The shape and filling of the glacially overdeepened Basadingen basin, determined from high-resolution reflection seismic

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Motivation

As part of the DOVE project (Anselmetti et al. 2016) of the International Continental Scientific Drilling Program, a research borehole is being drilled into a glacially overdeepened basin in northern Switzerland. The aim of the borehole is to analyze a Quaternary sequence as complete as possible in the branched basin of the Rhine glacier (Fig. 1). For detailed preliminary seismic exploration, two profiles were acquired by LIAG in collaboration with ETH Zurich across the previously known course of the basin. In this presentation, the processing and interpretation of profile 1 will be discussed.

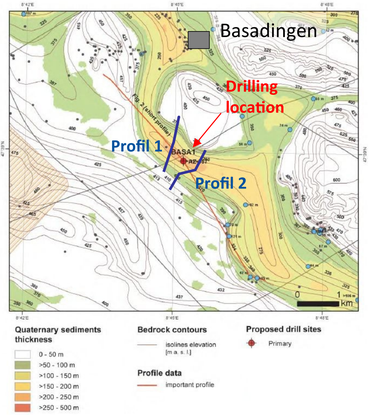


Fig. 1: Quaternary thicknesses, location of profiles, and the previously planned location of the well, after Anselmetti et al. (2016).

Results

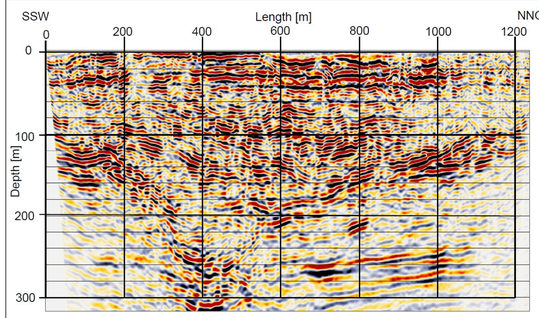


Figure 6: Seismic section after poststack processing (steps 15 -18 in tab. 2).

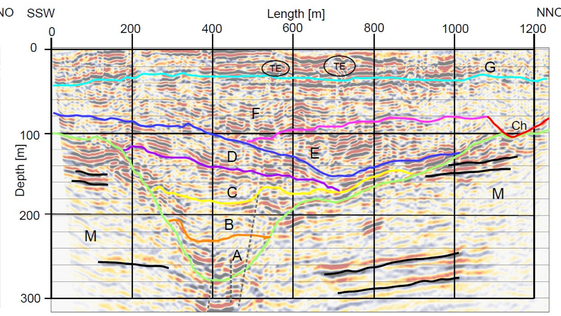


Figure 7: Seismic interpretation. The green line indicates the basin base.

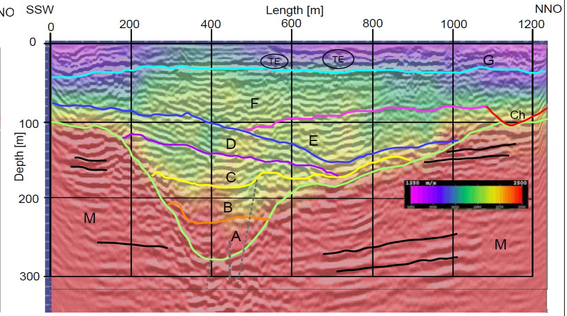


Figure 8: Interval velocities from the interactive velocity analyses.

The reflections represent the shape of the basin and the internal storage conditions quite well: M Molasse, A, B, C, D, E, F and G are sedimentation bodies characterized by different internal reflection patterns and/or by unconformities at the boundaries. Reflectors in the molasse (black lines) possibly indicate a fault zone that would favor initial erosion of the basin. Two subsidence structures interpreted as dead ice holes (TE) are prominent in the center of the profile, and a small-scale channel structure (Ch) is prominent at the NE margin.

Acquisition

The profiles followed unpaved forest roads. Boundary conditions were the proximity to the targeted borehole and a preferably straight course of the profiles. The HPV-30 hydraulic vibrator with a peak force of 30 kN was used for stimulation.

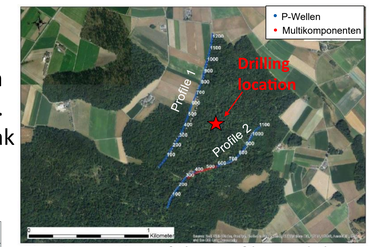


Fig. 2: Location of the profiles and the targeted borehole

source	vibrator HPV-30
sweep	linear, 20-240 Hz, 10 s
correlation	field correlation
source distance	4 m
vertical stack	2 x
no shots	628
receiver	sensor SM6 geophones, vertical, 20 Hz
receiver distance	2 m
no of channels	600
spread type	fixed spread
recording unit	Geode (25x)
sampling rate	1 ms
listen time	2 s

Table 1: Acquisition parameters



Fig. 3: LIAG vibrator in action

Processing

1	quality control	kill bad traces
2	vertical stack	2 x
3	geometry load	1 m CDP bin
4	refraction statics	delay time, datum processing datum
5	trace muting	surface & shear waves
6	spectral balancing	15 panels, 20-240 Hz
7	scaling	AGC 300 ms
8	residual statics	correlation autostatics
9	bandpass	30/40-200/240 Hz
10	velocity analysis	first iteration
11	DMO	ensemble DMO (T-X)
12	velocity analysis	second iteration
13	NMO	35% strech mute
14	CDP stack	enhanced mean 10%, final datum 450 m
15	migration	Stolt, Dip Explicit FD Time Migration, up to 50° dip angle
16	bandpass	0-300 ms: 55/60-180/200 Hz, 300-1000 ms: 20/25-160/240 Hz
17	τ-p filter	max. dip 1 ms/trace
18	time-depth conversion	smoothed DMO velocities

Table 2: Processing parameters

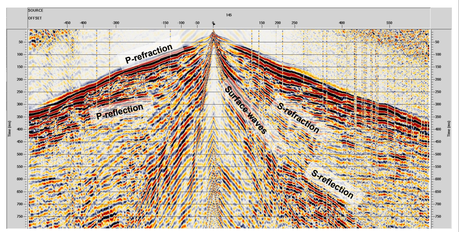


Figure 4: Shotpoint No. 145; raw data (AGC 0.5 s)

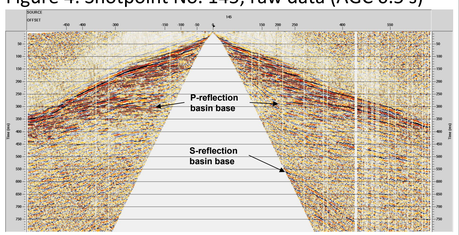


Figure 5: Shotpoint No. 145 after prestack processing (steps 1- 9 in table 2)

Conclusions

- The applied acquisition and processing are well suited to explore the Quaternary deposits. Detailed velocity analysis and DMO processing are the key processing steps.
- Deviating from the previously assumed valley shape (cf. Fig. 1), the Basadingen basin shows a narrowly defined additional depression up to 280 m. The Basadingen basin is asymmetric and has a high dip angle.
- The basin is asymmetrical and in the lower part the sediments are strongly inclined.
- The inclinations indicate an initially high and then weakening sedimentation dynamic over time.

References

Anselmetti, F. et al. (2016). Drilling overdeepened Alpine Valleys (DOVE). ICDP Full Proposal, 174 pp.

Brandt, A.-C. (2020). Investigation of the alpine, glacially-overdeepened Basadingen Valley using P-wave seismics. Bachelor thesis, Leibniz Universität Hannover, Institute of Geology, 68 pp.