Supplemental material to Patterson et al. "**Seismic reflection end electrical resistivity imaging reveals pre-Quaternary glaciation in the Rocky Mountains (Unaweep Canyon, Colorado)**"

Figure S1 (next page): Map view of the acquisition. Grid coordinates are in UTM Zone 12N.

Cyan line: Three-component 5 Hz Fairfield 'ZLand' seismic recorders at 5 m spacing (120 stations). Blue line: One-component 4.5 Hz Reftek 'Texan' seismic recorders at 5 m spacing. Grey dots: Manual sledge hammer source locations at 10 m spacing. Red dots: Nitrogen-pressured impact source A200 locations at 10 m / 5 m spacing. Yellow dashed line: Location of the vertical projection plane used in Figs. 2,3, DR5 – DR8. Labels indicate profile distance (in meters) shown in those figure axes. Qt, pC: Quaternary and Precambrian surface cover. White lines: Elevation contours (m).

A detailed description of the survey layout is provided in Patterson (2019).

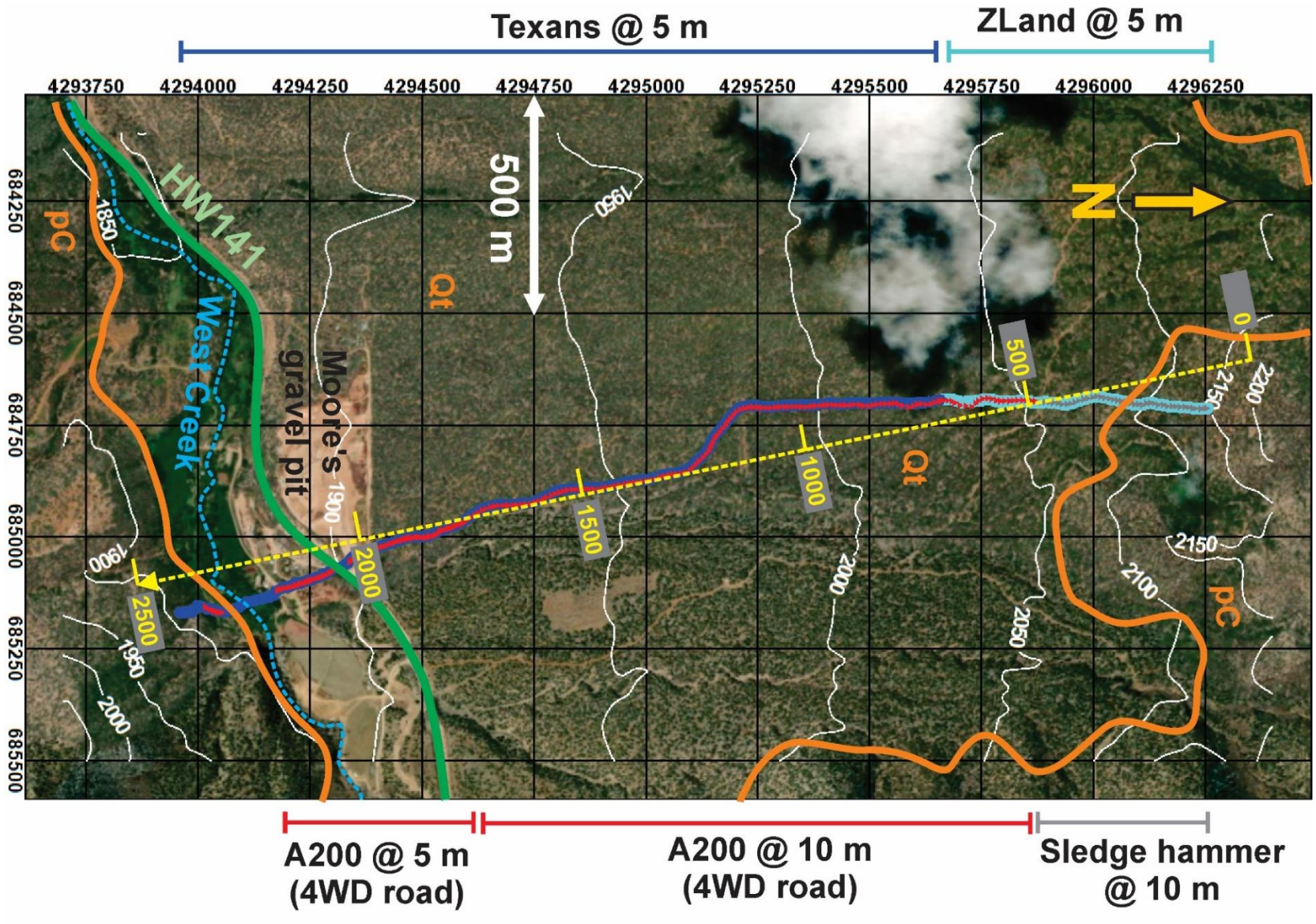
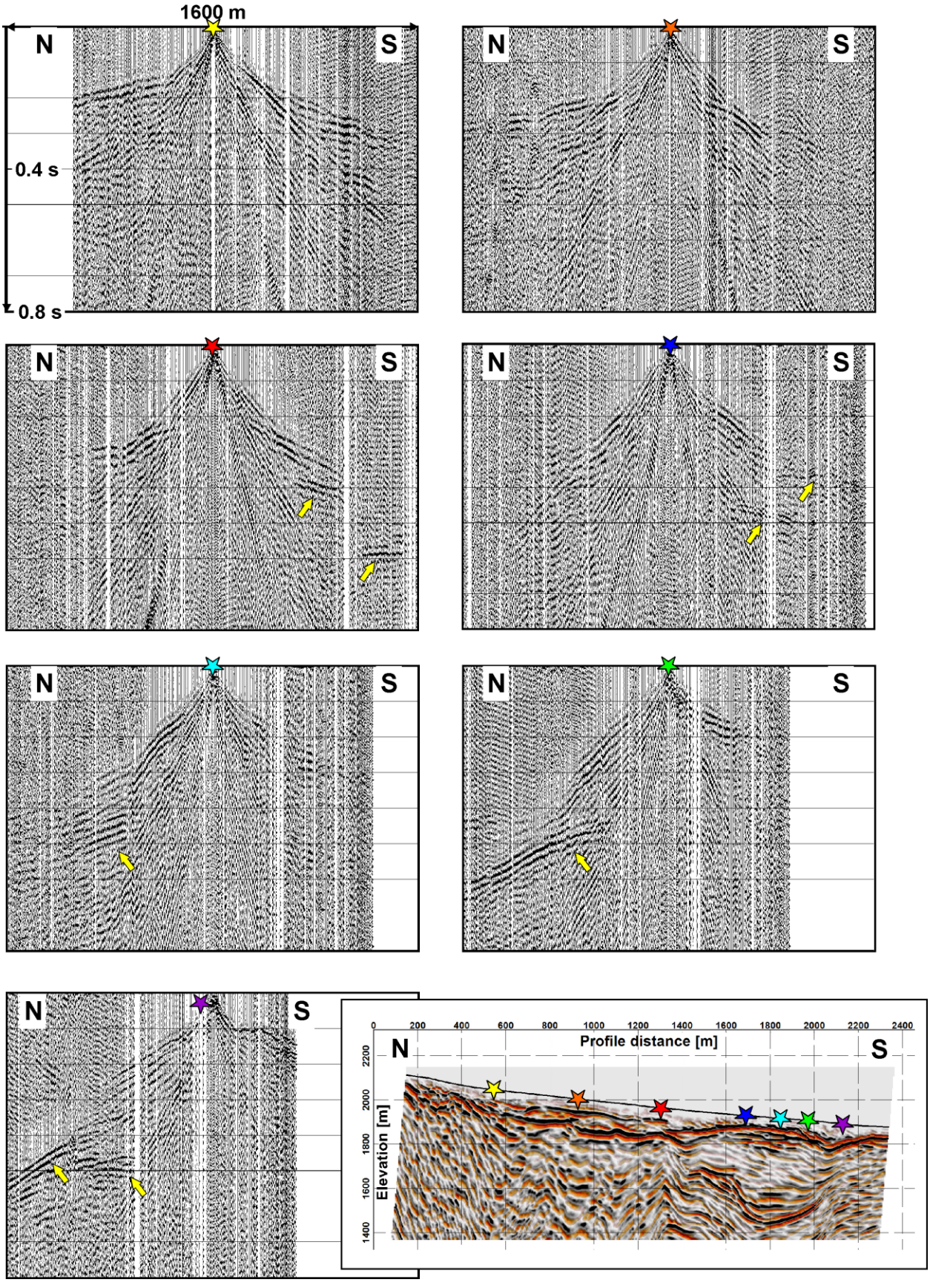

Texans @ 5 m
ZLand @ 5 m
4293750
4294000
4294250
4294500
4294750
4295000
4295250
4295500
4295750
4296000
4296250
684250
684500
684750
685000
685250
685500
500 m
N
HW141
West Creek
Moore's gravel pit
Qt
pC
1850
1900
1950
2000
2050
2100
2150
2200
0
500
1000
1500
2000
2500
A200 @ 5 m
(4WD road)
A200 @ 10 m
(4WD road)
Sledge hammer
@ 10 m

Figure S2 (next page): Selected shot gathers (raw data) along the profile after application of a bandpass filter (30 – 60 – 130 – 160 Hz) and AGC with 500 ms window length. Vertical and lateral extent is identical for all shot gathers (+/- 800 m offset, 0.8 seconds recording time). The colored stars correspond to the shot locations at the profile shown in the PSTM image. The yellow arrows highlight asymmetric and skewed reflection arrivals and are indicative of a complex subsurface structure with sudden changes in basement depth.


1600 m
N
S
0.4 s
0.8 s
N
S
N
S
N
S
N
S
N
S
N
S
N
S
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Profile distance [m]
N
S
Elevation [m]
2200
2000
1800
1600
1400

Data have been processed independently with Haliburton ProMAX and SLB Vista, providing similar results in terms of subsurface structure and velocities. The final results are from the Vista processing sequence, which turned out to image the data slightly better.

1. Trace editing, crooked line geometry application, CMP binning (bin size 5 m)

2. First arrival picking, elevation and refraction statics, reduction to floating datum

3. Initial Signal processing: Bandpass filter (10-25-90-130 Hz), AGC (window length 250 ms), notch filters, FK filter, Top and bottom mute

4. Predictive Deconvolution: Operator length 120 ms; Prediction lag = second zero crossing of the autocorrelation, taper length 20 ms, pre-whitening 2%

5. CMP sorting and velocity analysis: Super gathers of 10 CMP bins, offset restriction 150 – 950 m, bandpass filter 10-15-80-100 Hz

6. Velocity model smoothing

7. NMO stack: Offset restriction 100 – 600 m, stack normalization by the square root of the number of traces, stretch mute 100%*

8. Residual power statics calculation and application, new NMO stack (Fig. DR4)

9. Iterative PSTM velocity and PSTM aperture angle analysis

10. Velocity model smoothing

11. PSTM: Offset restriction 100 – 600 m, rephasing filter, stack normalization by the square root of the number of traces, anti-alias filter 15-75 Hz, stretch mute 100%*(Fig. DR4)

12. Depth conversion with the smoothed PSTM velocity model

13. Bandpass filter (10-15-65-80 Hz), AGC (window length 300 ms), mean scaler, trace mix (weights 1-3-1) (Fig. 2)

*: A large stretch mute was required to image the shallow basement ‘B1’ in the left part of the profile and the reflector ‘L’. We attribute this uncommonly high value to a large velocity gradient in the sedimentary cover above the reflectors, which causes reflection rays to arrive at larger offsets.

Table S3: Processing sequence and parameters

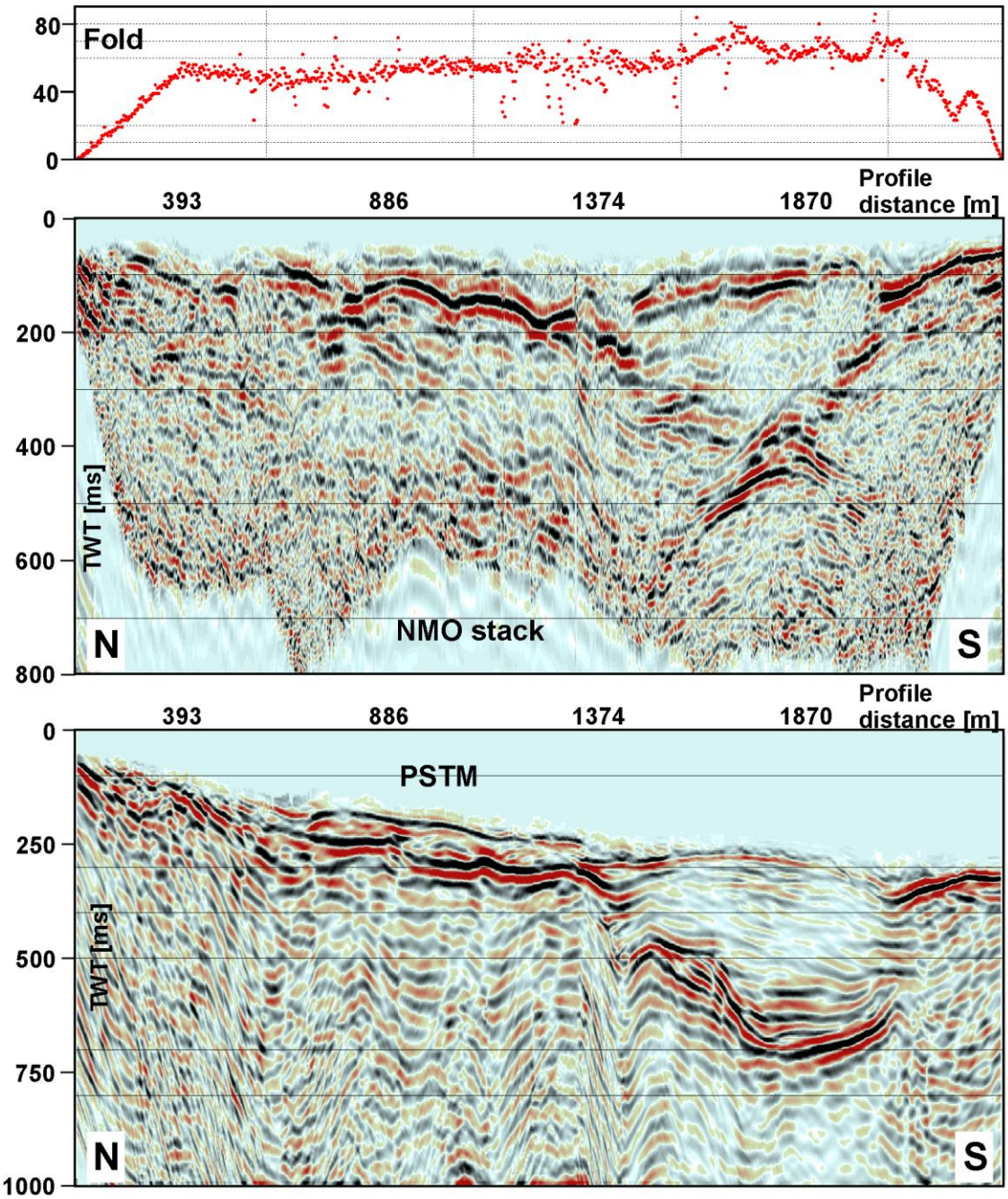



Figure S4: NMO stack referenced to the floating datum with corresponding fold, and PSTM image referenced to the final datum. The fold scatters is due to the crooked line bins. The stack clearly shows significant overdeepening and is indicative of a U-shaped structure (e.g., compare to de Franco et al., 2009, Figs. 3 and 5). The superposition of the horizontal reflectors and the diffraction hyperbola (profile distances 1400 – 1900 m) illustrates the necessity of pre-stack time migration. Both NMO stack and PSTM image are bandpass filtered (10-15-65-80 Hz) and scaled with AGC (window length 500 ms)

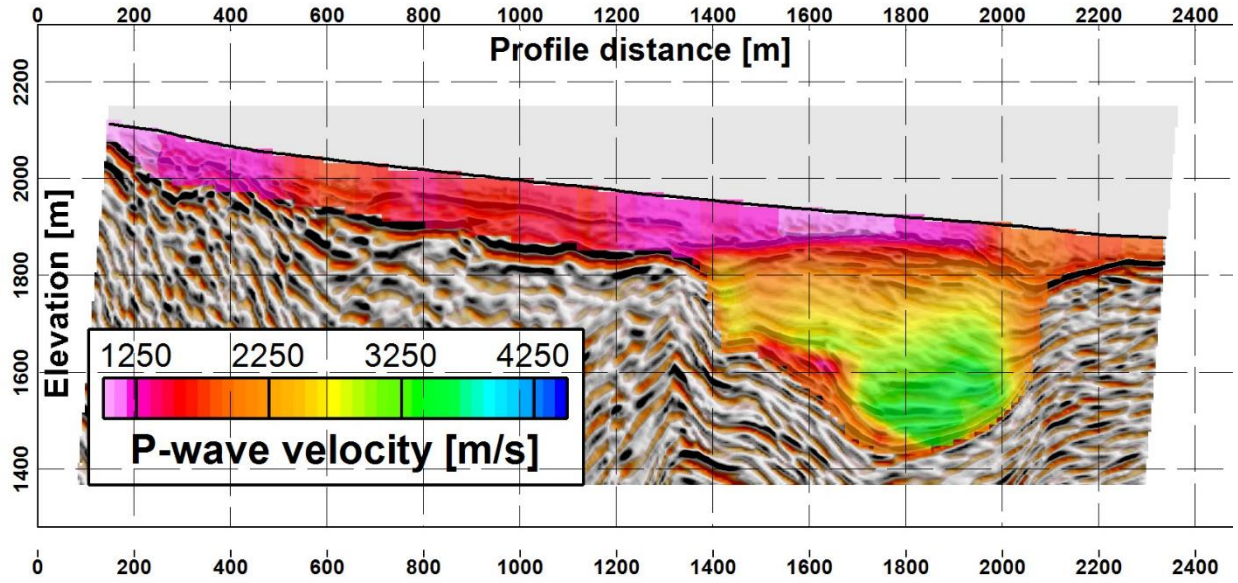



Figure S5: Smoothed and depth-converted PSTM interval velocity model. In absence of a local well, this velocity model was also used for the time-to-depth conversion of the PSTM image.

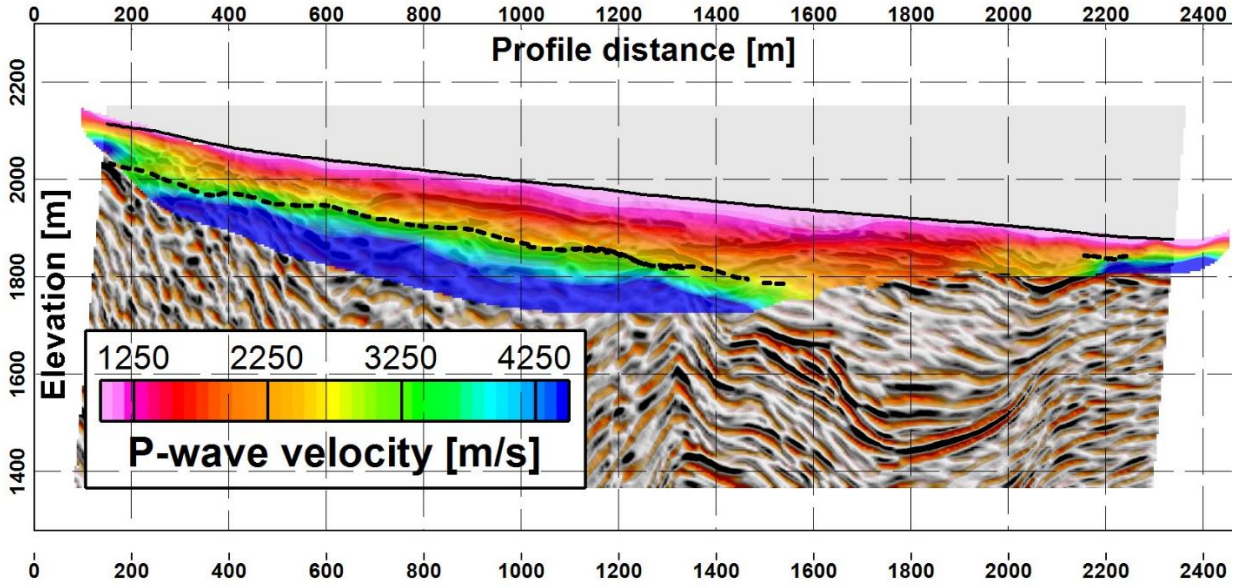



Figure S6: Tomographic velocity model and refractor depth (black dashed line) based on first arrival travel times (see Behm et al., 2019 for details). The lack of basement rock velocities (> 4000 m/s) and the absence of a well-defined refractor coincides with the area of overdeepening (profile distance 1500 – 2100 m). Tomographic velocities and refractor depth were established independently from reflection processing.

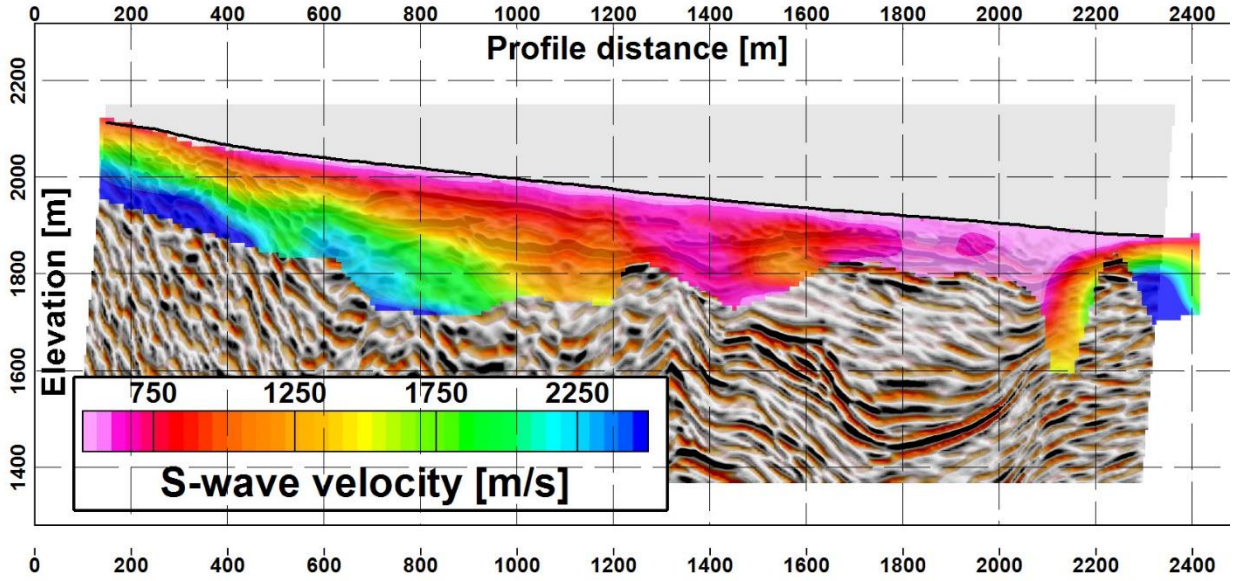



Figure S7: Shear wave velocity model based on surface wave inversion (see Behm et al., 2019 for details). The low velocities in the deeper section are indicative of significantly weathered basement rock. The resolution and accuracy of surface wave inversion is in generally inferior to travel time tomography, but nonetheless we observe a similar structure as in figures 2, S5, and S6 (shallowing of basement towards the north, sudden change from deep basement to shallow basement at profile distance ca. 2100 m).