Seismic reflection soundings

XL3D Seminar 17th June 2020

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Programme for Sustainable Growth and Jobs

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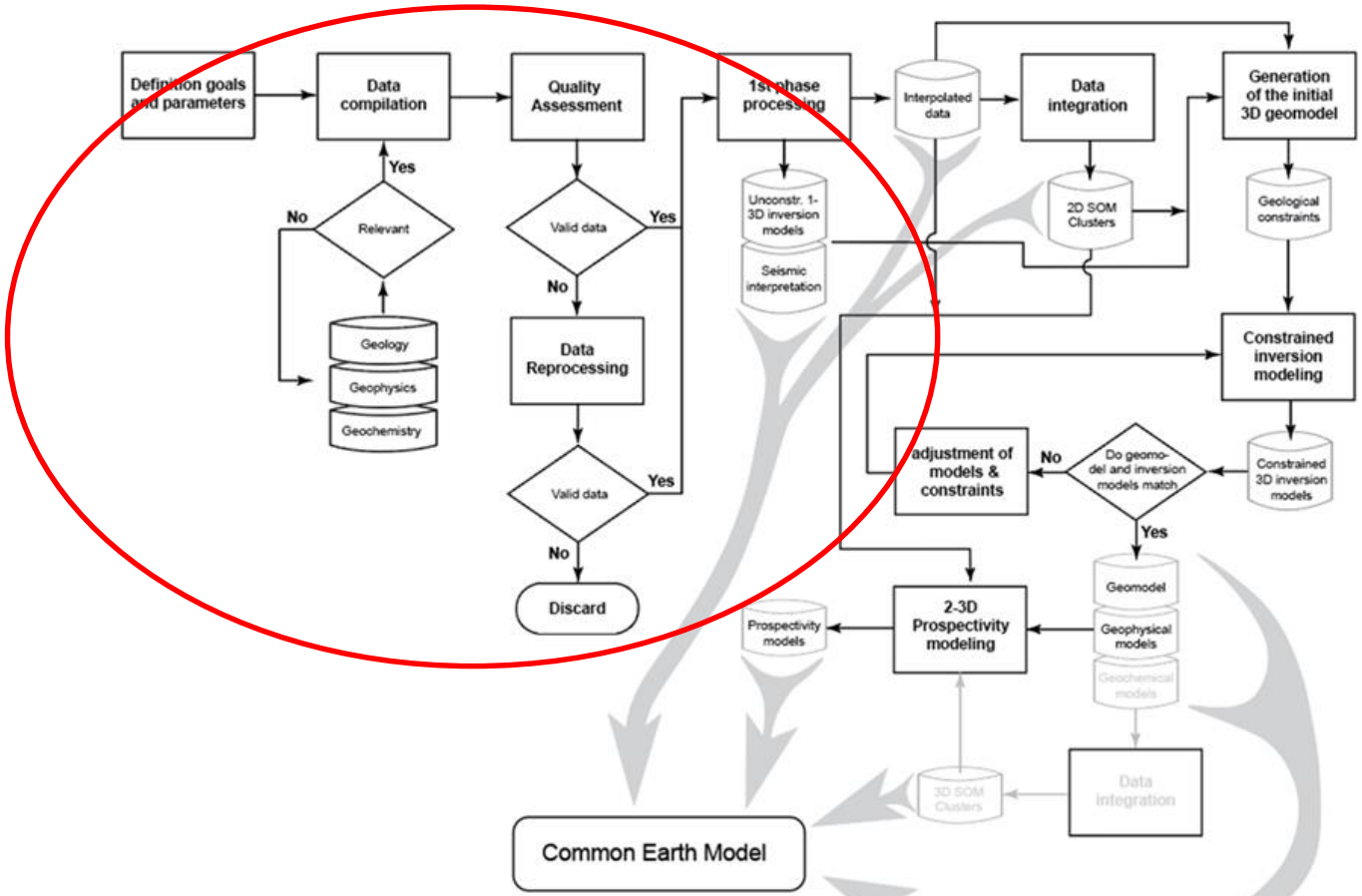
XL3D workflow



Content of the talk

- Principle of seismic reflection method
- XSoDEx data acquisition and processing
- Reprocessing of the Alaliesintie seismic profile
- Seismic interpretation

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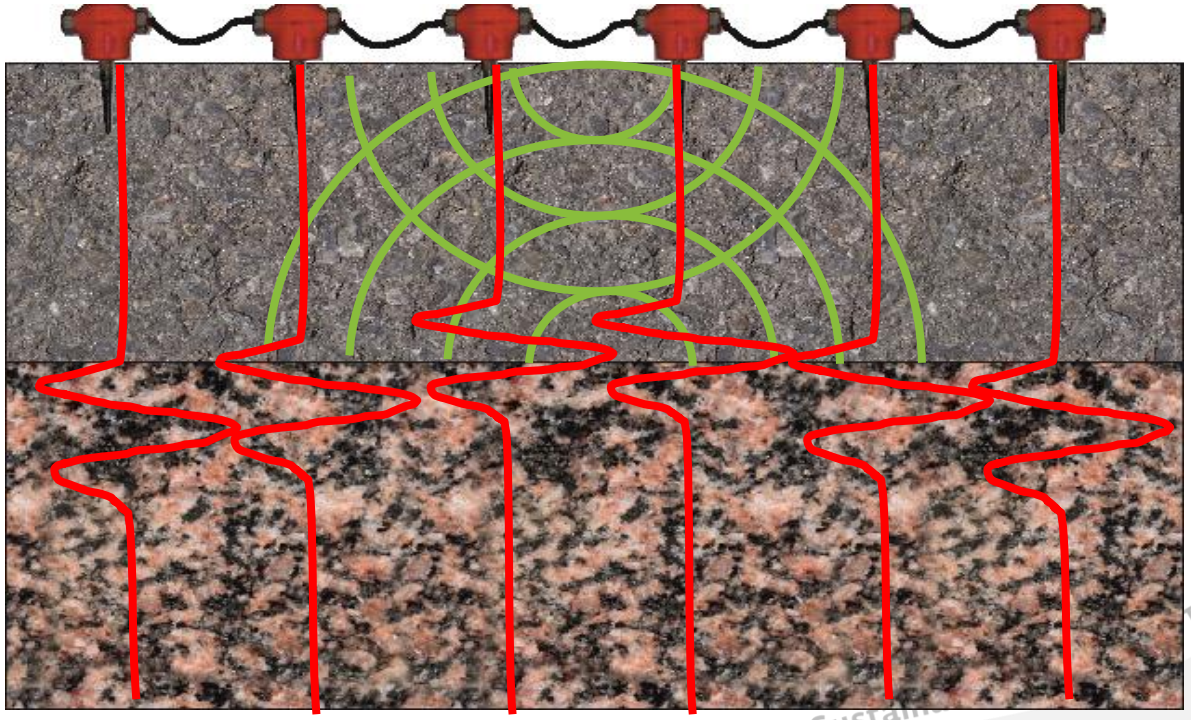
Principle of seismic reflection surveys

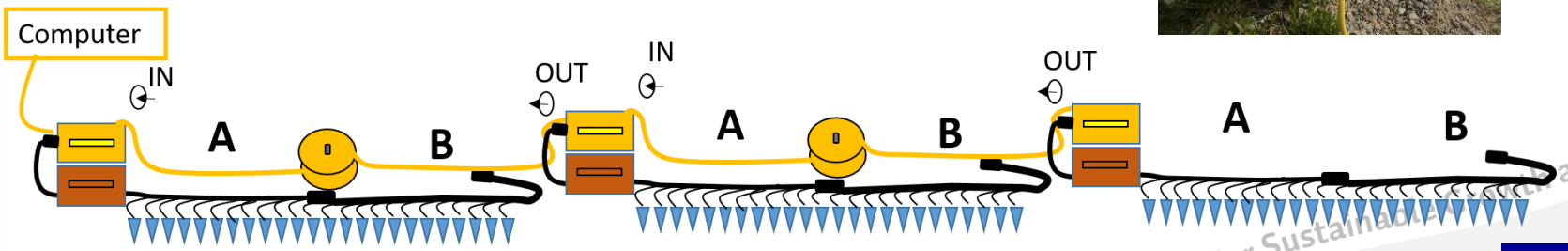
Change in acoustic impedance cause reflections



XSoDEx seismic reflection survey

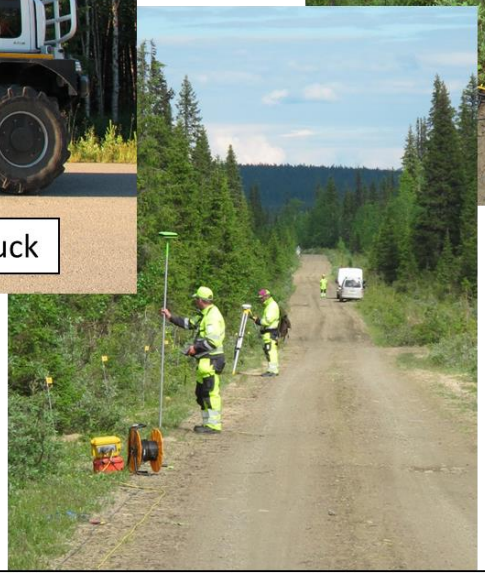
- 8 - 15 Geodes (”data logger device”)
- 24 geophones connected to each Geode
- 10 m receiver spacing
- Seismic data with max 360 channels
- Max spread length 3600 m
- Each receiver position measured with GPS

- 32 000 kg, 10 m long Thomas VIB 3246 vibroseis truck
- 3-4 sweeps / source point
  - 10-170 Hz (part of line 30-170 Hz)
  - 16 s Linear upsweep



TU Bergakademie Freiberg 32 tonnes vibroseis truck

Geodes with 24 channels each
10m channel spacing



Each channel measured with GPS

Over 10 000 shot gathers

Real time data quality monitoring

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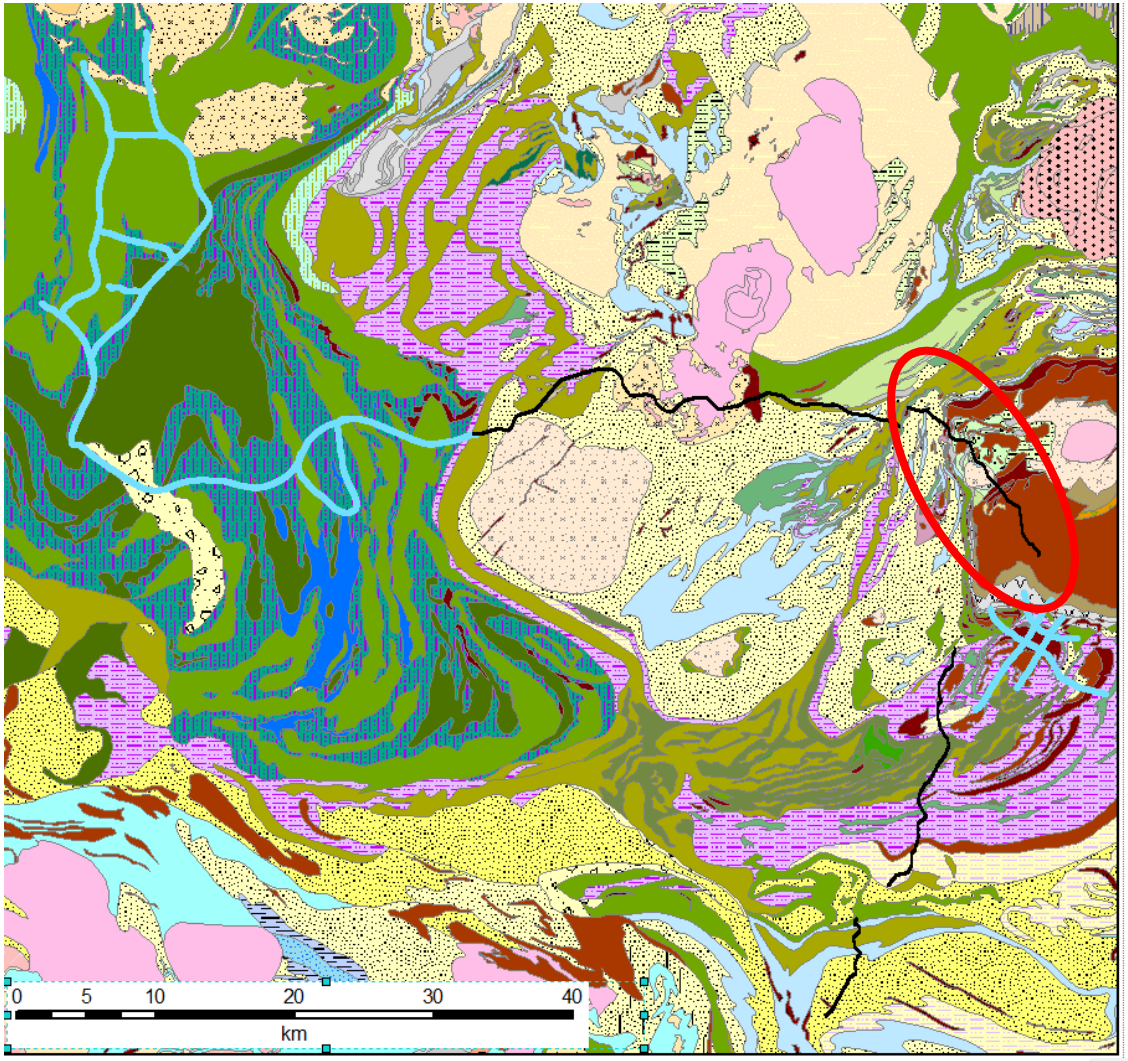
Unique data for mineral system studies



- New XSoDEx data combined with HIRE seismic reflection profiles is providing information about geological structures of Central Lapland down to several kilometers depth along hundreds of line kilometers!
- Alaliesintie seismic profile selected to XL3D project.

Data processing by TU Bergakademie Freiberg

- - “Jena cable rotation”
- - Geometry setup
- - **“t0-time-shift”**
- - **Conversion to SEG-Y format and input into processing system (ProMAX/SeisSpace)**
- - **“Spike-muting”**
- - **Vibroseis© correlation**
- - Quality control
- - Vertical stacking
- - Predictive deconvolution
  - Type of deconvolution: minimum phase predictive
  - Deconvolution operator length: 100
  - Operator prediction distance: 16
  - Operator white noise level: 0.1
  - Window rejection factor: 2.0
- - Frequency bandpass filtering 30-40-100-120
- Notch filter 50 Hz
- **“Air wave” attenuation**
  - Approximate velocity of energy to be attenuated: 320
  - Time gate width of air blast energy to attenuate: 400
- Trace equalization
- Automatic Gain Control (AGC)
  - Type of AGC scalar: MEAN
  - AGC operator length: 250
- Top mute

- **Data output from processing system in SEG-Y format**

Pre-stack Fresnel Volume Migration

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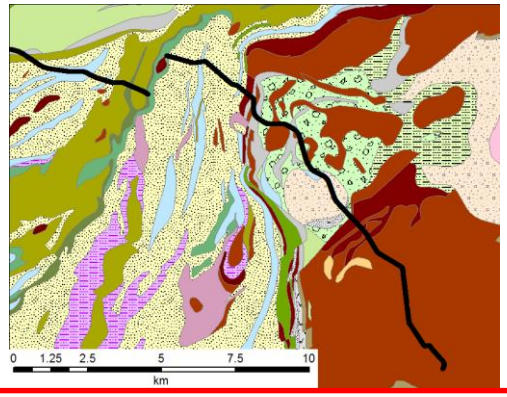
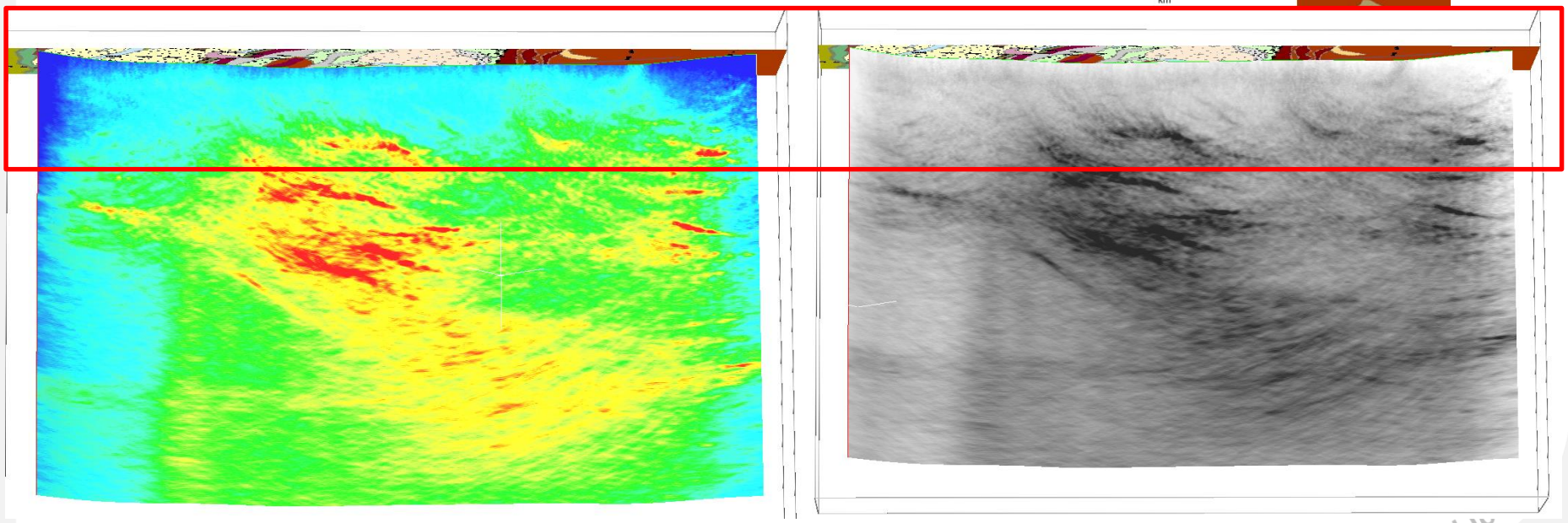
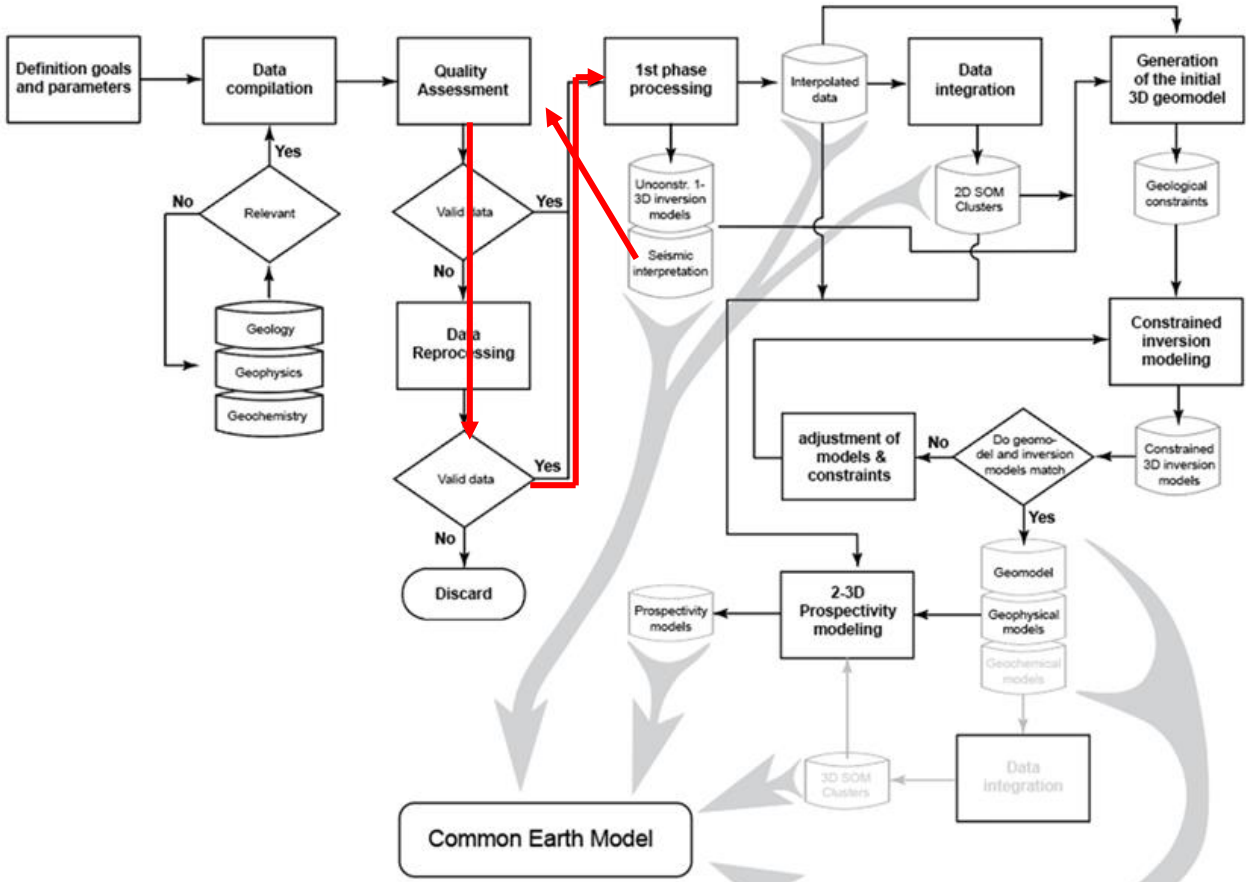
FVM results for Alaliesintie





Issue with data: upper 1.5 km no reflectors

XL3D workflow



Conventional time processing Alaliesintie seismic reflection data

```
READSEGY Data read from SEG-Y file
/cygdrive/o/xsodex/deliverables4gtk/deliverables4gtk/1a_rawdata/alaliesintie.sgy
ADDGEOM
STATIC Bulk shift of 80ms applied.
STATIC Shifts based on refraction static modeling
AGC window  250 ms
FDFILT BP (32-36-175-200)Hz
DECONW
FXDECON
AIRWAVE Airwave mute, V= 333m/s, LenZ,LenT=  82, 120ms
FDFILT BP (32-36-175-200)Hz
AGC window  250 ms,
DATUM_SRD Correction from floating datum to SRD
SMUTE End muting
NMO with 60% stretch mute & 20ms taper
STACK Stack with no normalisation
AGC window  498 ms,
STOLT STOLT migration, stretch=0.6
TDCONV
WRITESEGY
```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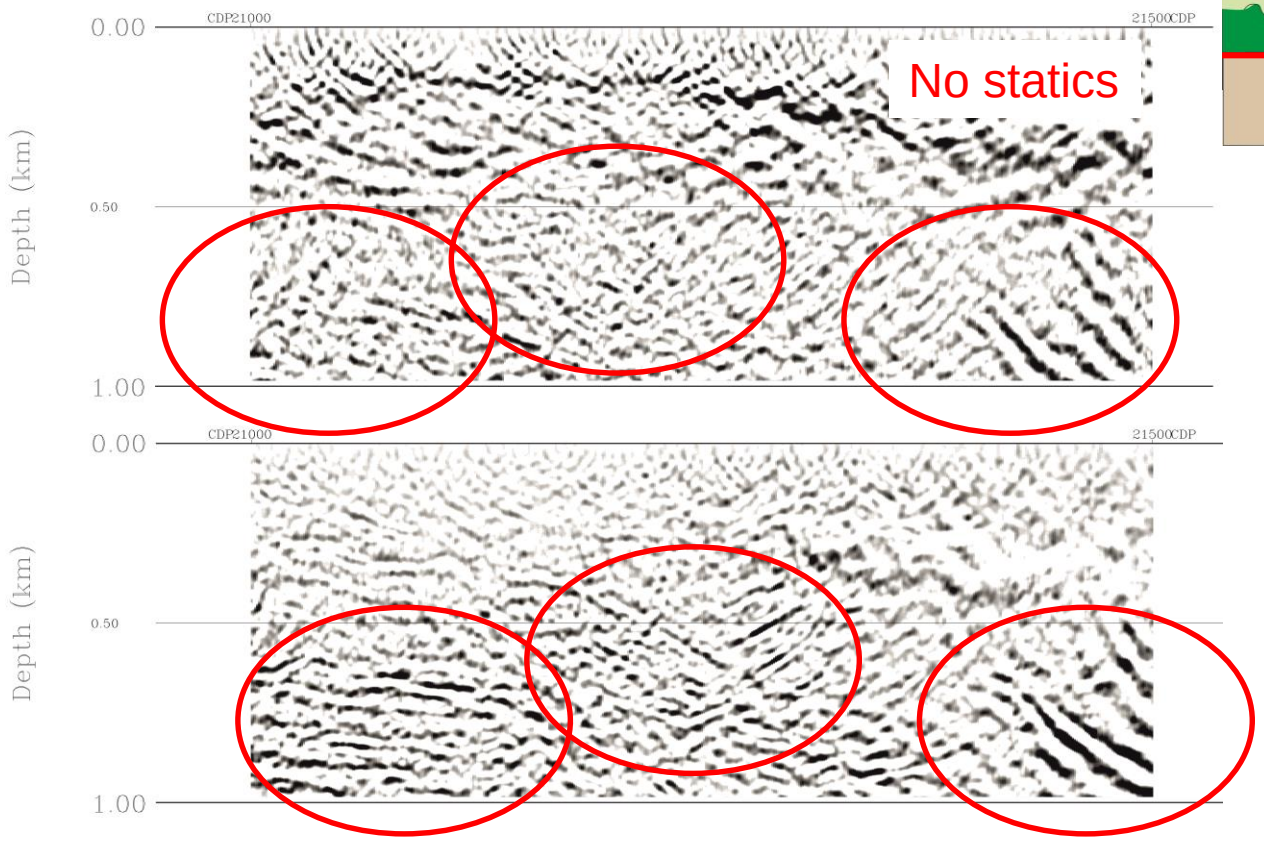
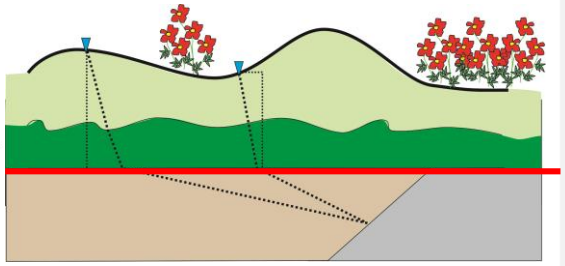
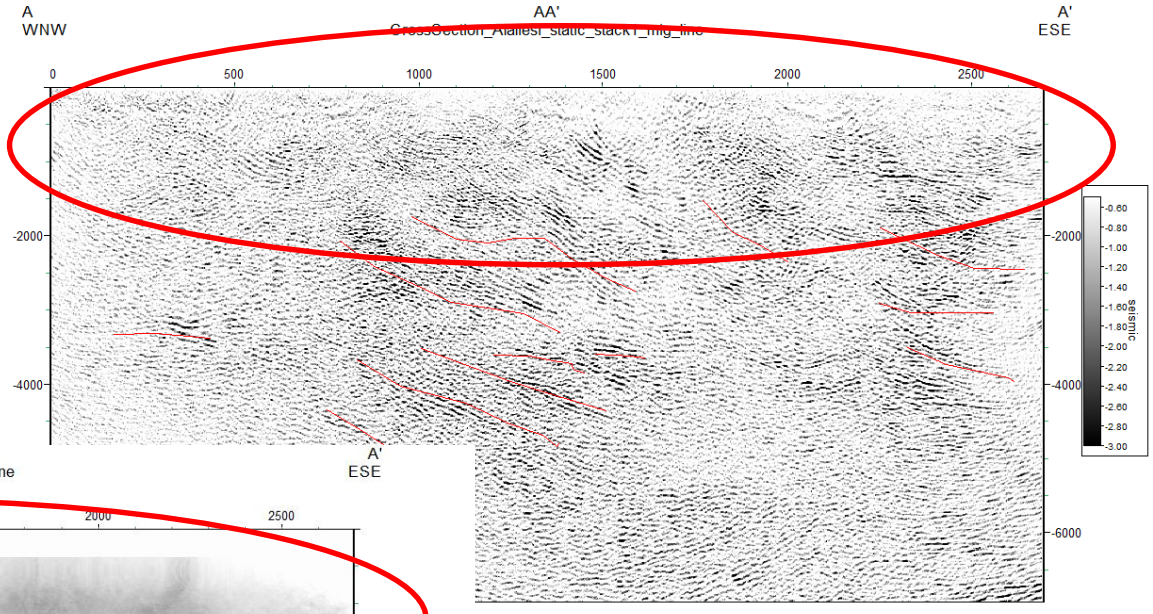
Importance of static corrections

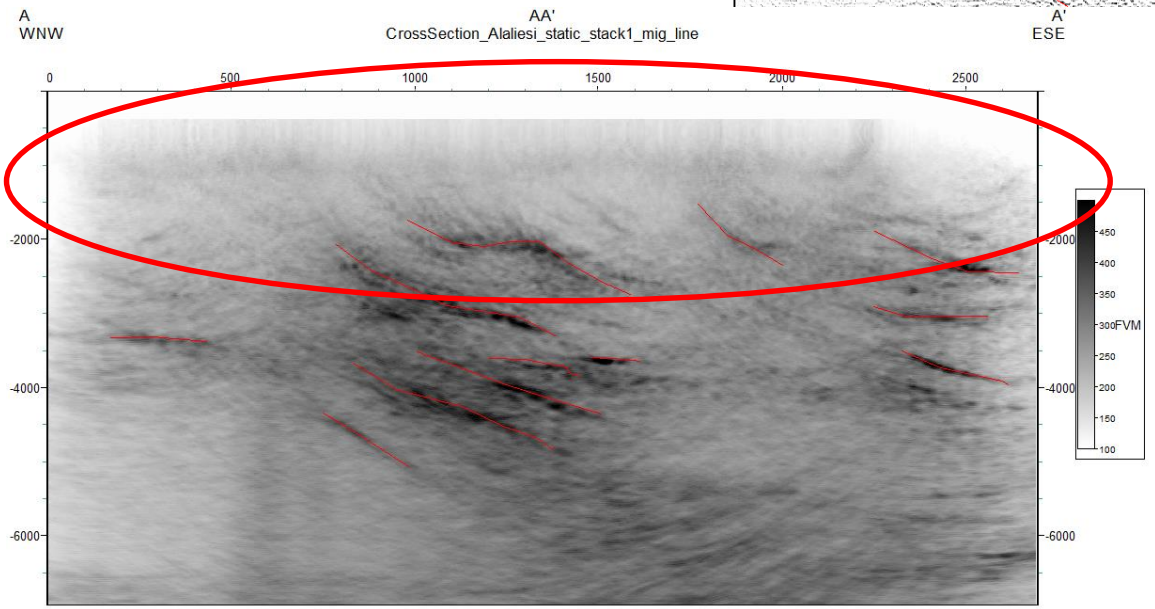




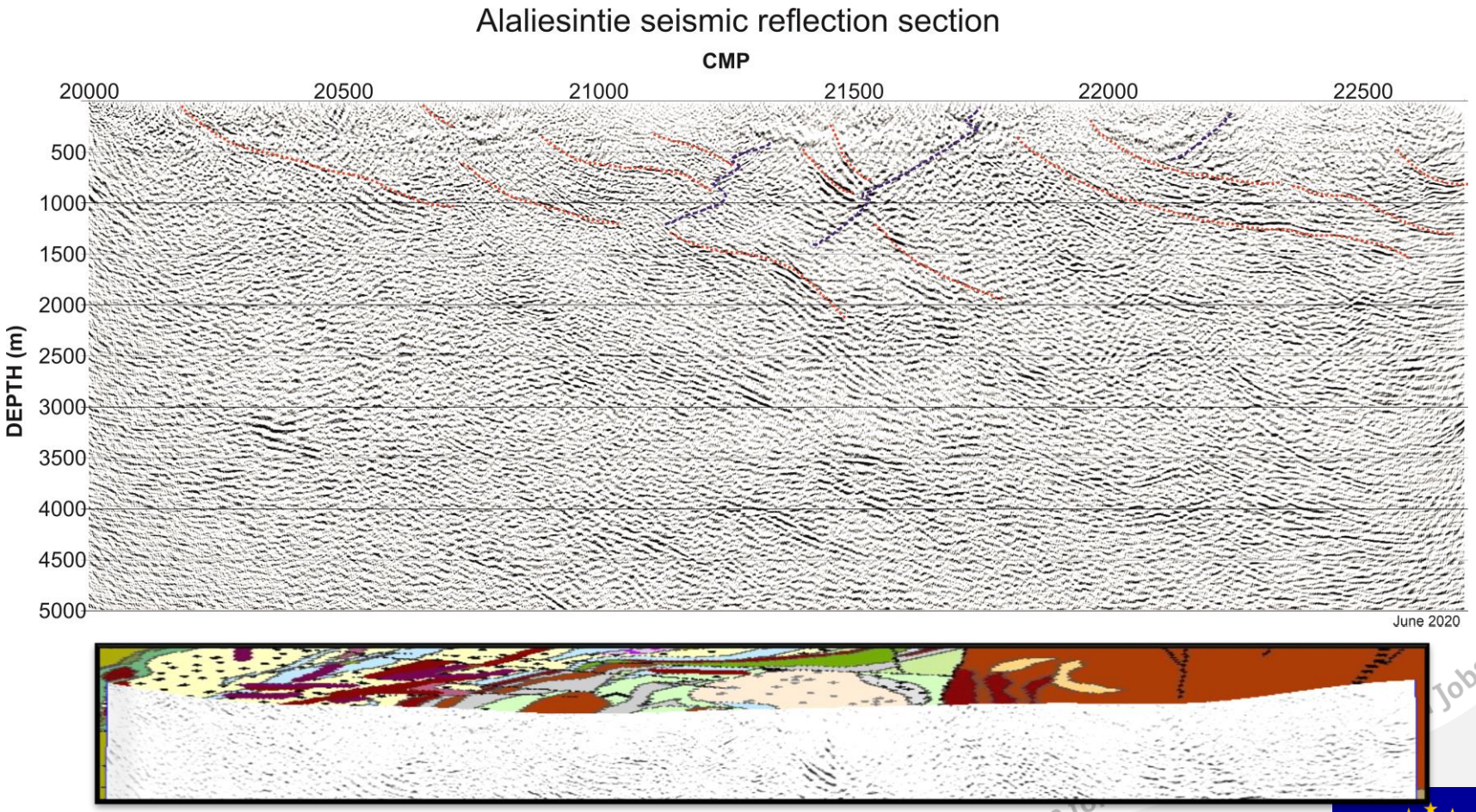
Static corrections are used to remove the effect of eleveation, overburden, and weathering.

Time processed vs FVM data

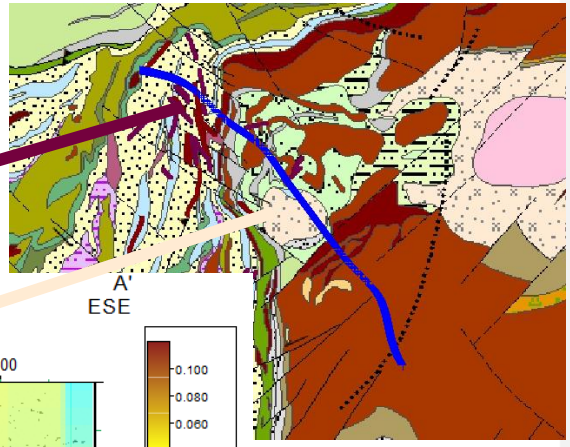


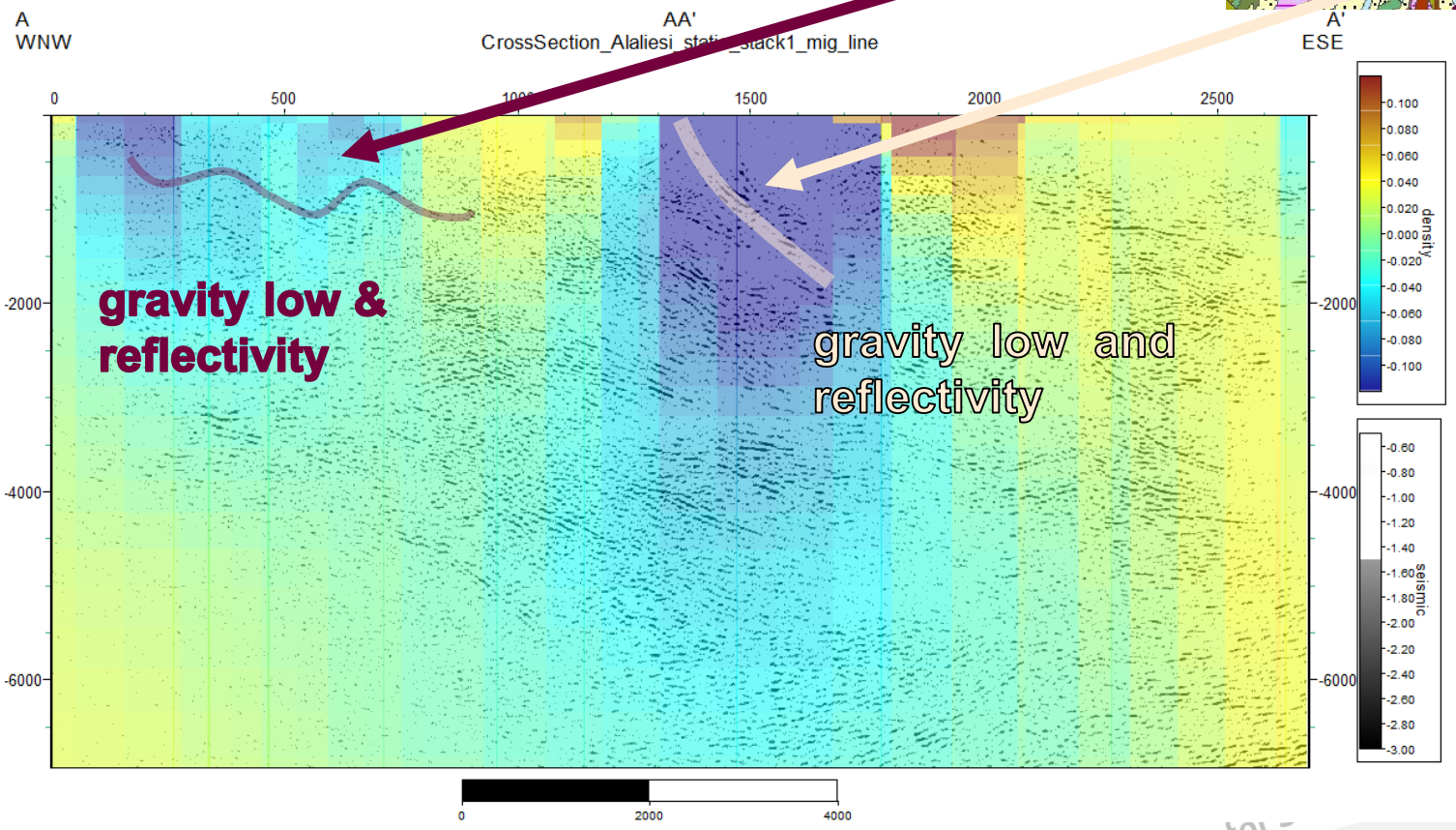


Time processed seismic section from Alaliesintie



Seismic data compared with gravity inversion





Key messages for using seismic reflection data in geological modelling

- XSoDEx seismic reflection data reveals abundance of reflectors that can be utilized to form ”sceleton” of the geological model
  - Reflections are caused by interfaces between rock formations with different physical properties
- Reprocessing can reveal new information of the subsurface and add resolution to interpretation
  - Static corrections are important in hardrock terrains
    - Varying near surface condition (swamps, glacial till, etc)
- Utilizing gravity, AMT and other geophysical data for seismic interpretation essential

Thank You!

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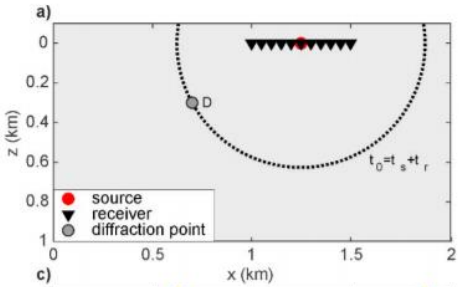
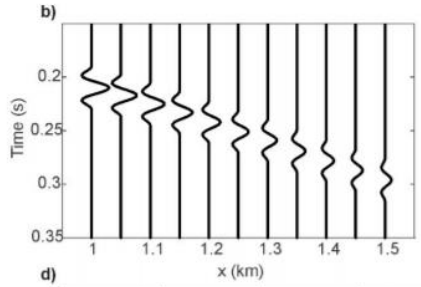
Principle of Kirchhoff and Fresnel Volume Pre-stack depth migration

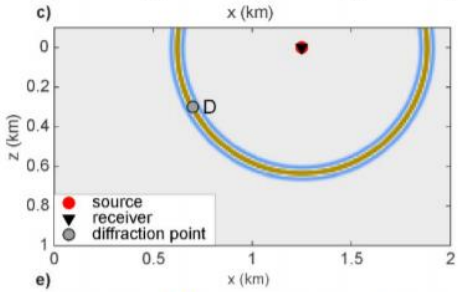
Model consisting of one diffraction point D embedded in a medium with a homogeneous velocity of 5000 m/s

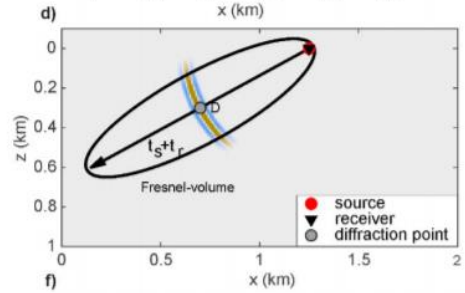




Syntethic shotgather for the source and 11 receivers

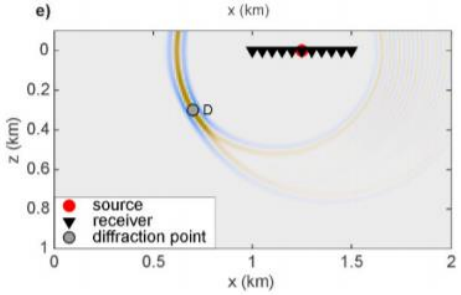
Kirchhoff pre-stack depth migration images for a single receiver located at the source

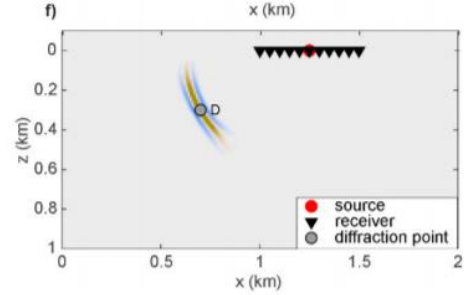




Fresnel Volume Migration pre-stack depth migration images for a single receiver located at the source

Kirchhoff pre-stack depth migration image for all 11 receivers





FVM pre-stack depth migration image for all 11 receivers

The Fresnel Volume is defined for a direct ray path starting from the receiver and propagated into the subsurface up to the two-way travel time of the corresponding time sample to be migrated