

Interactive comment on “Characterization of groundwater dynamics in landslides in varved clays” by J. E. van der Spek et al.

Anonymous Referee #1

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This review is based on my reading of the manuscript of the Discussion Paper only. I have not looked at any other discussion comments that may have been posted.

General comments.

This paper examines a generally uncommon but locally important hydrological mechanism that is considered to have a direct influence on stability conditions within pre-existing landslides in the French Alps. Groundwater in varved clays associated with landsliding has received little attention previously, with most of that attention coming from this research group. As such, based on this previous work, the present paper develops a simple model of the hydrological system of interest which directly addresses the hydrological controls on landslide activity. Therefore the paper clearly falls within the scope of this journal. The conceptualisation of the system and its mathematical rep-

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resentation appear to be sensible and the approach to the modelling of a generalised landslide fissure system appears logical and appropriate given the relative scarcity of field data that can be used for validation purposes. The paper is generally well-written in terms of organisation and clear, concise text.

Specific comments.

Generally, the paper is sound. There are just a few details that require attention.

1. The text is perhaps a little too concise in some respects. For example, there is little indication of scale for the reader to understand the nature of the system. How thick are the silt lenses, and how thick are the clay layers that separate them? How large are the landslides (length? typical width?) and how are the major fissures aligned with respect to the geometry of the landslide and its slope context? How steep are the slopes, and is there any possibility that surface runoff from large rainfall events may contribute directly to the water in the fissures?

2. The main problem is the lack of clarity regarding the connections between fissures that permit downslope drainage, and how these connections relate to the shear surface. Indeed, the precise mechanism by which the pore water pressures at the shear surface between fissures are being affected by the changing head in the fissures. Are the shear surfaces all contained within clay layers, and if so, how easily/quickly can water penetrate along the shear surface from the base of a fissure? The paper refers to 'infiltration from fissures at the level of the slip surface', but this phrase implies infiltration into a layer of material rather than possible preferential seepage into and along the weakness that is the shear surface. The effectiveness of the changing head conditions within the fissures for driving the reactivation of movement will depend on the mechanism by which the effect(s) of those conditions are transmitted to the failure surface.

3. It is difficult to evaluate the results because of the design of some Figures and their captions. In this section, Figure 6 needs attention: the columns should be identified as (a), (b) and (c), and so the 'measured' lines in (c) (middle) and (c) (bottom) need to be

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shown as broken lines (dark blue and black lines of the same thickness are effectively indistinguishable). If there are no measured data at all, do you need this item in the legend? Figure 5 also needs attention: what is each part showing? A cross-section or a plan? If a cross-section, is the x-direction aligned across the slope or parallel to the slope? How do these plans/sections relate to fissures? Any fissures relating to any of these diagrams need to be clearly identified.

Technical corrections.

page 296, line 26 – Malet et al 2005 is not listed in the reference list

page 297, line 9 – rephrase ‘is considered as sliding’ – suggest something like ‘is considered to be unstable’

page 297, line 10 – what is the level of risk that velocities may suddenly increase?

page 297, line 20 – van Asch et al 1996

page 297, line 24 – ‘these dynamics’ not ‘the dynamics’

page 297, line 25 – rewrite: ‘ments. The approach presented is applied ...’

page 297, line 25 – I don’t think ‘pressure propagation in varved clays’ is the appropriate way of describing the work

page 297, line 27 and elsewhere – ‘a conceptual hydrological model’ not ‘a hydrological conceptual model’

page 298, line 9 – ‘10 000 years ago’ or ‘10 000 y ago’, not ‘yr’

page 299, line 1 and elsewhere – check whether the journal requires American ‘meters’ or English ‘metres’ spellings?

page 299, line 8 – ‘indicated that ...’

page 299, lines 20-21 – ‘Vertical flow in the varved clays is considered negligible’ – this statement needs qualifying with respect to the presence of fissures – are you saying

that including the fissures the vertical flow is negligible? This is not clear.

page 301, line 12 – ‘Equation (1), subject to boundary conditions (2),’ – add commas

page 301, line 16 – ‘Water infiltrates in the horizontal ...’

page 300, line 17 and page 301, line 20 – the symbols probably won’t reproduce in the review text box, but it appears that two different symbols for ‘phi’ (pressure head in the silt layers) have been used, which is confusing – please check and amend as necessary

page 302, lines 20-21 – for a water balance of the fissure, surely water entering the varved clays from the fissure should be described as an ‘outflow’ from the fissure rather than an ‘inflow into the clays’?

page 305, lines 13-14 – ‘head halfway between the fissures ...’

page 306, line 11 – rewrite: ‘Data are available from four landslides in the Trieves area: La Mure ...’

page 306, line 12 – ‘The data are very scattered ...’ (not ‘is’)

page 307, line 20 – Jongmans et al – 2008 or 2009? (no 2008b in the reference list)

page 309, line 7 – cite as ‘BRGM (2011)’ – the web address is in the reference list

page 310, line 7 – van Asch et al (1996)

page 310, line 9 – ‘Third, the ...’ (delete ‘And’)

page 310, line 23 – ‘pressure propagation’ – not adequately demonstrated – see comment 2 under ‘Specific comments’ (above).

page 311, line 18 – ‘retrogressively, in an upslope direction.’

page 312, line 14 – ‘drains in the downslope ...’

page 312, lines 17-18 – ‘modelled’ (English) or ‘modeled’ (American)?

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page 313, lines 14-15 – ‘Both the width and the reservoir coefficient of a fissure ...’

page 318, Fig. 1 – either the caption or the legend needs to state that the black dots represent the landslides

page 320, Fig. 3 – identify upper graph as (a) and lower graph as (b) – also the caption is not sufficiently informative to stand alone: dynamic equilibrium of what?

page 324, Fig. 7 – what does $h = 0$ mean in this figure?

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