Seismic response of three glacially overdeepened valleys – a comparison

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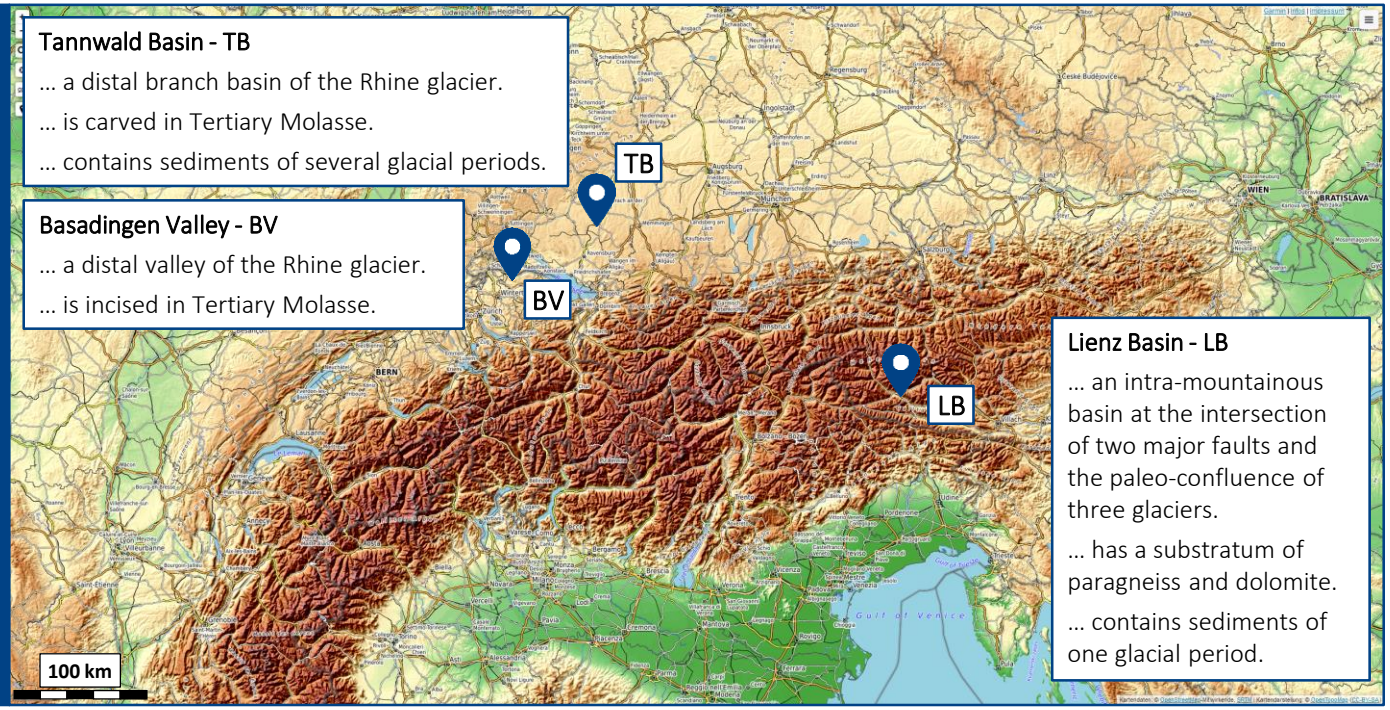
Introduction

The ICDP-project DOVE investigates the evolution of the past Alpine glaciations by drilling overdeepened valleys. In this context, we explore the erosional surfaces and the sedimentary successions of three overdeepened valleys by the means of seismic reflection. A comparison reveals the similarities and differences of these three valleys.

Acquisition parameter

Source: 4t LIAG Minivib **HVP-30**
Sweep: 20-200 Hz, 10 s
Source spacing: 5 m
Receiver: 1-C geophone
Receiver spacing: 2.5 m
# of ch.: up to 600

Study sites



Take-home masseges

1. P-waves image the bedrock topography and the interior of overdeepened valleys in high resolution.
2. Foreland and intra-mountainous valleys show the same overall structure for each accumulation cycle (from bottom to top: basal till, basin fines, fluvial deposits).
3. The sedimentary succession and thickness of the deposits vary among overdeepened valleys in detail. Even valleys in the same catchment area differ significantly (e.g. Tannwald Basin and Basadingen Valley in the Rhine Glacier arena).
4. A detailed study of each overdeepened valley is mandatory for a comprehensive understanding. We show that seismic reflection is a suitable method.

Relevant publications *(and references within)*

Burschil et al. (2018). High-resolution reflection seismics reveal the structure and the evolution of the Quaternary glacial Tannwald Basin. *Near Surface Geophysics,* **16**, 593-610.

Burschil et al. (2019). Unravelling the shape and stratigraphy of a glacially-overdeepened valley with reflection seismic: The Lienz Basin (Austria). *Swiss Journal of Geosciences*, **112**, 341-355.

Burschil & Buness (2020). S-wave seismic imaging of near-surface sediments using tailored processing strategies. *Journal of Applied Geophysics*, **173**, 103927.

Acknowledgement

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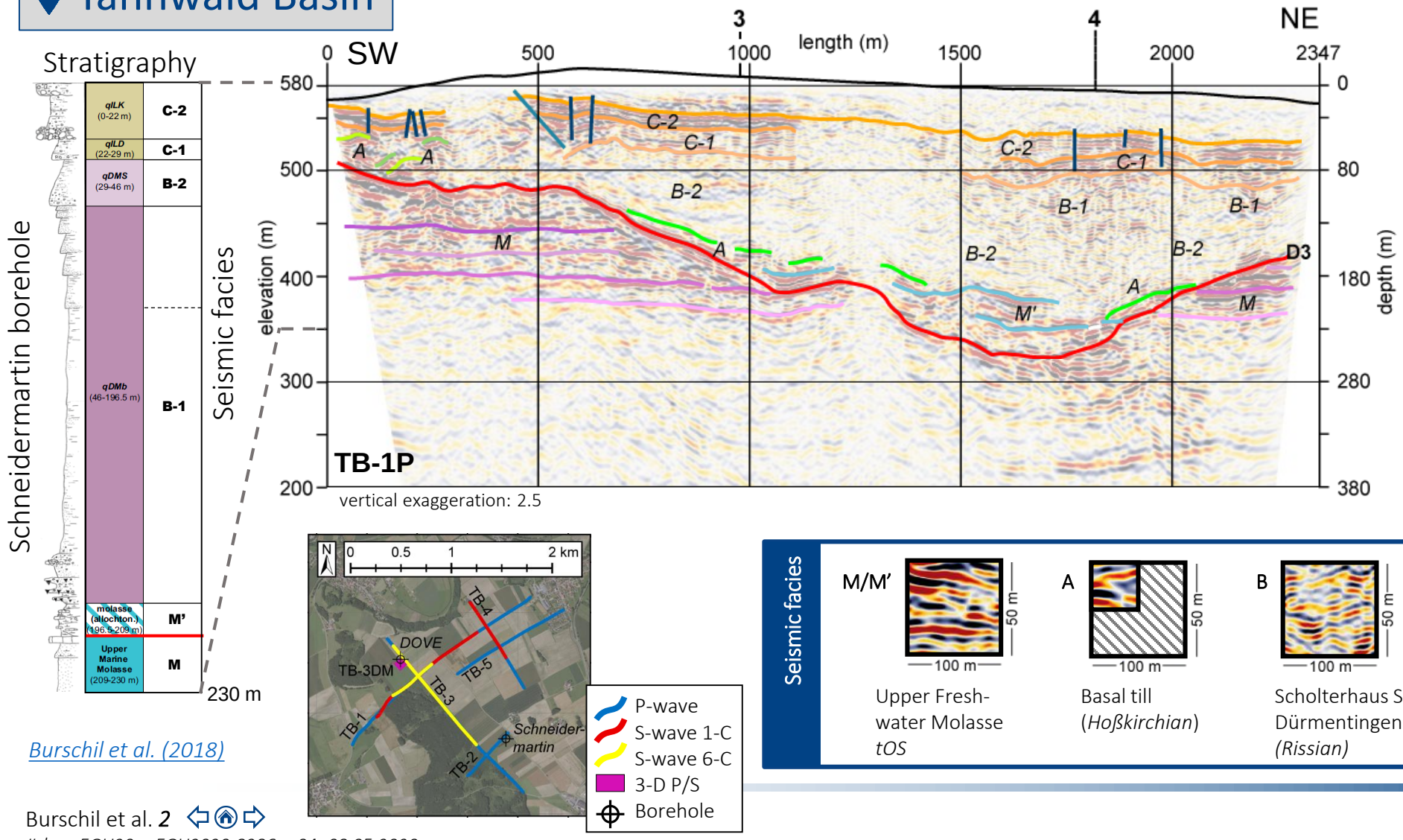
Tannwald Basin



Seismic imaging, supported by the stratigraphy of a nearby borehole, uncovers the bedrock morphology (**D3**, red line) and images the N-S elongated valley on the basis of five seismic profiles. Within the sedimentary succession, we reveal allochthonous molasse units (**M´**) at the bottom of the basin that were presumably transported during the erosion process. Arch-shaped stuctures indicate esker deposits (visible on profile TB-3). On top of basin fines (facies **B**), till and till sequences of younger glaciations are found (facies **C**).

[Burschil et al. (2018)](#)

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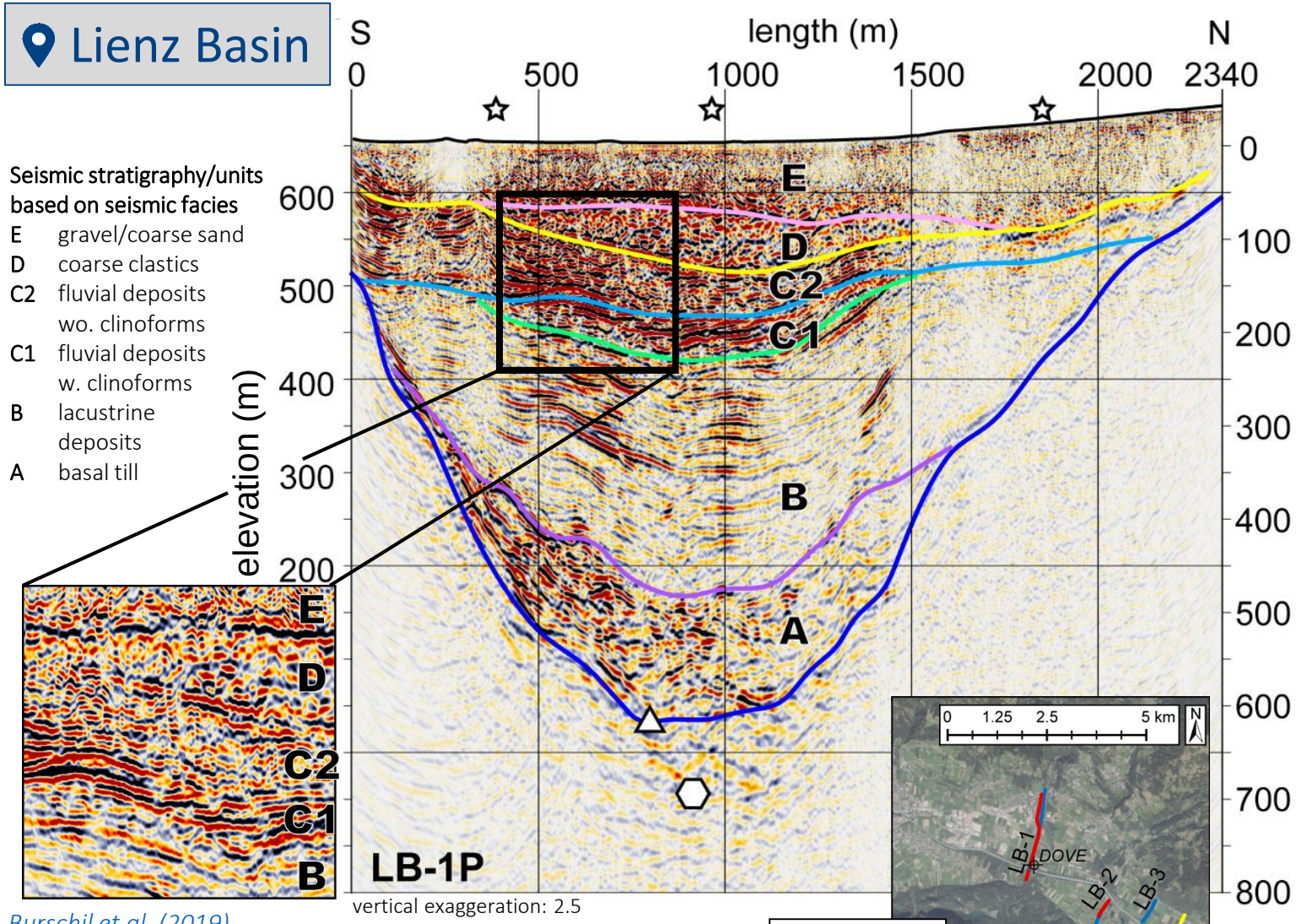
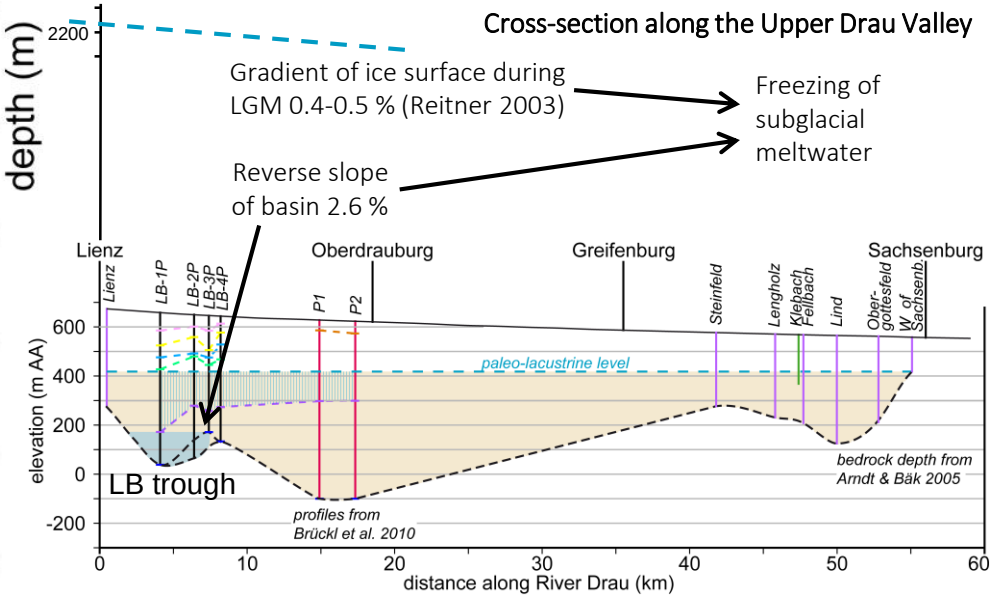
Lienz Basin



Burschil et al. (2019)

Seismic imaging unravels the erosional surface and the basin base in 622 m depth. The trough of the Lienz Basin along the Upper Drau Valley shows a local overdeepening of 146 m. The reverse slope of the outlet of the LB would cause freezing of subglacial meltwater and thus indicates erosion prior to the last glacial maximum. The sedimentary succession reveals the depositional history of one glacial cycle. From the sedimentary succession, we derive a paleo-water depth of 216 m.



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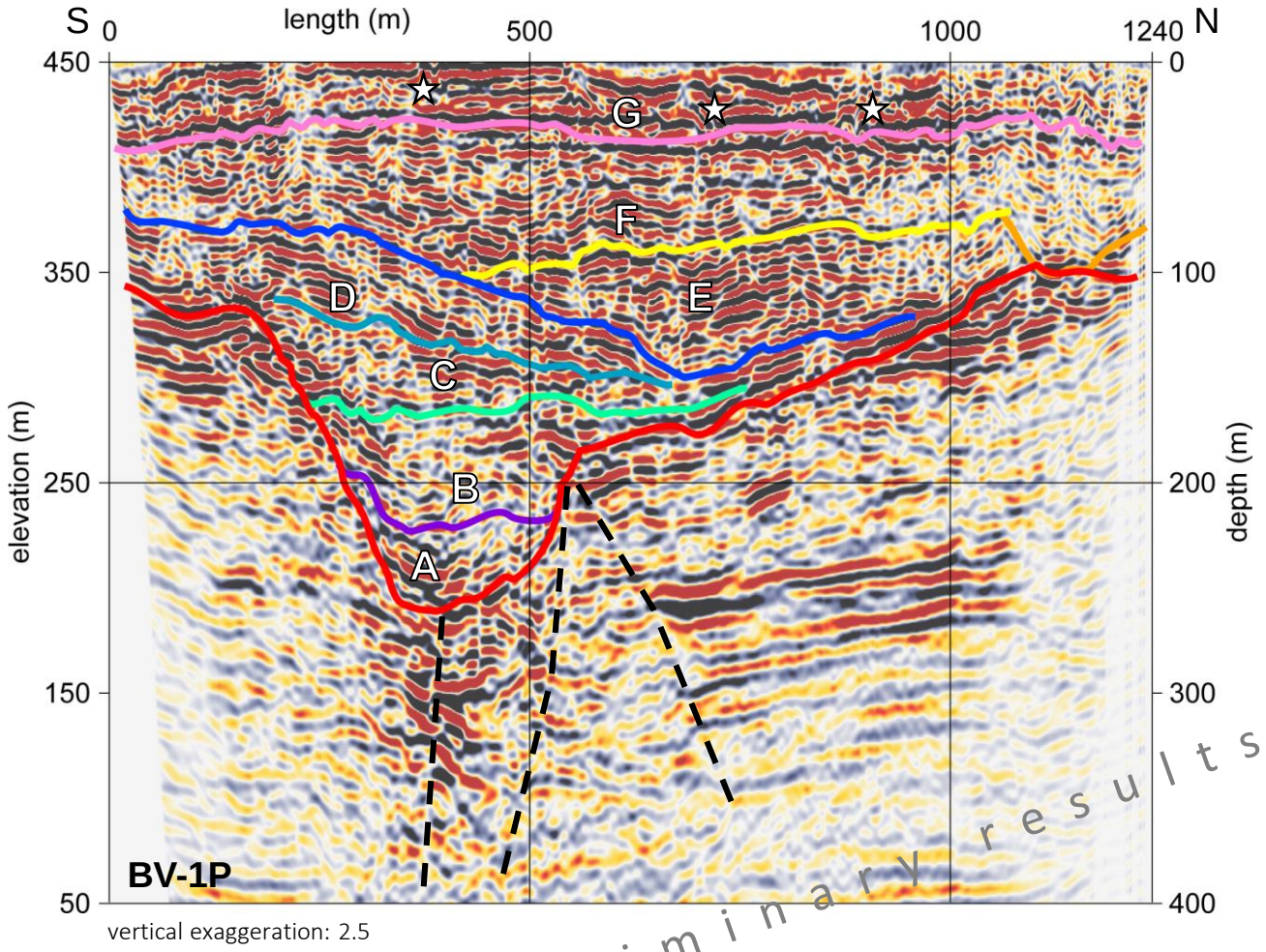
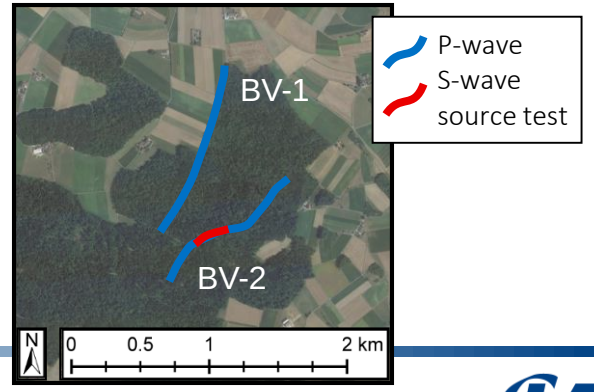
Basadingen Valley



The overdeepened Basadingen Valley is carved (red line) into layers of Molasse. A 275 m deep inner-trough is located in the southern part of the profile. The bedrock shows indication of faulting (black dashed lines).

Seven seismic facies differentiate the sedimentary fill of the valley. We interpret facies **A** as basal till that contains slumping. The inner-trough is filled with deposits containing clinoforms (facies **B**), followed by mega-clinoforms of hypothetically different, most likely fluvial, deposits that migrated from S to N (facies **C** and **D**). Facies **E** and **F** show high reflectivity. The uppermost layer (facies **G**) shows several small-scale depressions (white stars) that could be refilled kettle holes.



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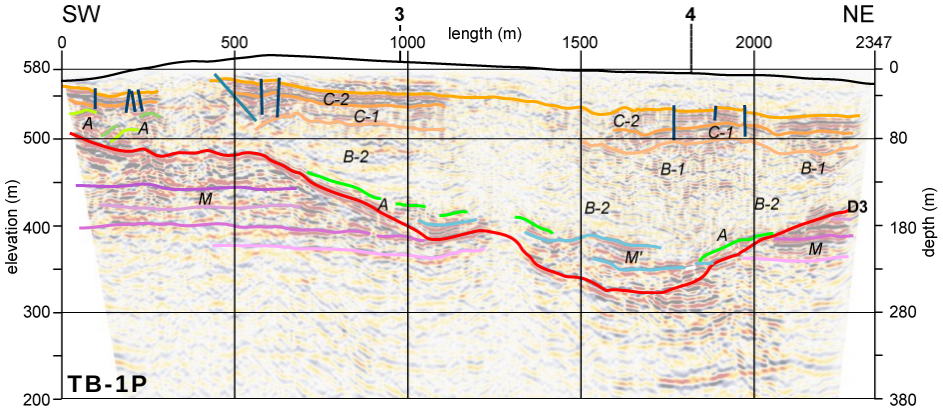
Comparison

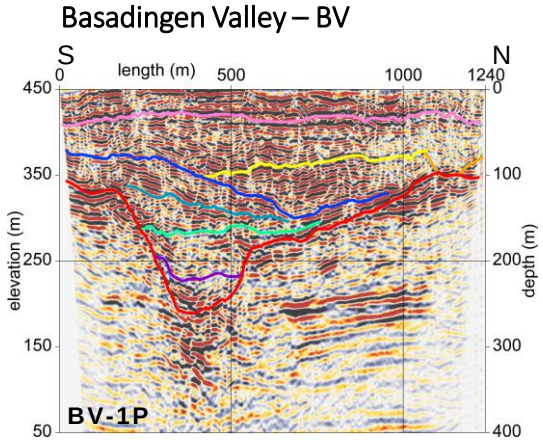
Seismic imaging shows **similarities** and **differences** in different overdeepened valleys. The overall sedimentary succession consists of basal till, lacustrine and fluvial deposits of the accumulation phase after the erosion. The thickness of each package varies significantly.

While the LB and BV show thick basal till with slumping structures at the bottom, the basal till in the TB is thin. The thick basin fines in the LB are laminated, while only little structure is present in the TB. Both foreland basins incise through a Molasse unit of high reflectivity. The reflection pattern of the upper part of the BV is like the upper part of the LB. The seismic image of the BV shows evidence of faulting in the bedrock. We also presume that the intersection of the faults promoted the formation of the LB, but these cannot be seen.

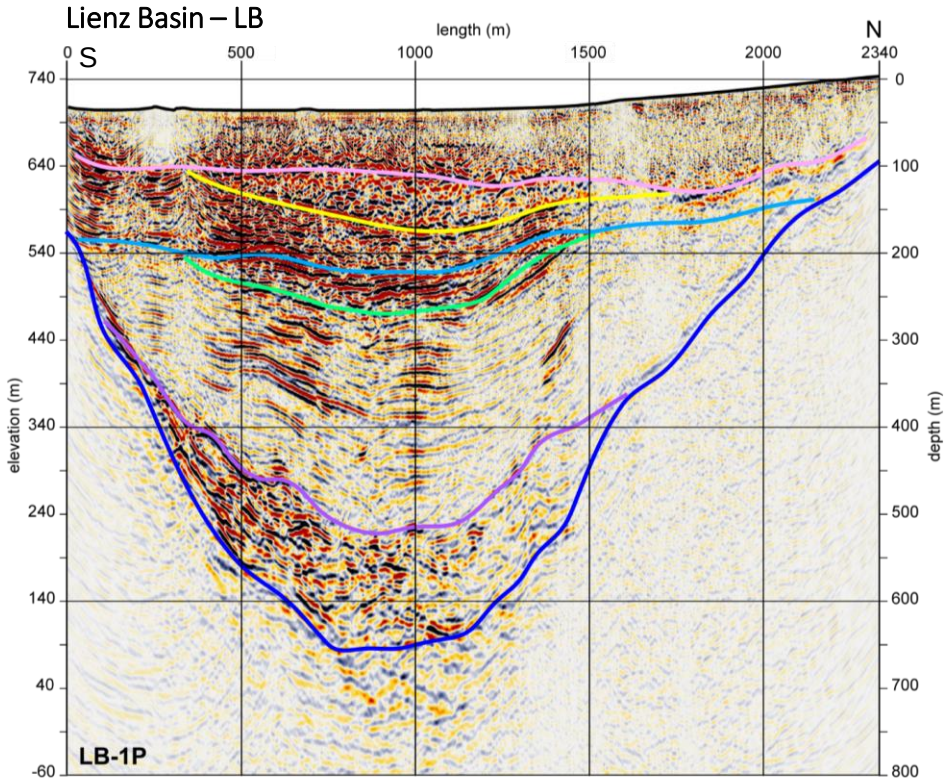
Tannwald Basin – TB



Basadingen Valley – BV



Lienz Basin – LB



All three valleys are foreseen as drilling locations for a first phase of the ICDP-project DOVE.

Seismic sections have same scale and elevation.