Combining a large, nationwide ambient noise database with morphometric analyses to map 2D resonance effects in sedimentary basins in Switzerland

Franziska Glueer[1], **Paolo Bergamo***[1], Anastasiia Shynkarenko[1], Afifa Imtiaz[1], Paulina Janusz[1], Xavier Borgeat[1], Francesco Panzera[2], and Donat Fäh[1]

[1]Swiss Seismological Service (SED), ETH Zürich, Switzerland

[2]Department of Biological, Geological and Environmental Science, University of Catania,Italy

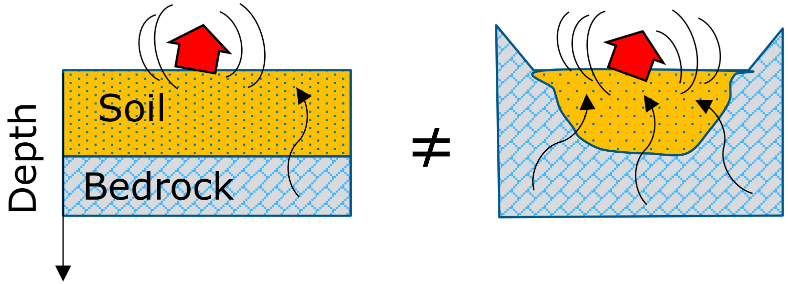
[*paolo.bergamo@sed.ethz.ch](mailto:paolo.bergamo@sed.ethz.ch)

Sharing is encouraged

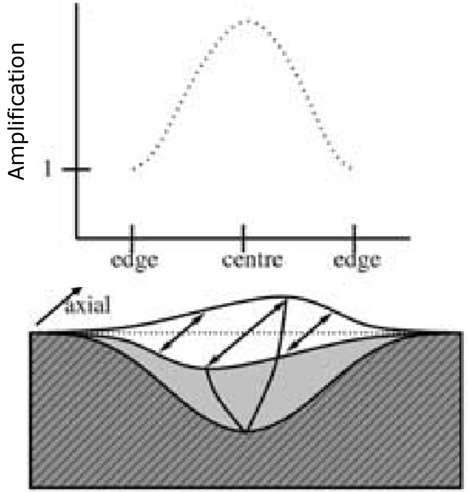
0) Motivation 1) Ambient noise DB 2) Basins’ morphometry 3) Results

Deeply-incised sedimentary basin (e.g. **Alpine valleys**) **host peculiar site-effects of ground motion:**

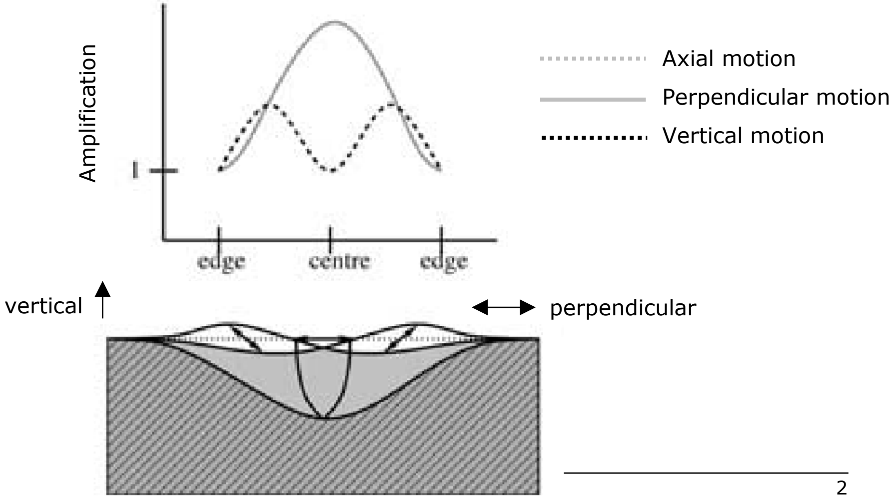
- Edge-generated surface waves
- «Trapped» seismic waves
- **2D resonance phenomena**



Anti-plane shear mode SH_{00}



In-plane shear mode SV_0



Roten et al. 2006

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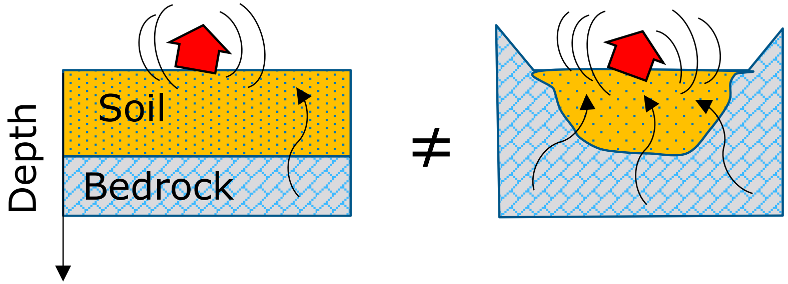

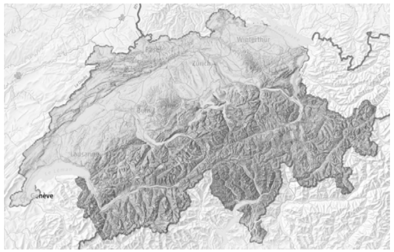

- Which valleys/basins display 1D *vs* 2D resonance regimes?
- What are the consequences for the local amplification of ground motion?

Our project: «Elastic response spectra for Alpine valleys»

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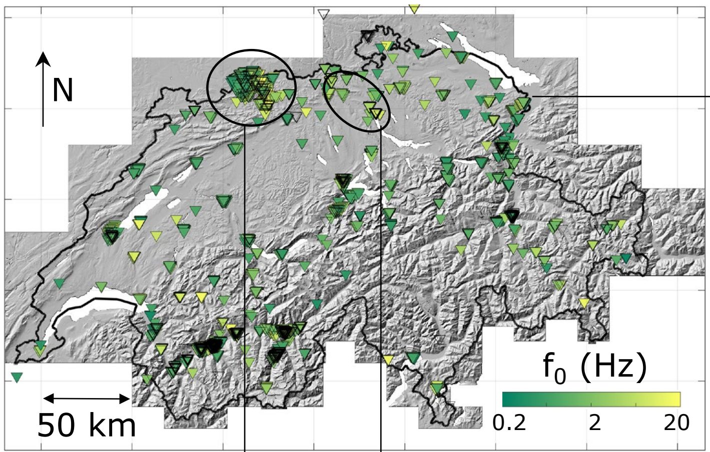
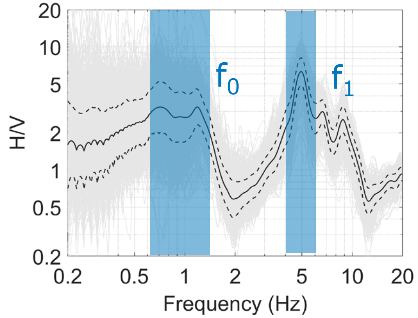
Swiss Seismological Service (SED) site characterization database



Shynkarenko et al. (2025), this session

Janusz et al. (2025), this conference

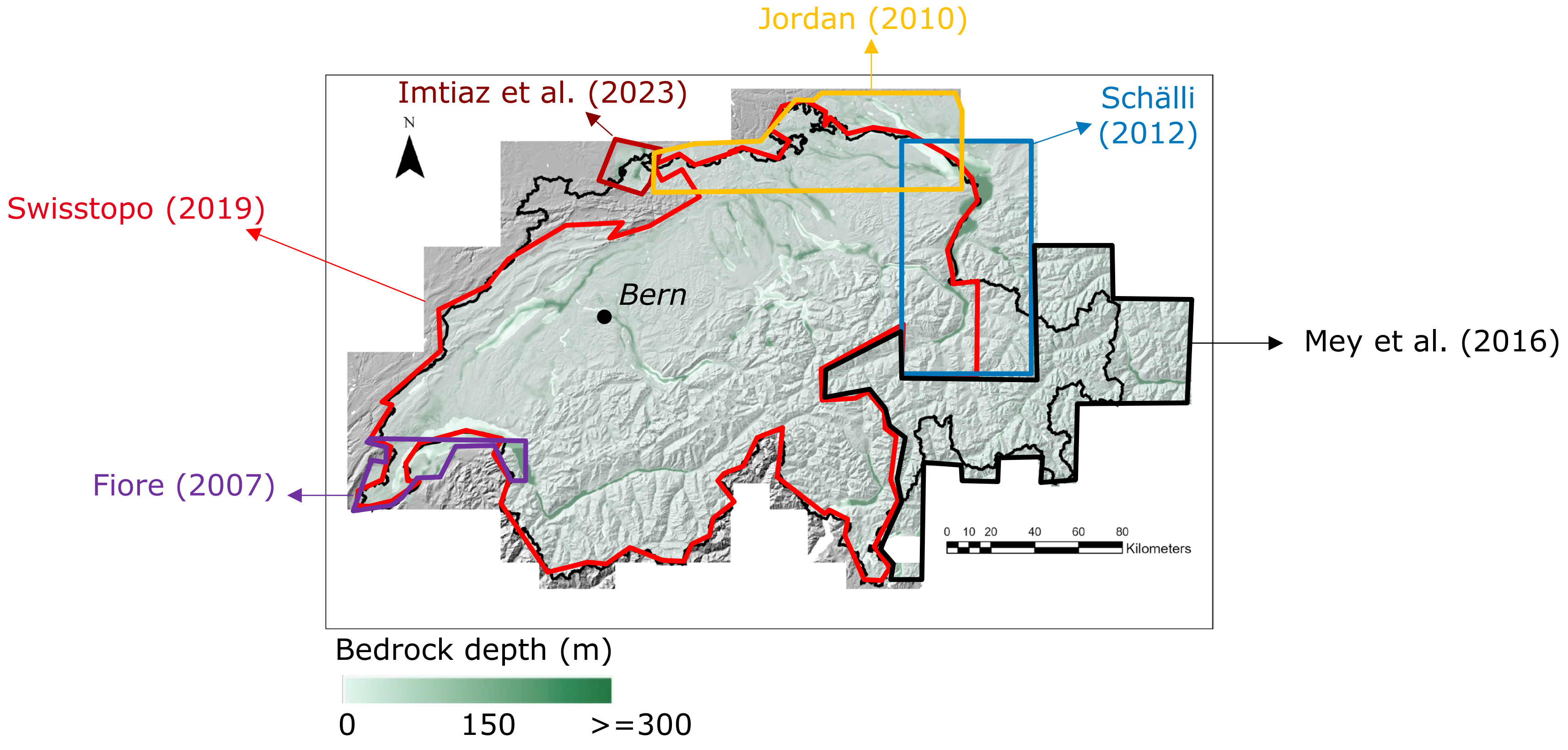
Horizontal-to-vertical spectral ratio (H/V)



f_0, f_1 = soil resonance frequencies

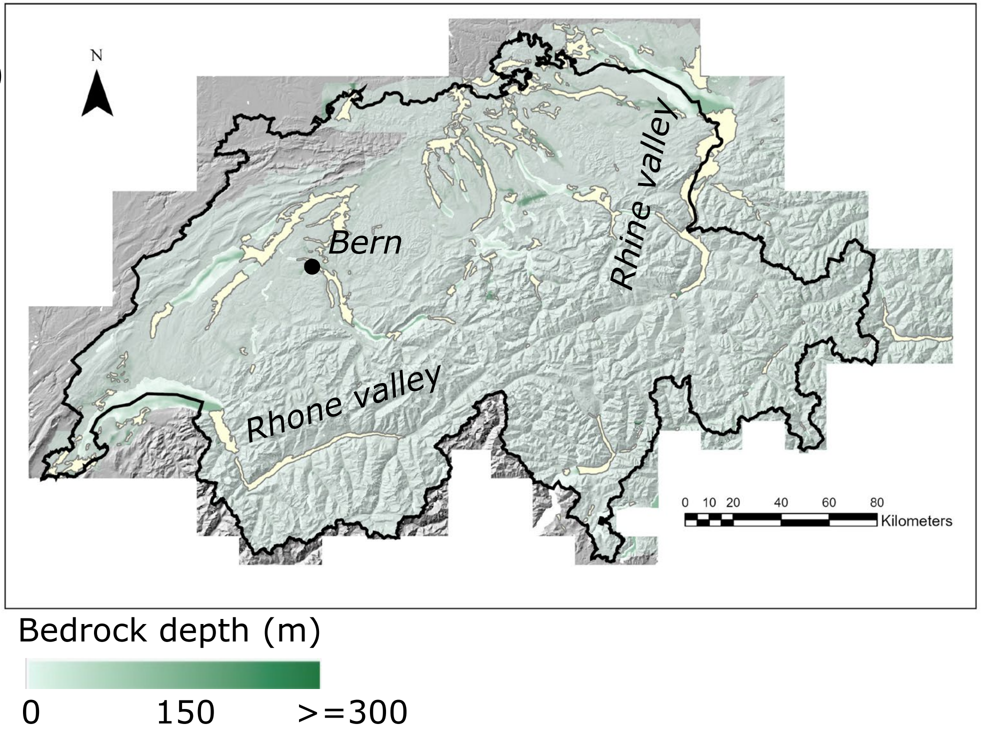
- **> 7800** free-field single-station, 3-C ambient noise measurements
- Acquired from 1996 to present day
- Processed with **H/V technique** -> soil resonance frequencies
- **SESAME guidelines** for acquisition, processing, interpretation

Collation of bedrock-depth models



Identifying large basins

Large sedimentary basins (width > 500 m, depth > 100 m)



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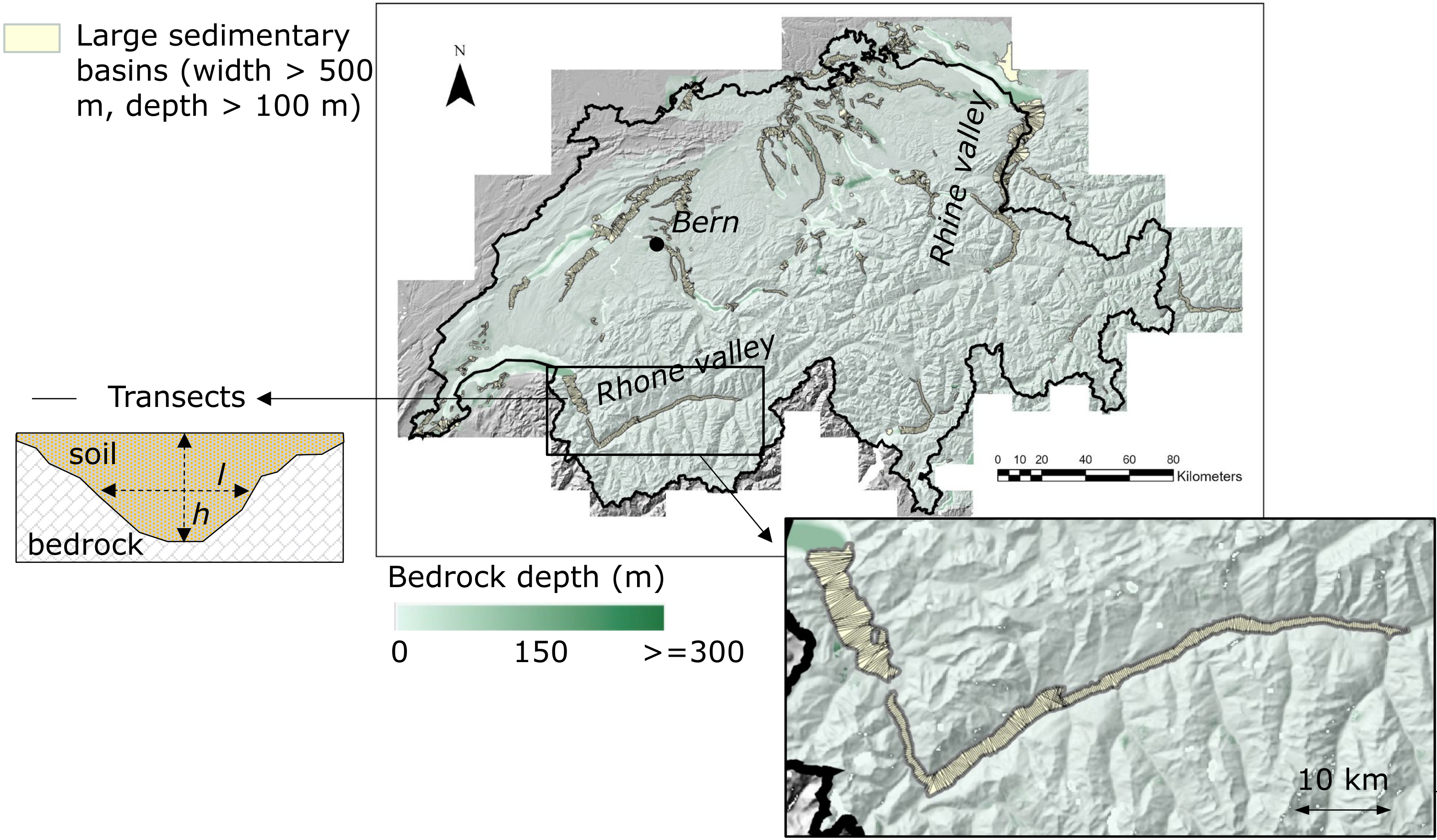

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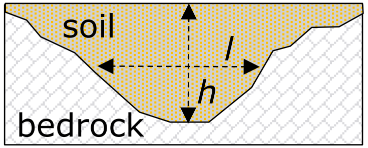
Geometry of large basins

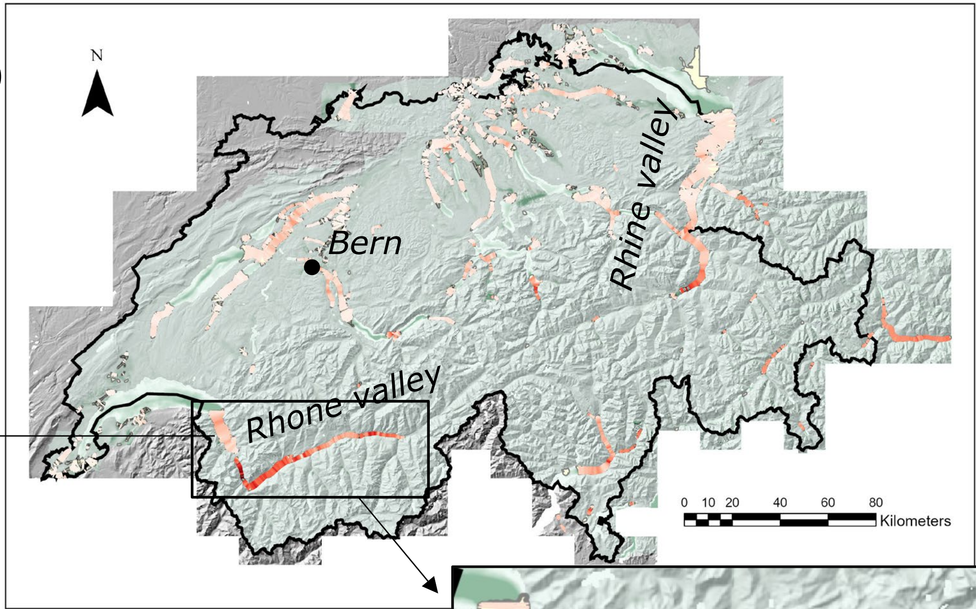
Large sedimentary basins (width > 500 m, depth > 100 m)

Transects



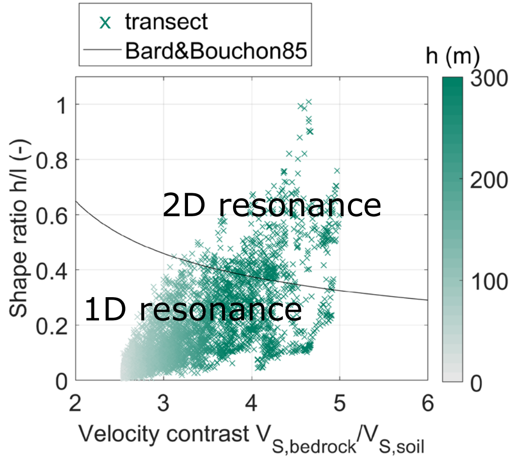
Shape ratio = h/l

0 0.5 1



Bedrock depth (m)

0 150 >=300



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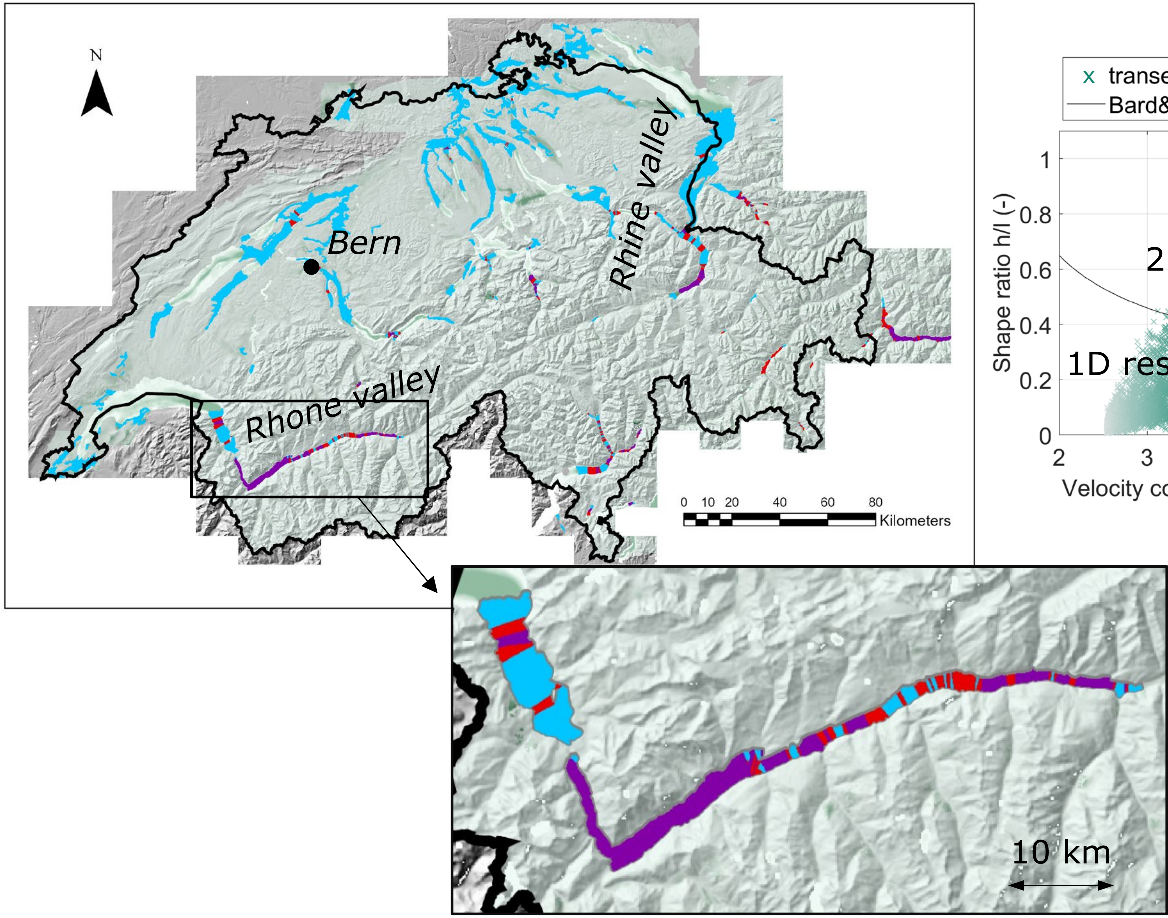
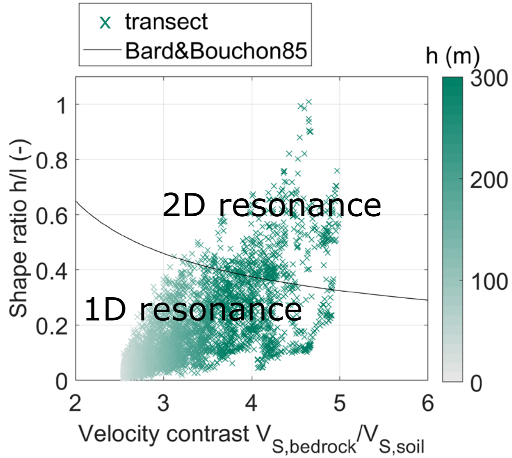
Resonance regime of large basins

Large sedimentary basins (width > 500 m, depth > 100 m):

- 1D resonance
- possibly 2D res.
- 2D resonance





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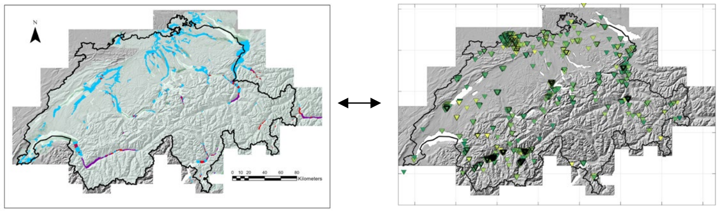
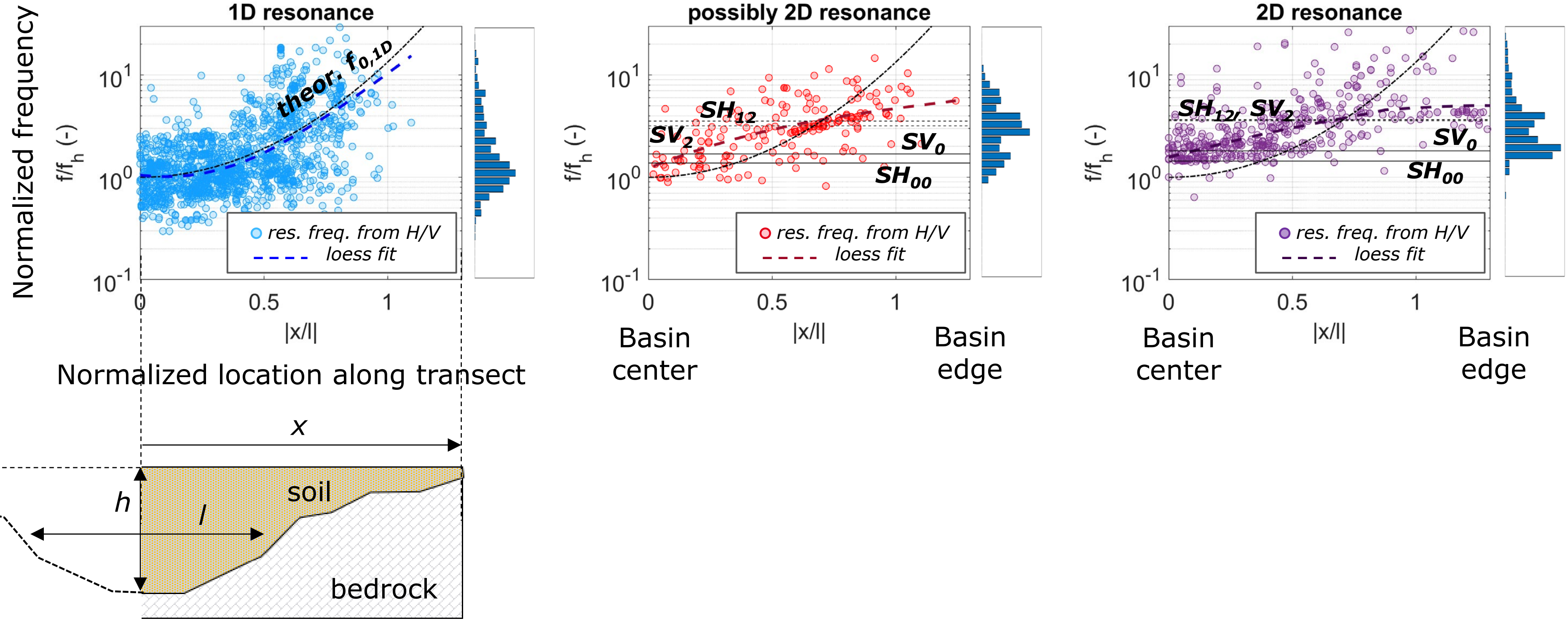


▼ Soil resonance frequencies from H/V_{noise}

Morphometric classification:



$$f_h = {V_{S,soil}}/{4h} = 1D\ resonance\ at\ valley\ center$$

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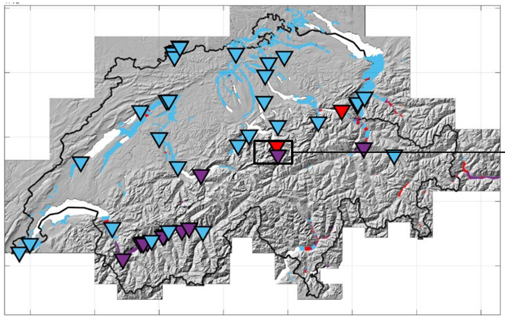
Directionality of ambient noise and earthquake site response

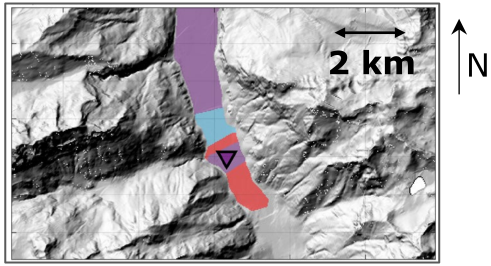


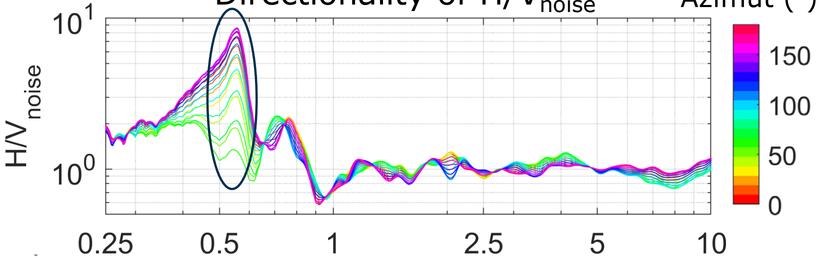
Morphometric classification of basins:

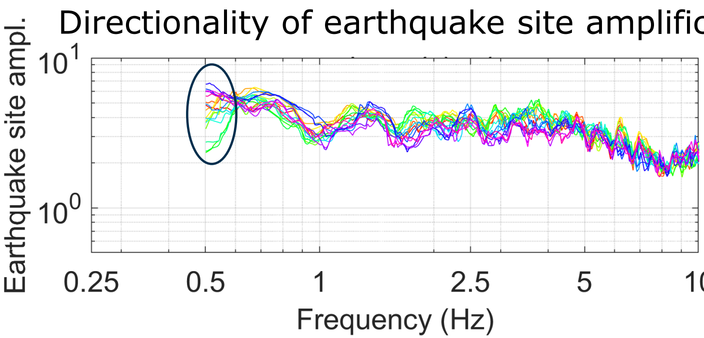
- 1D resonance
- possibly 2D res.
- 2D resonance

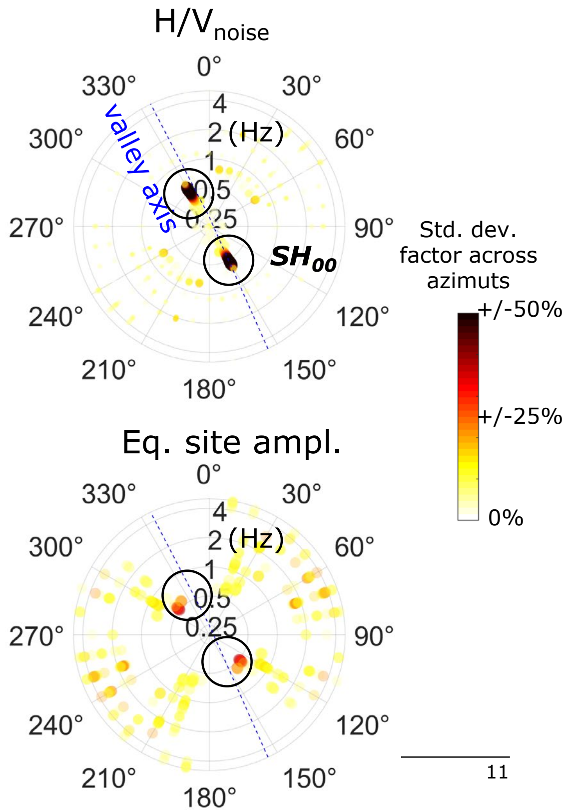
∇ Seismic stations

Station SEFS

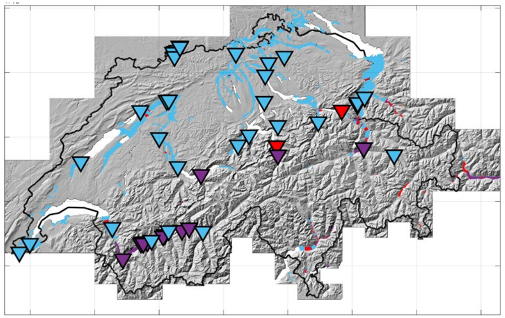








Directionality of ambient noise and earthquake site response



Morphometric classification of basins:

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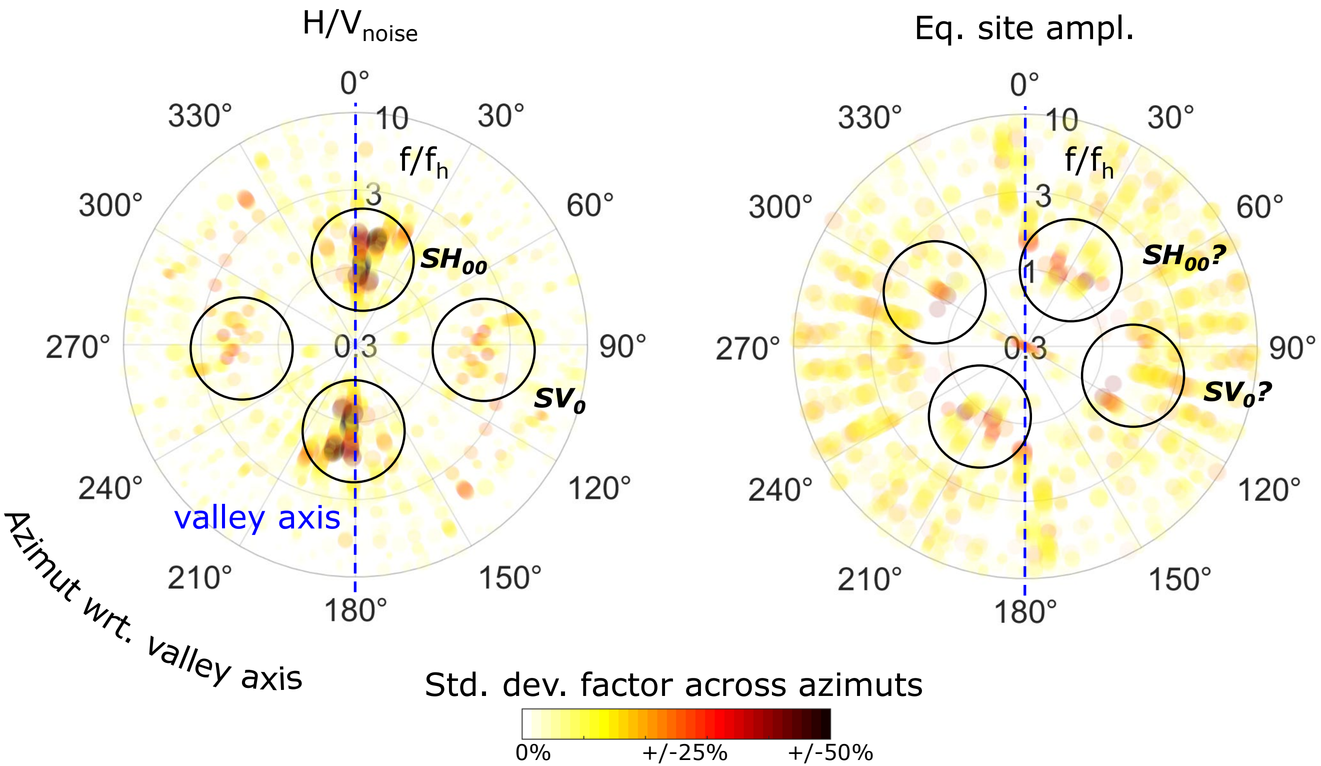
- 2D resonance

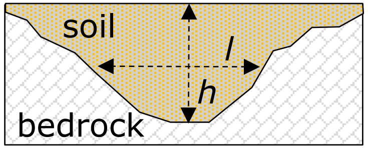
∇ Seismic stations

2D resonance stations (14 stations)
Stacked polarplots of std. dev. factor across azimuts



Conclusions:

- We combine a nation-wide database of **ambient noise recordings** and **morphometric analyses** to identify and characterize **1D *vs* 2D resonance phenomena in sedimentary basins**
- **Good agreement** between classification of basins according to morphometry and experimental data of soil resonance from ambient noise
- The distinction between 1D *vs* 2D resonance basins and their associated patterns follow **straightforward models derived from numerical analyses** found in the literature
- 2D resonance regime sets in from **shape ratios h/l > 0.3**



- **Dominant modes** of 2D resonance: SH_{00}, SV_0, SH_{12}, SV_2
- **Directionality** due to 2D resonance modes is **sharper in ambient noise recordings than in earthquake site response**

Thank you for your attention

paolo.bergamo@sed.ethz.ch, franziska.gluuer@sed.ethz.ch

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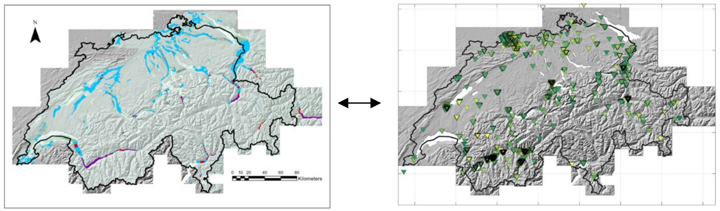

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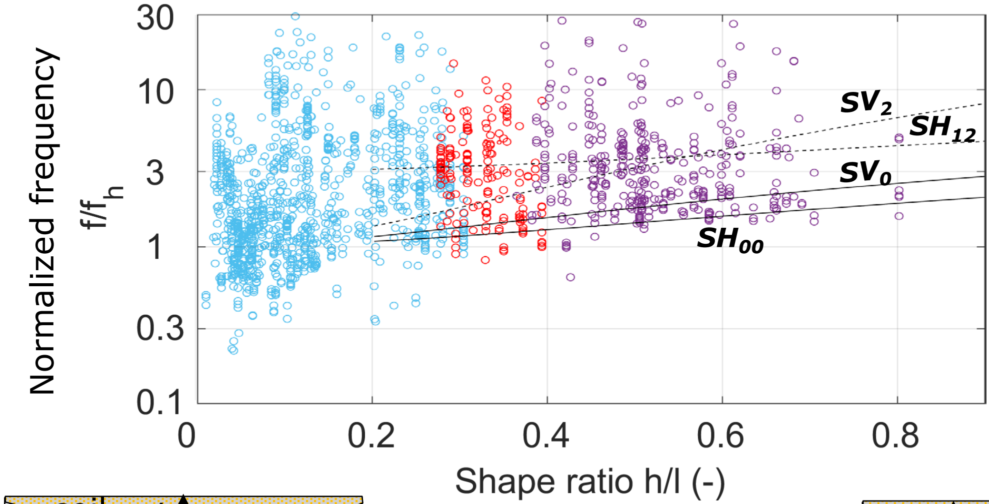

Color legend
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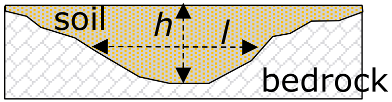
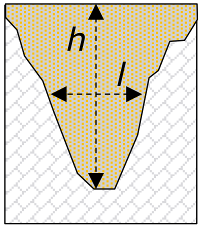
- 1D resonance
- possibly 2D res.
- 2D resonance

Symbol legend

- o res. freq. from H/V
- —— theor. 2D resonance
- - - - modes





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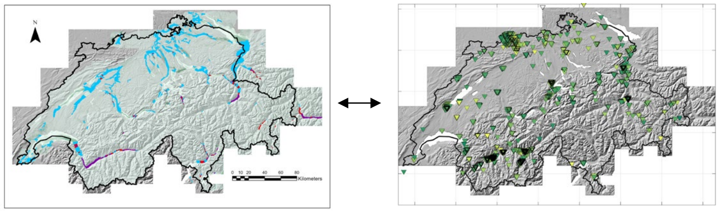

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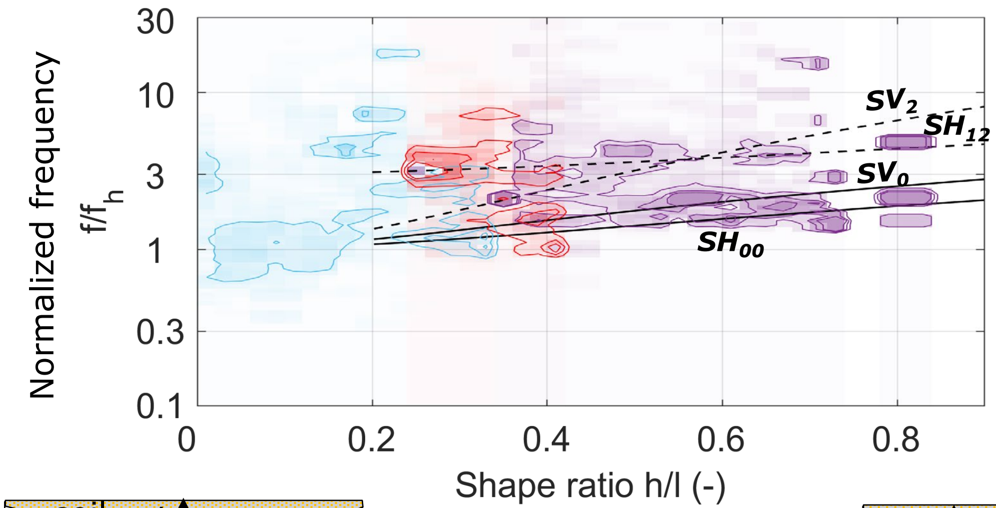

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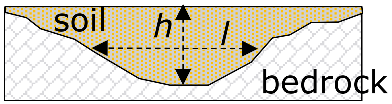

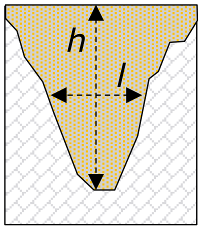

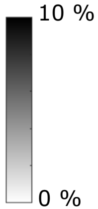

Relative density of data points

$$f_h = {}^{V_{S,soil}}/_{4h}$$