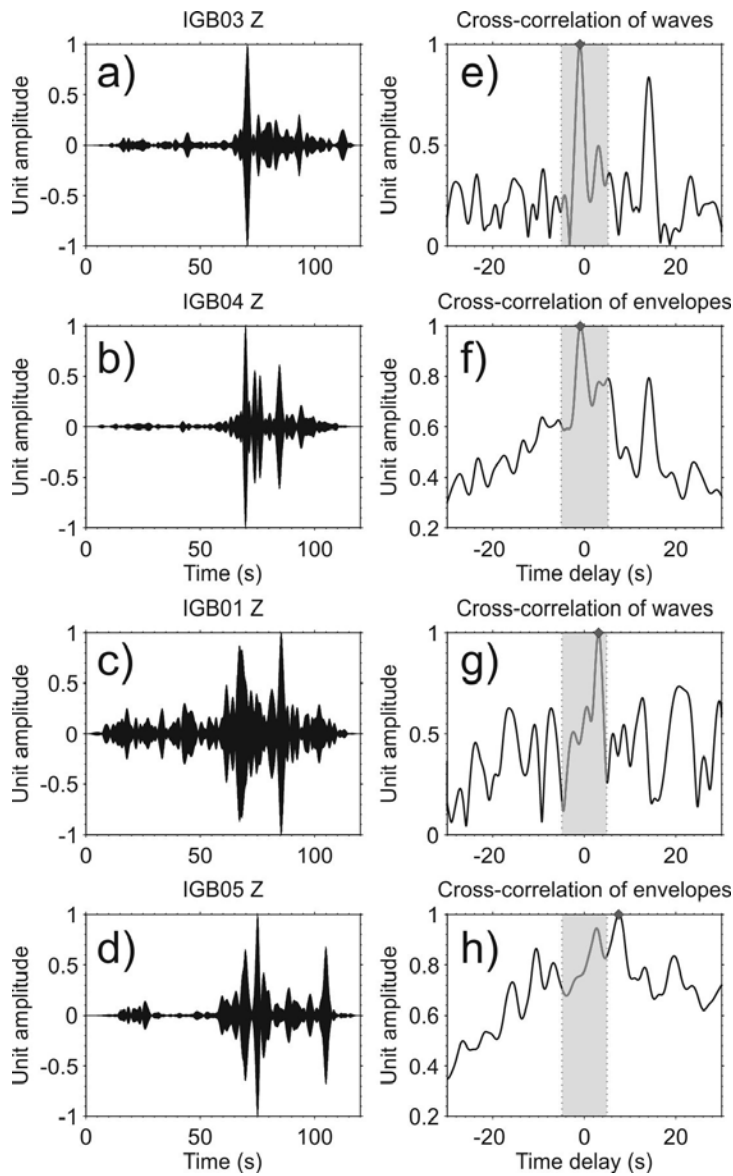


1

2

3 Figure S1. Ray path with topography in the Illgraben. Illustration of a ray path between
 4 stations IGB05 and IGB08 with (red) and without (gray) respect to the topography (black).
 5 Due to the steep relief, the difference between a realistic and a flat ray path can exceed 10%.



1

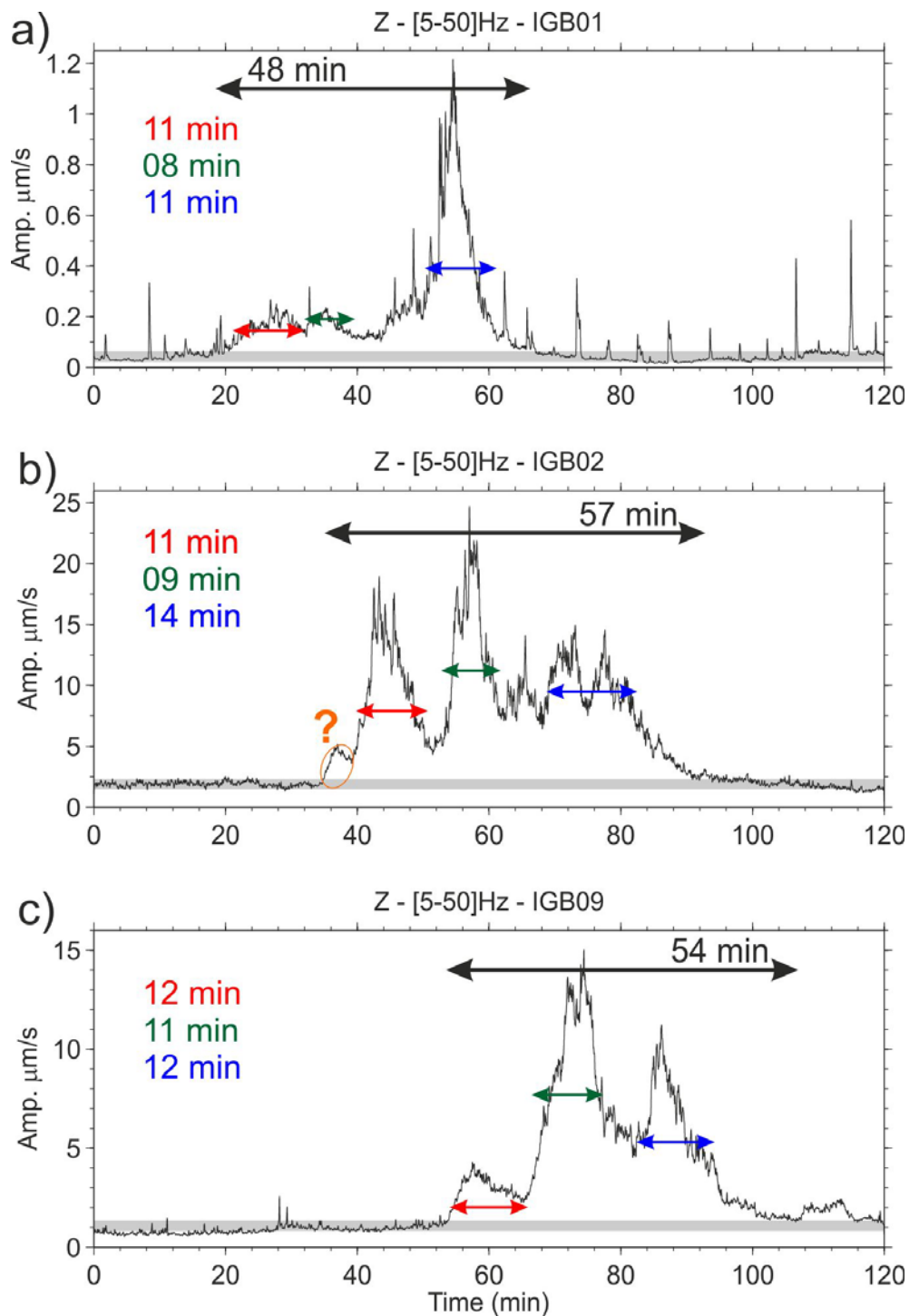
2

3 Figure S2. Difference between the cross-correlation of seismic waveforms and seismic
 4 envelopes for event “Rock 1”. Individual plots show the vertical seismic signals recorded at
 5 stations IGB03 (a), IGB04 (b), IGB01 (c) and IGB05 (d) in the [29-30] Hz frequency band,
 6 the envelope of the cross-correlation function resulting from seismic waveforms (e) and
 7 envelopes (f) at stations IGB03-IGB04 and at stations IGB01-IGB05 (g-h). The grey shaded
 8 area delineates the interval of possible dt_{obs} that takes into account the distance between
 9 stations and a ballistic velocity of 0.5 km/s. Grey diamonds mark the maximum of the
 10 envelope of the cross-correlation function, which determines the best time delay. This delay is
 11 used for the location procedure. With the use of the seismic envelopes, this peak of amplitude
 12 may not always sit within the interval of possible dt_{obs} .

	Pulse Velocity (m.s ⁻¹) at...			Seismic Energy (dB) at...		
	IGB01	IGB02	IGB09	IGB01	IGB02	IGB09
Pulse 1	∅	1.49	3.61	-97.6 ±0.5	-75.7 ±2.4	-91.4 ±3.3
Pulse 2	∅	1.07	3.17	-97.4 ±0.5	-74.0 ±2.4	-79.0 ±3.3
Pulse 3	4.45	1.13	3.43	-91.1 ±0.5	-75.1 ±2.4	-79.9 ±3.3

1

2 Table S3. Seismic metrics compiled from Figure 8. For each seismic pulse, the propagation
3 velocity in m.s⁻¹ and the seismic energy in dB are measured at stations IGB01, IGB02 and
4 IGB09, deployed along the Illgraben channel.



1
2

3 Figure S4. Vertical seismic envelopes for [5-50] Hz frequency band at IGB01 (a), IGB02 (b),
4 and IGB09 (c). The total duration of the debris-flow sequence is highlighted with a black
5 arrow. The pulses duration are represented with a red (flow 1), green (flow 2) and blue (flow
6 3) arrow. The grey line represents the background seismic noise level used to determine the
7 duration of the total flow sequence.