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# **Coevolution of relief and landslides on a volcanic landscape. The bassin of Puy-en-Velay, Massif central, France**

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# COEVOLUTION OF RELIEF AND LANDSLIDES ON A VOLCANIC LANDSCAPE\*

## The basin of Puy-en-Velay, Massif central, France



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### CONTEXT AND PHILOSOPHY OF THE RESEARCH

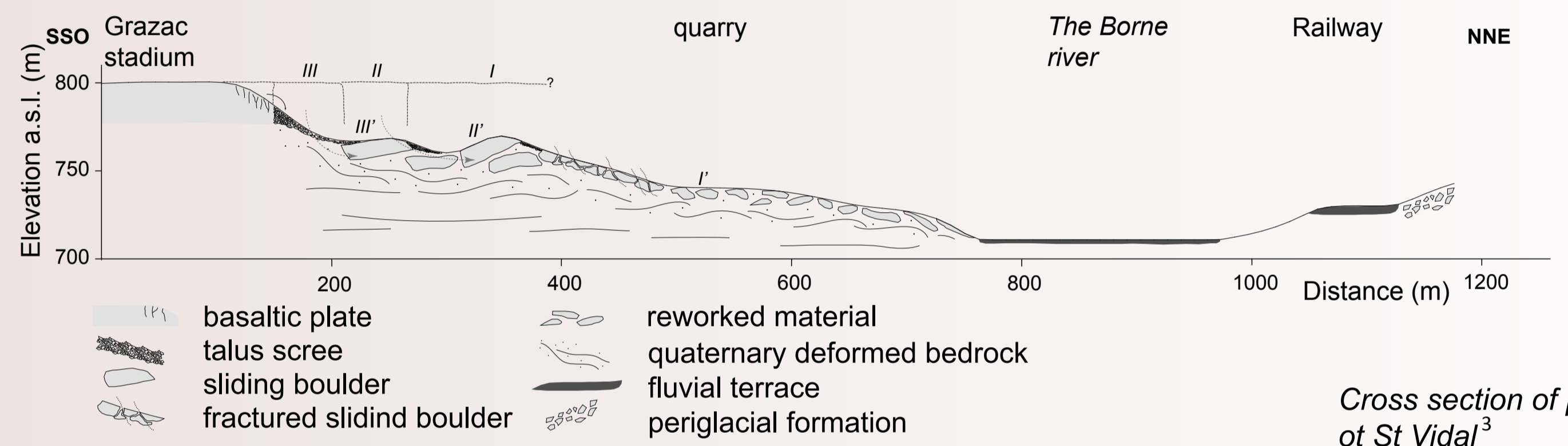
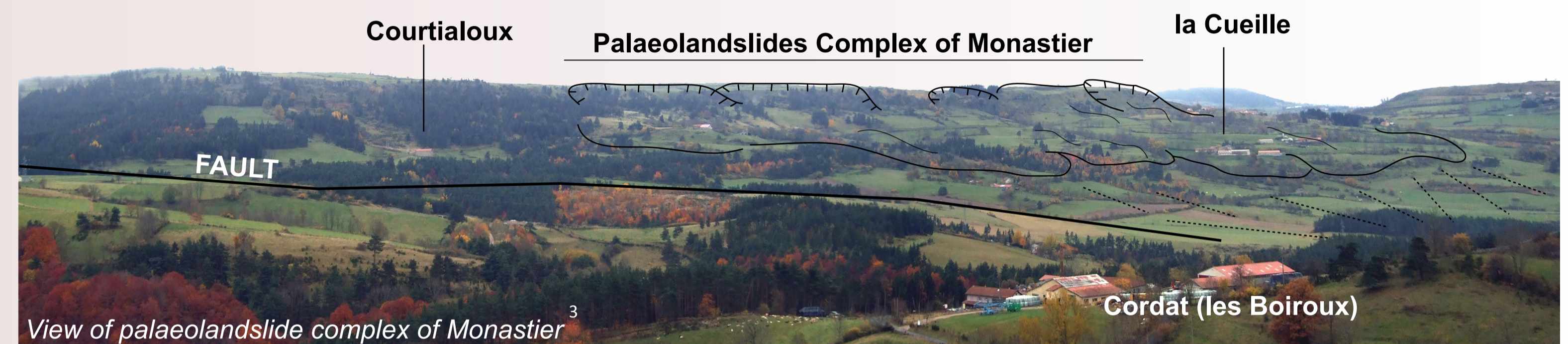
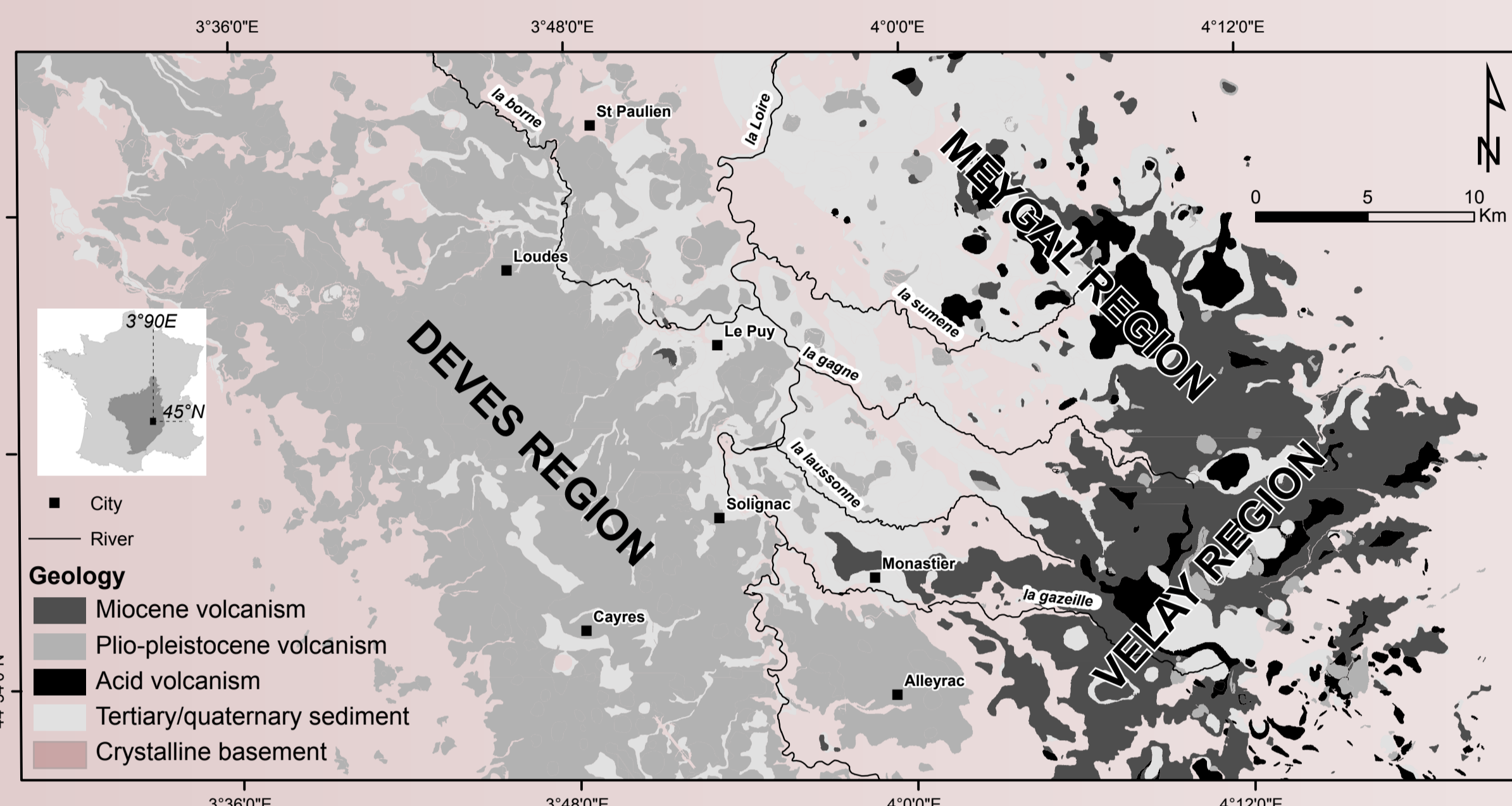
- . 20 years ago, the symposium "Morphogenic rythms in Volcanic Domain" at Clermont-Ferrand
- . PhD Thesis about the landslide hazard mapping in the basin of the Puy-en-Velay (Massif central, France)
- . Linking the temporal short scale of engineering geology with the temporal long term of relief evolution

### HOW VALLEYS AND LANDSLIDES EVOLVED TOGETHER ?

### METHODOLOGY

- . Morphometric analysis of 19 palaeolandslides
- . Morphometric analysis of 22 watersheds by mean of multivariate statistics (PCA and HAC)
- . Dating of basaltic tables as a chronological indication of the beginning of a new erosion cycle (bibliography)

### STUDY AREA AND PALAEOLANDSLIDES



Tertiary basin with sandy clay material

Two volcanic phases<sup>1</sup>:

- 1- Miocene => VELAY REGION
2. Plio-pleistocene => DEVES REGION

Rapid uplift during Pliocene with a great incision of hydrographic network<sup>2</sup>

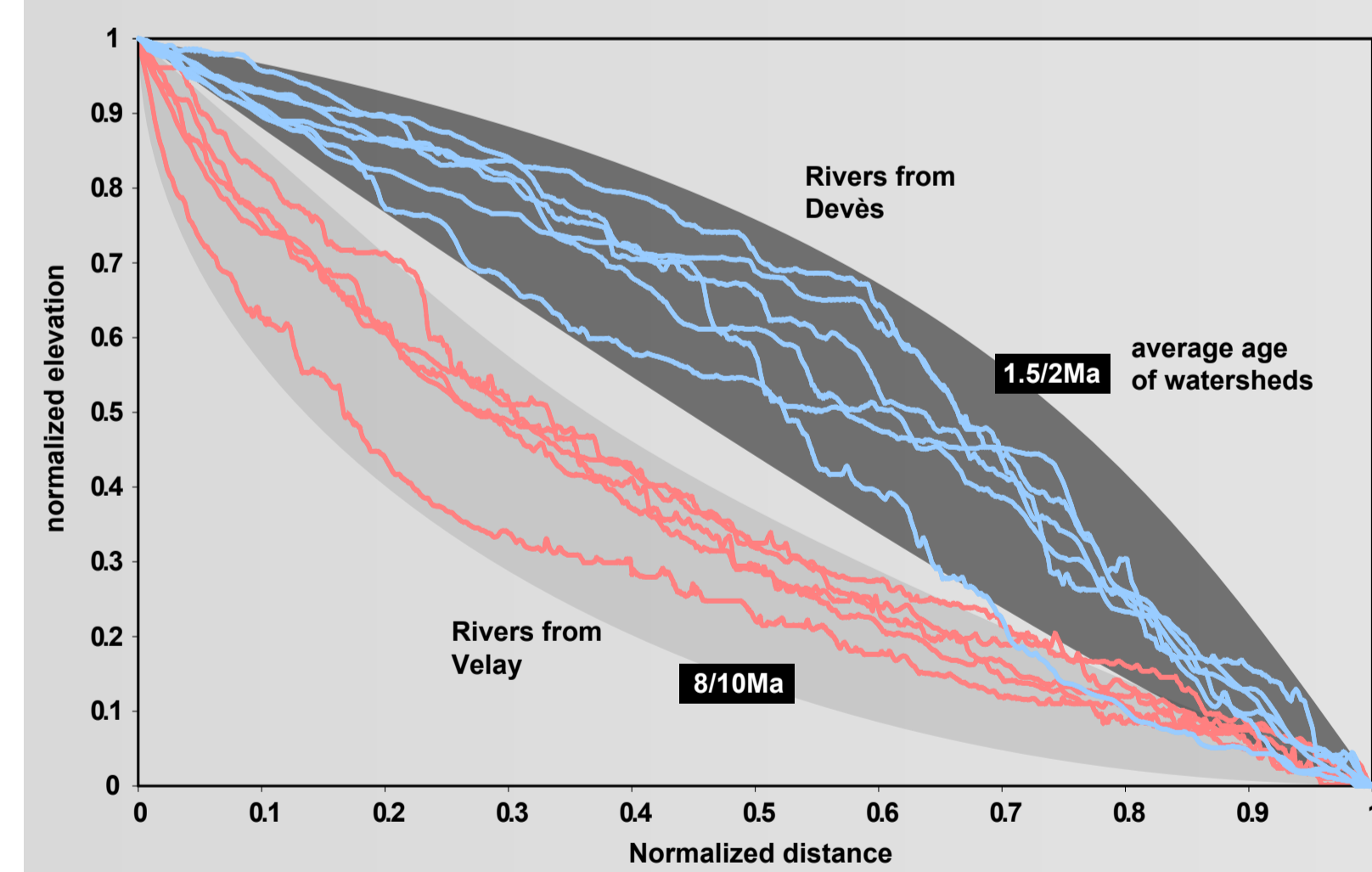
RELIEF INVERSION  
OVERSTEEPENING

HUGE COMPLEX LANDSLIDE

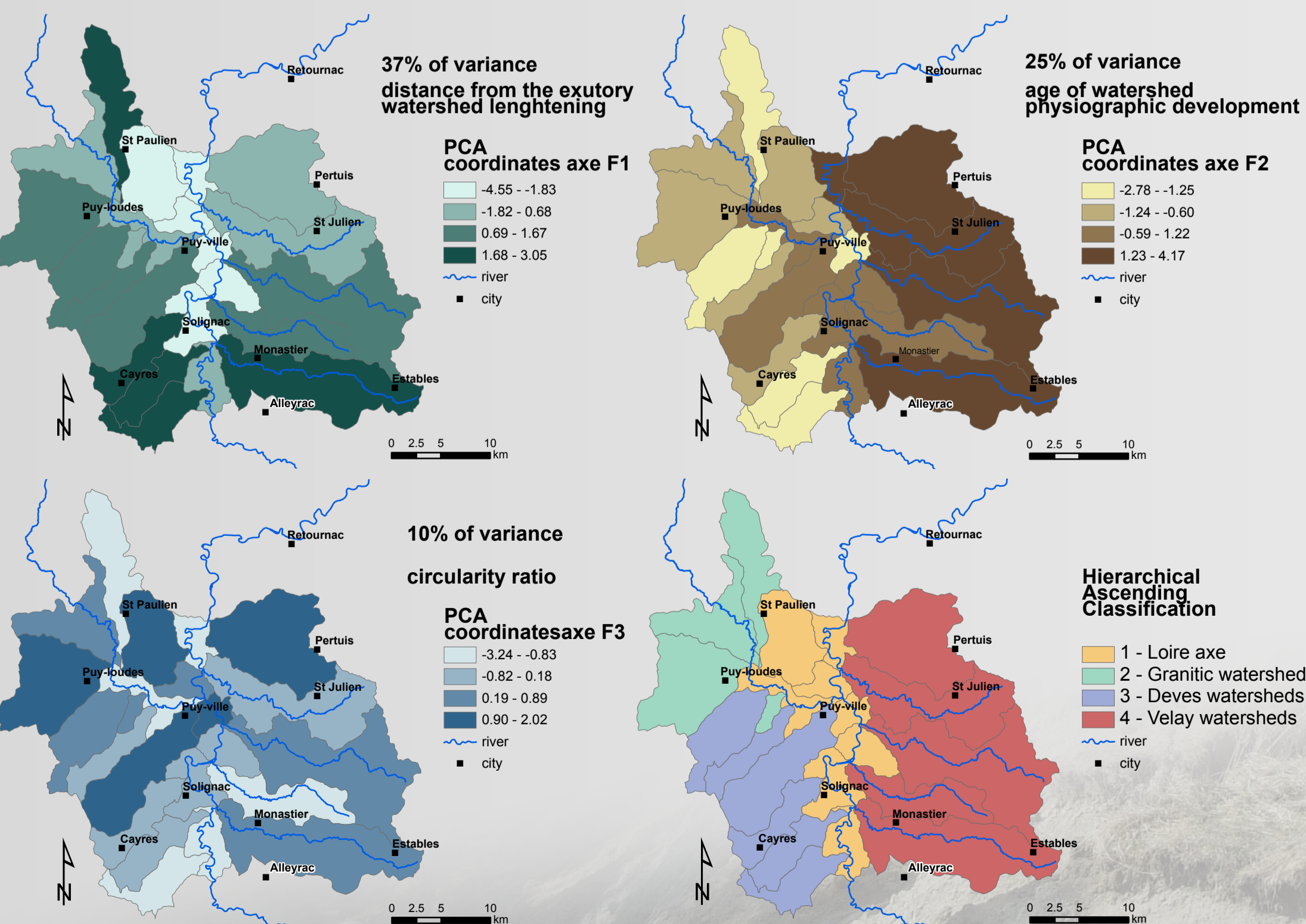
Initiation and reactivation during the Pleistocene and Holocene

### RESULTS AND INTERPRETATION

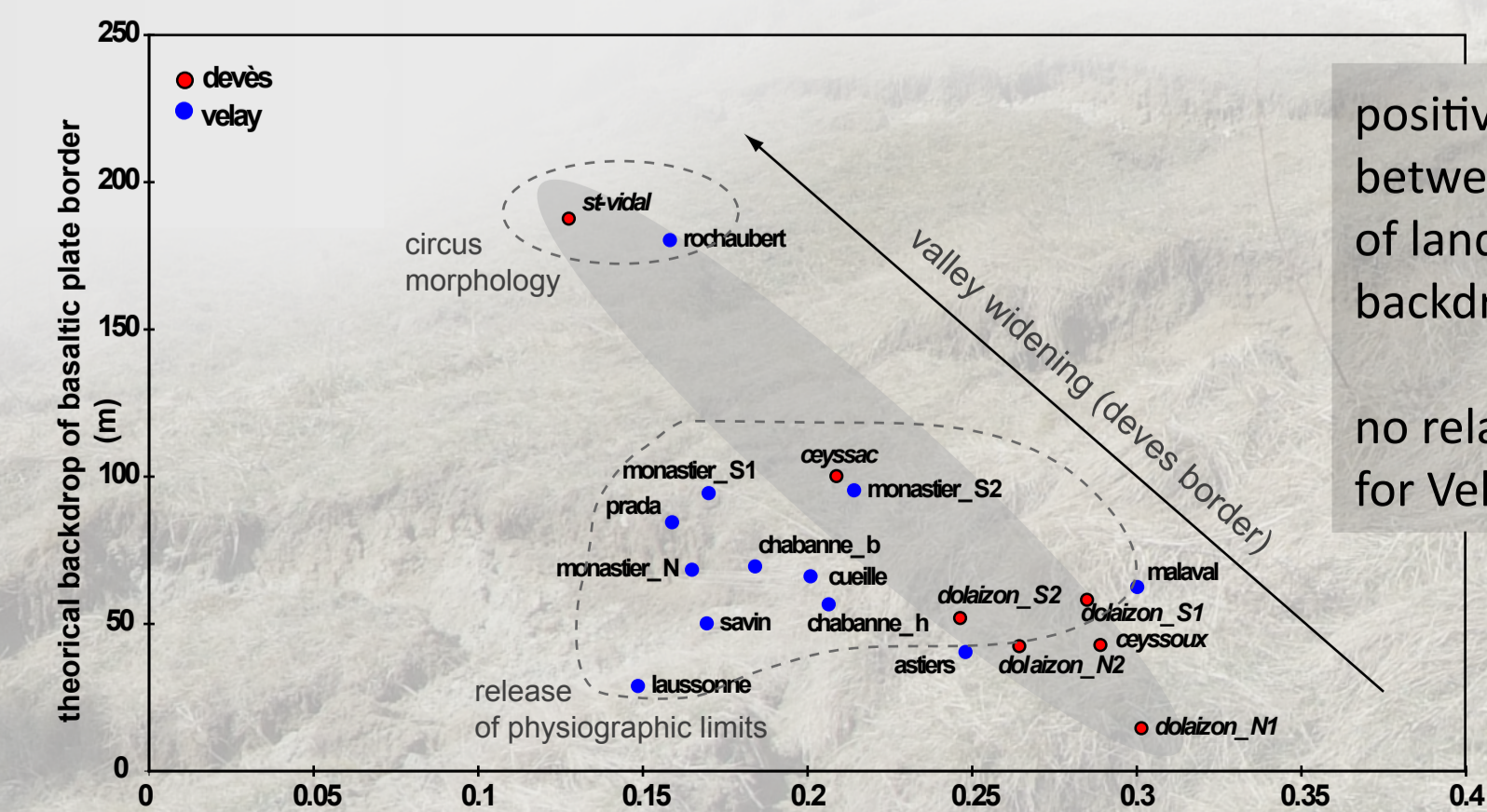
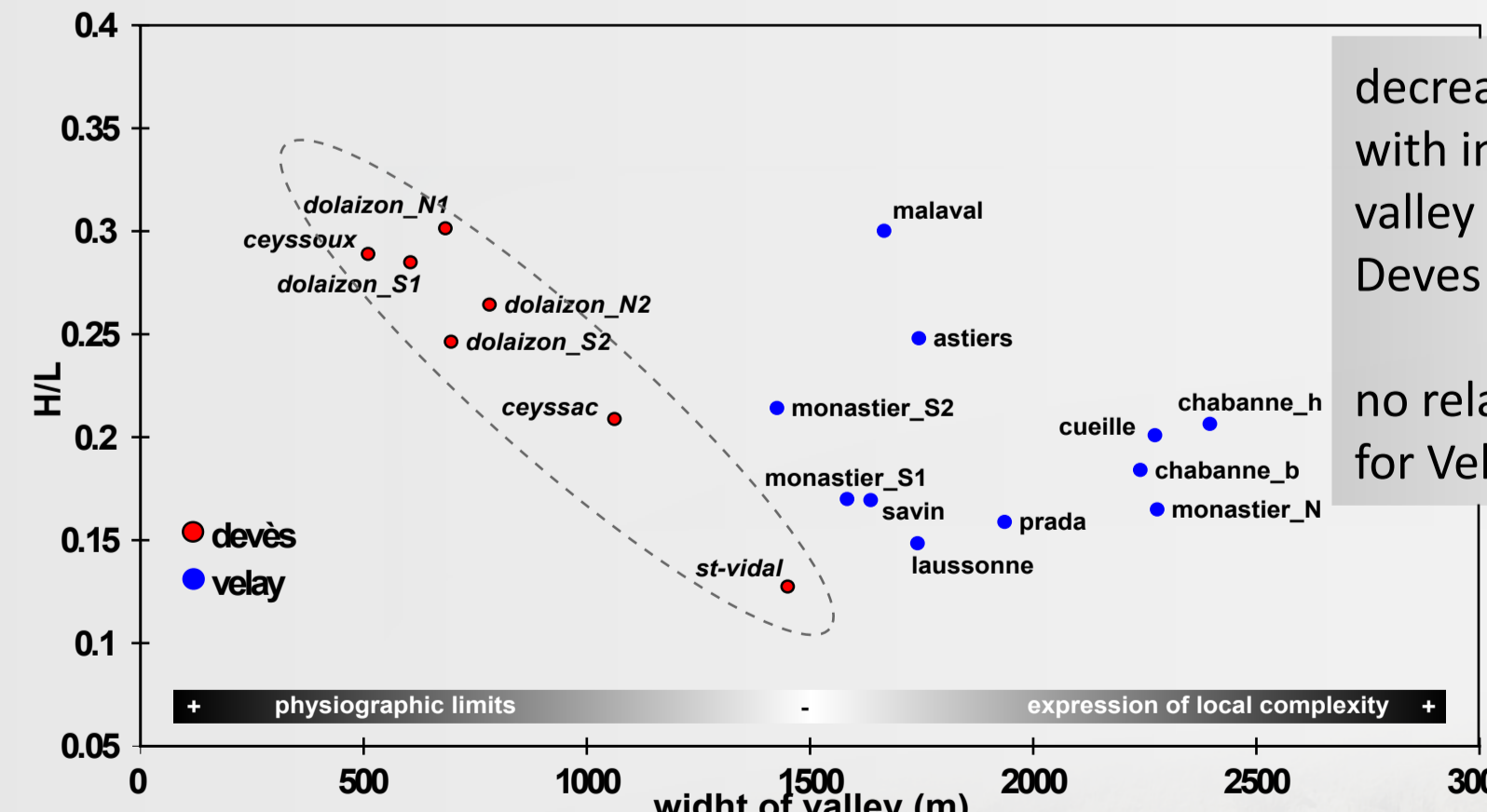
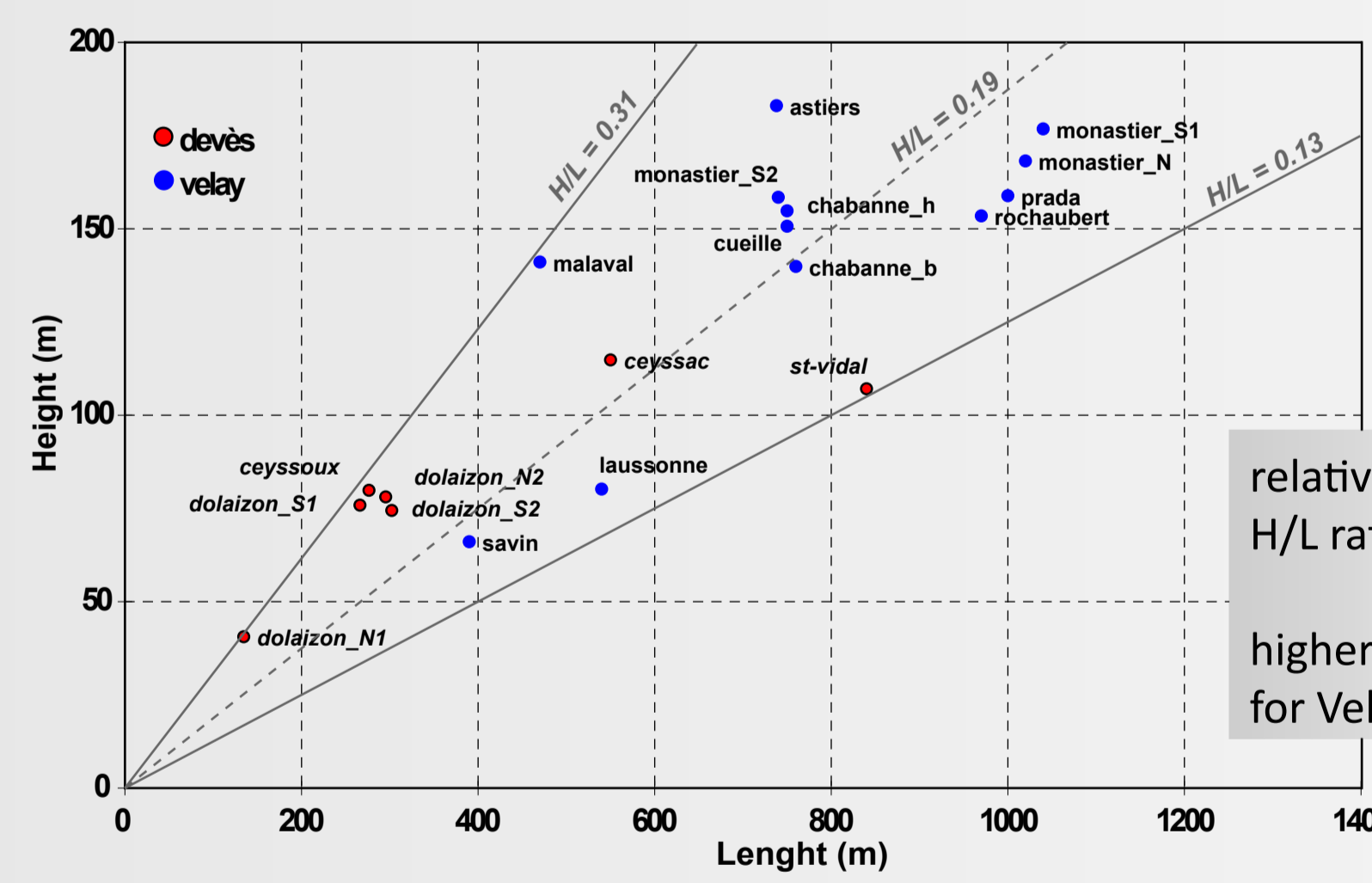
#### 1 the morphometric difference between Deves and Velay



Deves = convex profile (young watershed)  
 Velay = concave profile (mature watershed)



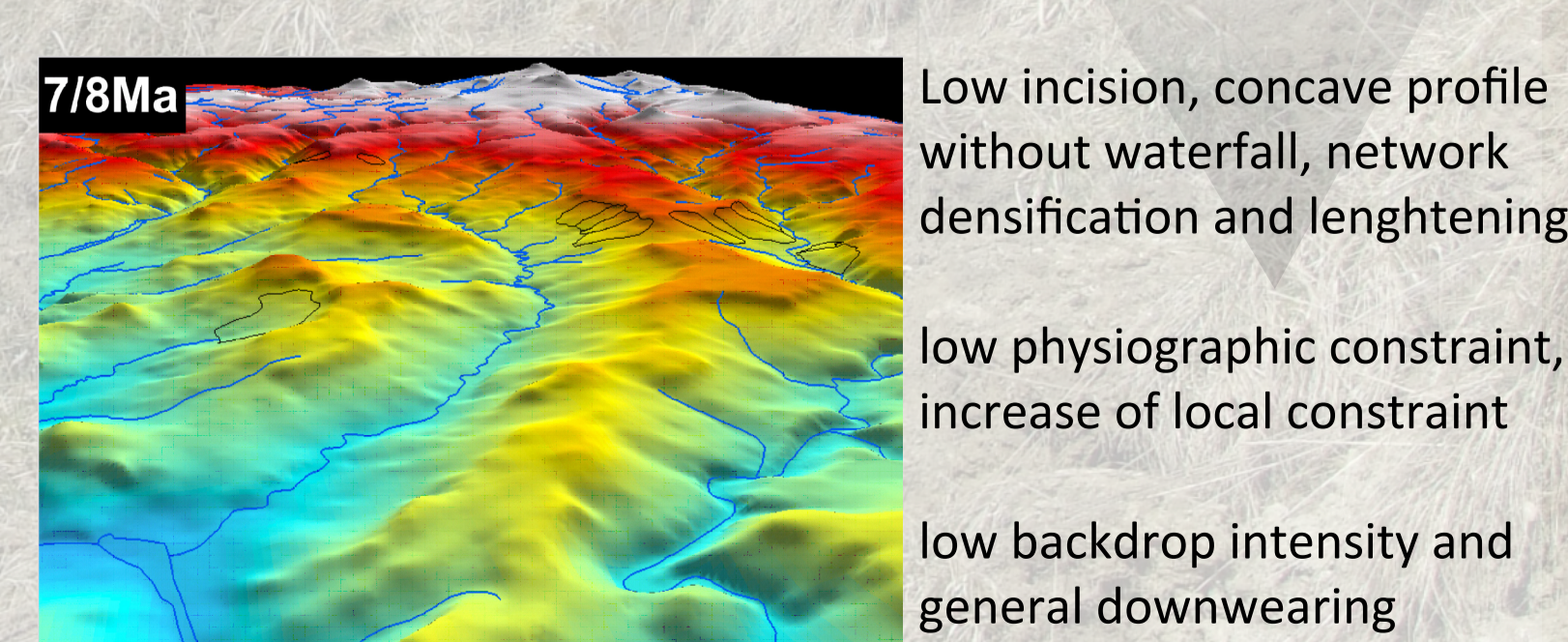
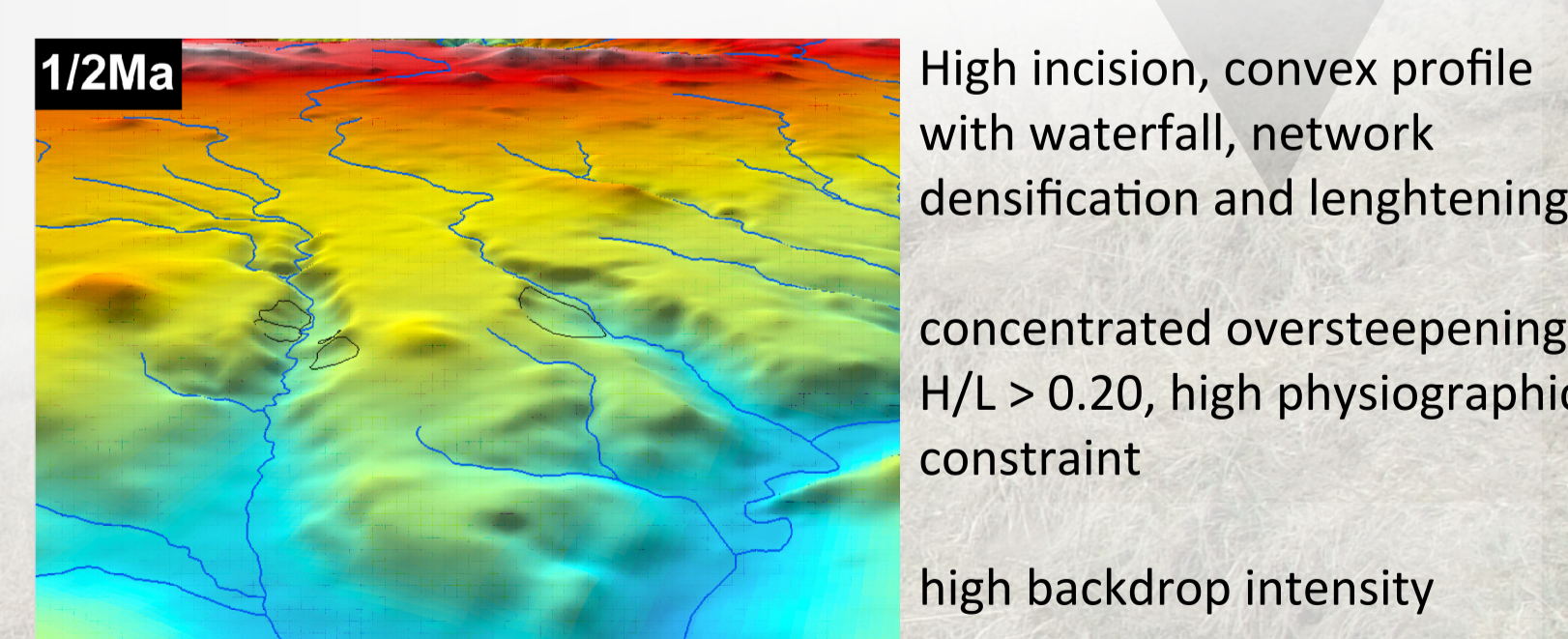
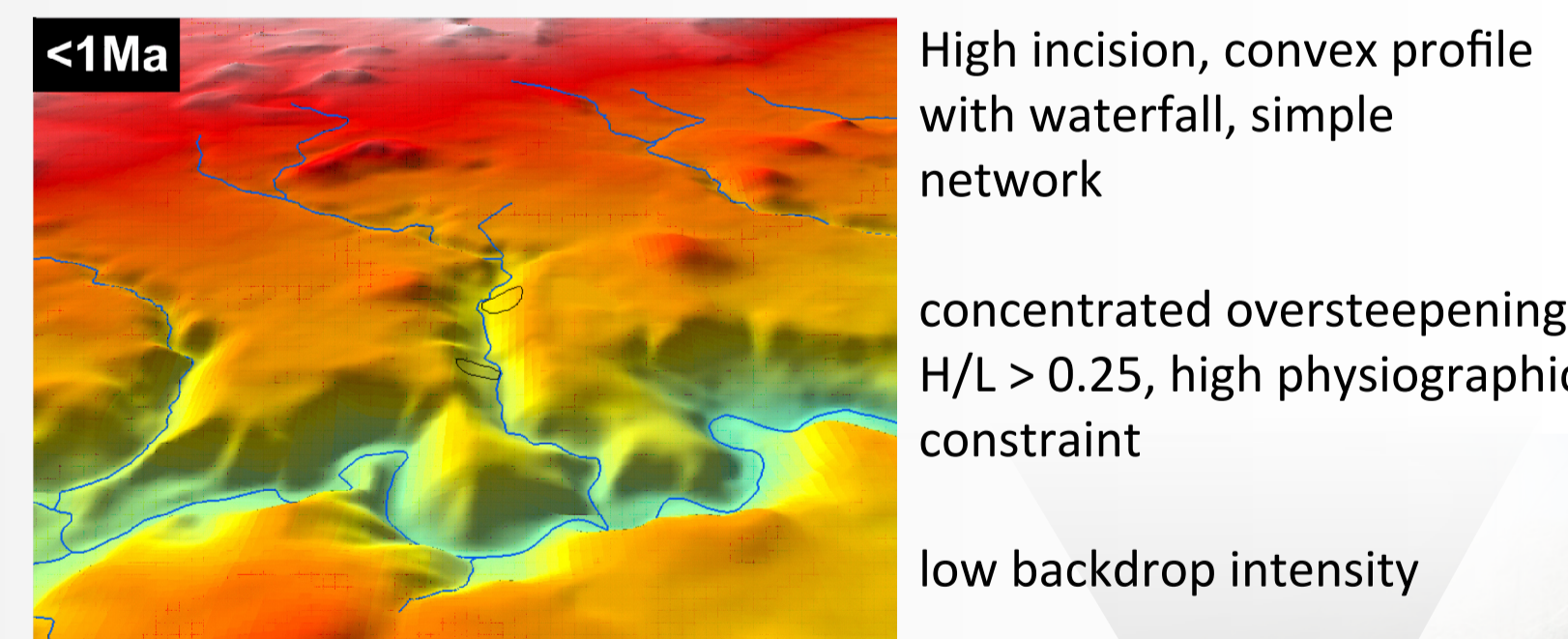
#### 2 morphometry of palaeolandslides and relationship with valley dimensions



#### 3 Interpretation and theoretical model of coevolution

Valley and landslide dimensions evolve together. When the watershed is "young" and that relief is due to a simple gorge, landslides are constrained by the limited dimensions of the valley. That is the "physiographic limit". The only way for landslide evolving is the retrogression processes witch cause the backdrop of basaltic. The H/L of landslide is so dependent of valley dimensions.

But, with the widening of valley, due to the backdrop of basaltic plate border by landsliding, the physiographic limit disappears. The geometry of landslides is then more dependent of local factors than the physiographic limits.



#### Acknowledgement

Thanks to Emmanuelle Defive for the numerous discussions we had on the topic

\* in reference to A. Jefferson, G.E. Grant, S.L. Lewis and S.T. Lancaster (2010) - Coevolution of hydrology and topography on a basalt landscape in Oregon Cascade Range, USA. *Earth Surface Processes and Landforms*, 35, 803-816

1 - Mergoil J. and Boivin P. (1993) - Le Velay, son volcanisme et les formations associées : notice à la carte au 1/100000. *Géologie de la France*, 3, 96p.

2 - Defive E. (1996) - L'encaissement du réseau hydrographique dans le bassin supérieur de la Loire - contribution à l'étude des rythmes d'évolution géomorphologique en moyenne montagne volcanisée. Thèse de doctorat, Paris I, Panthéon-Sorbonne, 551 p.

3 - Poiraud A. and Defive E. (2011) - Morphology and geomorphological significance of relict landslides in the Tertiary basin of Puy-en-Velay (Massif Central, France). *Géomorphologie : relief, processus, environnement*, 3,