Hochauflösende Seismik quartärer Sedimente

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Was können seismische Methoden?

Prinzip Seismik
Various acquisition conditions - Processing PSDM with MVA

Seismic velocities derived from MVA

Depth (m) after SRD

Slumps

Onlap

Burschil et al 2019 (SJG)
Seismische Quellen
Seismisches Equipment
Fig. x: Different seismic resolutions, illustrated at an example from the Upper Rhine Valley: (a) high resolution 2D seismic  
(b) detail of a 3D seismic volume section. The red box in (b) indicates the position of the profile in (a). Source frequencies were (a) 30-300 Hz, (b) 12-96 Hz and CMP distances (a) 20 m, (b) 1 m. Fault imaging starts at only 20 m depth and fault activity in Quaternary times could be inferred from the high resolution profile. Details in Musmann and Buness (2012).
Seismische Wellen

P-waves ↔ SV-waves ↔ SH-waves

\[ v_p = \sqrt{\frac{k + \frac{4}{3} \mu}{\rho}} \]

\[ v_s = \sqrt{\frac{\mu}{\rho}} \]

\( \rho \) Dichte
\( \mu \) Schermodul
\( k \) Kompressionsmodul
Seismische Wellen

Seismik - Wellentypen

**P-waves**

\[ v_P = \sqrt{\frac{k + 4/3 \mu}{\rho}} \]

\( \rho \) Dichte

\( \mu \) Schermodul

\( k \) Kompressionsmodul

**SV-waves**

\[ v_S = \sqrt{\frac{\mu}{\rho}} \]

**SH-waves**

Oft angenommen für „Festgestein“

Possionzahl 0,25 -> \( \frac{V_p}{V_s} = \sqrt{3} \)

In der Realität oft höher, s. Beispiel Oberrheingraben. Oberflächennah in unkonsolidierten Sedimenten treten Werte von bis zu 10 auf.

Aus \( \lambda = \sqrt{\nu/f} \) folgt eine entsprechende Erhöhung der Auflösung, falls die Frequenzen gleichbleiben.
Seismik - Wellentypen

Quelle: http://www.geo.mtu.edu/UPSeis/waves.html
Prestack processing sequence:
- raw data (geometry load)
Pre-stack processing sequence:
- raw data (geometry load)

P- waves outside,
S-waves inside
'noise cone'
Prestack processing sequence:
- raw data (geometry load)
- spectral whitening
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- raw data (geometry load)
- spectral whitening
- scaling
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- raw data (geometry load)
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- scaling
- fk-filtering
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- raw data (geometry load)
- spectral whitening
- scaling
- fk-filtering
- muting (after CMP sorting)
Motivation

Burschil et al. 2012

P wave seismics
Motivation

Föhr – S-Wellen

Burschil et al. 2012
- SH-waves reveal same overall structure (bottom of the basin); generally the deeper parts less well imaged.
- Main facies units can be seen also in Sh-section.
- Shallowest part (< 50 m) much better resolved with SH waves.
- SH-waves not at the same processing level as P-waves.
Benefits of S-waves:
- S-waves **lift the detection limit** for very shallow reflectors (A).
- S-wave reflectors are less coherent but reveal **more details** (B).
- S-waves **image reflectors** in areas that are **transparent** for the P-waves (C).
S-wave processing

AGC 250 ms, spectral whitening, fk-filter, stack, FD-migration, depth conversion

AGC 250 ms, **no spectral whitening**, fk-filter, stack, fk-filter, FD-migration, depth conversion

AGC 1000 ms, spectral whitening, fk-filter, stack, FD-migration, depth conversion

Offsets < 60m (*requirement for 3D application by LIAG*), AGC 250 ms, spectral whitening, fk-filter, stack, FD-migration, depth conversion
Fig. 7: Depositional architecture and sedimentary facies of the Porta complex. A and B) Shear-wave seismic profile measured north of the gravel pits Brinkmeyer, Edler 2 and Müller 2 (for location see Fig. 6). Coarse-grained subaqueous fan deposits overlie fluvial deposits of the Weser River and lake-bottom sediments. The subaqueous fan deposits are unconformably overlain by two generations of delta deposits. C) Photograph of scoured massive gravel, erosively overlain by scoured planar and trough cross-stratified gravel and pebbly sand (proximal jet-efflux deposits of the incipient subaqueous fan, Brinkmeyer pit). Palaeoflow directions are towards the south and south west. D) Steeply (8–35°) eastward-dipping coarse-grained delta foreset deposits of the older delta system (Hainholz pit). E) Gently (5–15°) eastward-dipping fine-grained delta deposits, unconformably overlying the older coarse-grained Gilbert-type delta (Hainholz pit).
Danke für ihre Aufmerksamkeit