Response to comments on revision 1 27 July, 2022

Mousumi Roy

I am very grateful to both Referees for the time taken to review this work and for their thoughtful and detailed comments–I gratefully acknowledge this in L454. All line numbers here and below refer to the track-changes version of the revised manuscript, where changes due to the responses below are highlighted in red.

I have also searched for and removed any remaining typos.

Referee 1

1. Your definition of Peclet numbers (eq. 8 – 10) is strange. You use a length scale l defined as the product of an advection velocity and a diffusion time t_f of channel width. Usually the Peclet number should give the ratio of an advective length scale divided by a diffusive length scale (both per time). Writing the characteristic diffusion time across a channel as $t_f = d_{channel}^2/\kappa_f$, your definition reads as $$Pe_1 = \frac{v_{channel} l}{\kappa_f} = \frac{v_{channel}^2 t_f}{\kappa_f} = \frac{v_{channel}^2 d_{channel}^2}{\kappa_f^2} = Pe_{channel}^2$$ where κ_f is the fluid diffusivity, $d_{channel}$ is the channel width and $Pe_{channel}$ is a Peclet number based on advection through the channel and diffusion across the channel. The same argument applies to your second Peclet number which seems to be the square of a Peclet number base on advection along the channels and diffusion across the grains (solid). Thus your definitions are no real Peclet numbers sensu stricto. I suggest to use alternative definitions (such as $Pe_{channel}$ above, see also definitions in my previous review) even though they may be smaller than the ones you used in the manuscript now.	Yes, I acknowledge that what I have is not strictly a Péclet number for the channel (your $Pe_{channel}$). Since the fluid diffusivity (your κf, my λ_f/c_f in Eqns 1 and 2) is a parameter governs conduction within the channel material, it is proper to define $Pe_{channel}$, as you have, for the axial (along-transport direction). However, what I really want is to represent the key role played in the model by the heat transfer between channels and surroundings, namely the heat transfer that is represented by *K*, the heat transfer coefficient (the across-channel heat transfer). This is why I used a length scale given by velocity/K_f (or K_s). This is also why I always refer to my Péclet number definitions as "effective" Péclet numbers (L XX). Importantly, this allows me to involve a combination of material parameters, from both within and outside the channels. I have decided to keep the definitions as they are, but I now explicitly state my thinking in using such a definition and I also acknowledge your argument that these are not the same as $Pe_{channel}$. This way, the reader is made aware of the unconventional definition and the ideas behind it. Lines 228-233.
2. Line 222: Missing ")"	Thank you for catching this – fixed.

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Referee 2

1. Explanation of model, especially relating to the heat transfer and channel spacing: I want to return to this issue as I think could be more clearly described. In the full physical system, heat will be transferred by advection and diffusion (and latent heat, if there were phase change). The diffusion will occur both in the vertical (along channel) and horizontal directions (across channel, from the hot channel into the colder surrounding rock). In revision, an extra term was added to equations (1) and (2), representing vertical diffusion. This is absolutely fine. However, generally you expect horizontal diffusion to be much more important than vertical diffusion (because the horizontal length scale is smaller than the vertical scale). In a 1D (vertical) model, you cannot represent horizontal diffusion explicitly. Instead, in this type of model, the effect of horizontal diffusion is represented by the heat transfer term involving K.	You raise a very good point – it is something I struggled with, since the heat transfer coefficient and its meaning are discussed below the first, general, sketch of the model.
I think that the text of the paper should make it much clearer that this term involving K arises from horizontal diffusion. At present, the first paragraph explaining K (starting L132) emphasizes that K is a proxy for the geometry of the channel wall interface. The block of text added starting on L173 starts to address the crucial issues. Based on dimensional and physical arguments, you would expect that the timescale of heat transfer to be proportional to the square of a boundary layer dimension (since thermal diffusivity has units length^2/time). Then you assume (on the grounds explained around L180), that the boundary layer dimension is proportional to d, which gives you essentially equation (4). So I would recommend rewriting L132–183 to start with the essential physics (horizontal diffusion) and assumptions first, before moving on to the details are the channel geometry. I would try to limit switching between K, $K_{f,s}$ (which have different units to K, something I found confusing at first, and would ideally be avoided), and C_{eff} as far as possible.	I have now followed your suggestion and discussed this idea of a heat transfer coefficient that is a proxy for the horizontal diffusion you mention. To be general, however, I refer to it as diffusion perpendicular to the transport direction in this 1D model. L133-152.
L119 was also quite confusing in that it talked about diffusion being ignored and used the symbols $D_{f,s}$ which don't seem to appear elsewhere.	Yes, this is a good point – it was confusing as D_f and D_s are defined later… I have removed the reference to these, but explained what I mean by diffusion terms, in L120-121
2. Thermal reworking zone width scaling: the expression given on L14, added in revision, is dimensionally inconsistent. The RHS doesn't have the same units as the LHS. I do not think the final result should be expressed with a term like $(\tau/d)^n$, given that τ/d is not dimensionless. Ideally, you want expressions like equation (14), where a dimensionless quantity is raised to some power. In the main results section, around L318, you have $\delta \sim \tau^n$, which doesn't have any dependence on d. But then the abstract (L14) and conclusion (L397) give a proportionality d^{-n}. It would be good	The idea of mentioning how the width δ of the TRZ depends on τ (timescale) and *d* (channel spacing) as a scaling relation is in the same spirit as saying "the mass of an object scales with a linear dimension, r^3". Or, to use an example from biology, we might say that the "metabolic rate scales as $(\text{mass})^{\beta}$". There is an implied prefactor that makes the corresponding equation dimensionally correct. Therefore, I don't agree that all scaling should only be expressed in dimensionless groupings.

to explain the dependence on d and to try to write the final result in dimensionally consistent groupings.	I do agree, however, that this may be confusing to some readers. I have now explicitly stated what I mean: that δ is found to be "proportional to" the various combination of parameters; L14, 315-316, 333, 412.

TECHNICAL CORRECTIONS

3. L14: n ≈ 2 (remove word 'is').	Thanks for catching this – done.
4. around L86: I would say that a key limitation of this type of study is that the channel properties are imposed, rather than emergent dynamically. This simplification is well described later in the paper, but probably should be mentioned somewhere in the introduction more explicitly.	This is a good point and is now spelled out in L 70-75
5. L110: perhaps should define x (particularly as x is often used a horizontal coordinate) and t.	OK – now added; L 115
6. L202: perhaps avoid extra spaces in, e.g., T'_f.	Yes, thank you for catching this typo – now fixed, throughout.
7. L207: I'm not entirely sure what ζ means (in particular, it is not entirely clear how it has been defined. Perhaps give a formula. I also think the choice of notation is a bit unusual.	The quantity ζ is a weighted heat capacitance ratio (its definition and formula are given on line 209-210). The notation was modified after comments by R2 on the first version of this paper – it used to be *z*, which was deemed inappropriate as resembled a vertical coordinate.
8. L281: missing space before 'years.' (I noticed some other examples of this too.)	Fixed.
9. Table 1: missing link to appendix.	Fixed; it now links to the section on the heat transfer coefficicent, 2.1