many scientific studies; but does have bearing on application to natural systems.

1333/24: authors claim this decrease in flux with time is due only to mechanical compaction. I am not certain this is true as some physico-chemical reactions on solid surfaces may also influence their observations.

In addition I observe that the authors used "water" as the solution. It is well-known that some ionic strength adjustment is generally utilized to minimize such physico-chemical changes in sediments/rocks. If DI water (distilled, de-ionized) was used, this would compound these "errors" in experiment. More detail on this could be provided and in the future I recommend an ionic strength adjustment.

It might also be that different types or sizes of particles (clays, silts, rounded v. angular)

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might behave differently, and I would be curious of the utility of the model in those scenarios. Some of these may be more or less responsive to physical v. chemical effects.

Finally, directional-dependence (anisotropy) of hydraulic properties in layered sediments is the norm, and I am curious how/if these observations and modeling might differ if sediments were packed (or collected) and placed into the cell in two different directions.

Technical comments: 1331/21: change was to were 1332/9: T is not labeled in the figure 1332/12: “after a few time” - does this mean “after a few times” or “after some time has passed”? might need better wording anyway 1335/13-22: misspellings of independent, successfully, represented 1339/10: change to “a priori”

Interactive comment on Hydrology and Earth System Sciences Discussions, 2, 1329, 2005.