„Acoustic impedance inversion analysis: Croatia offshore and onshore case studies“

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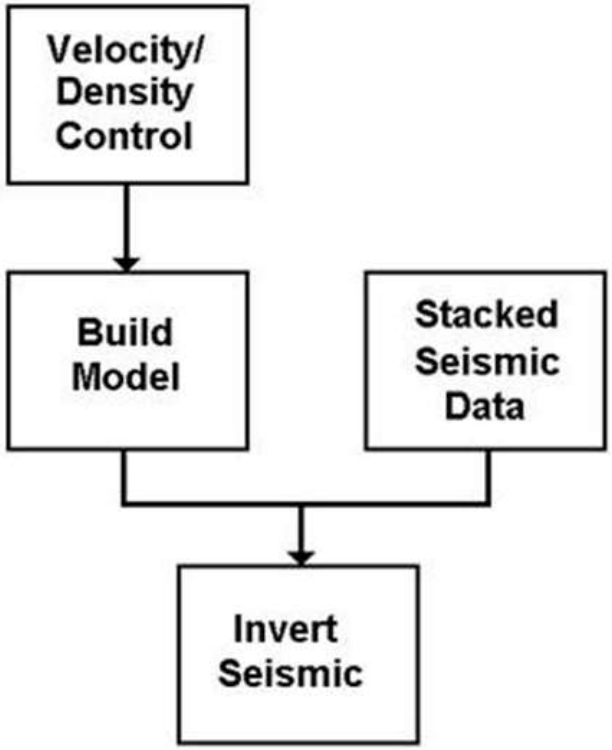
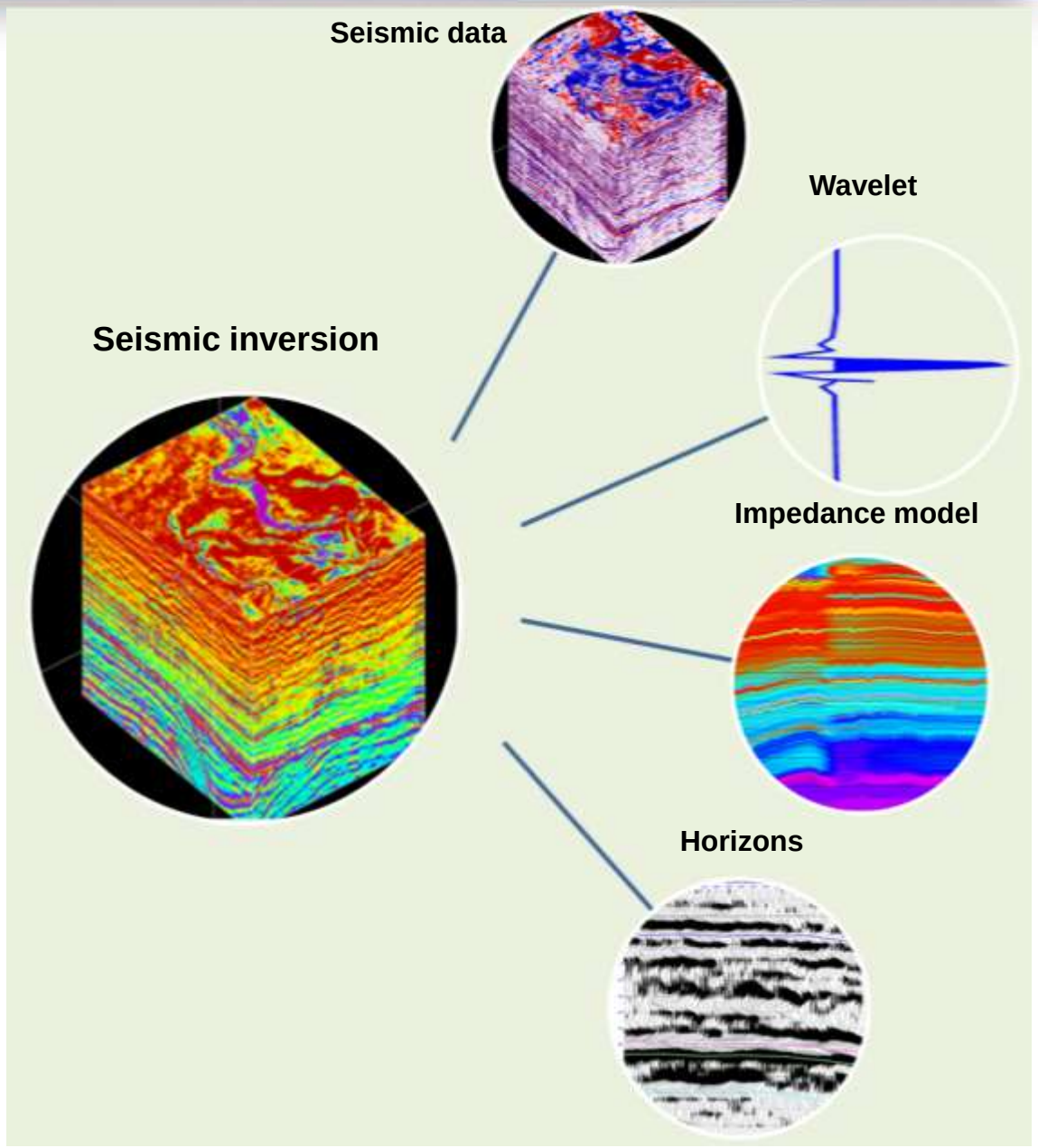
Introduction

- Acoustic impedance is the product of rock density and compressional velocity, and therefore is measure of physical properties of the rock.
- „Inversion” implies converting seismic reflection amplitudes into impedance profiles. This involves removing the bandpass filter („wavelet”) imposed by seismic acquisition and processing.
- In this paper inversion of post-stack seismic data is done to obtain information about the P-wave impedance.
- The inversion procedure includes background impedance model, wavelet extraction and inversion analysis by synthetic seismogram and finally seismic inversion.

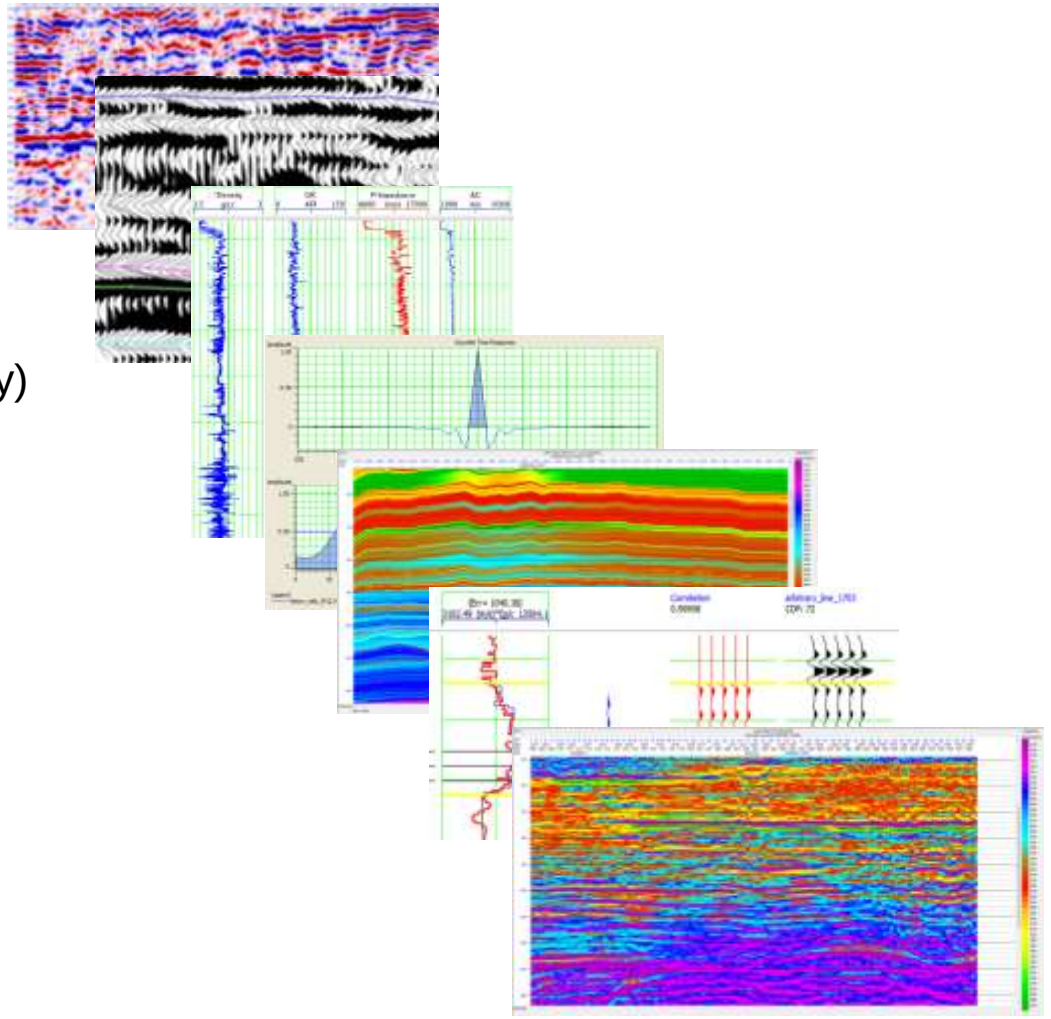
Methodology





Methodology

- PostStack seismic inversion steps:
  - Seismic volume
  - Seismic horizons
  - Well log data (P-wave and Density)
  - Extraction of wavelet
  - Acoustic impedance initial model
  - Inversion analyses
  - Seismic inversion volume



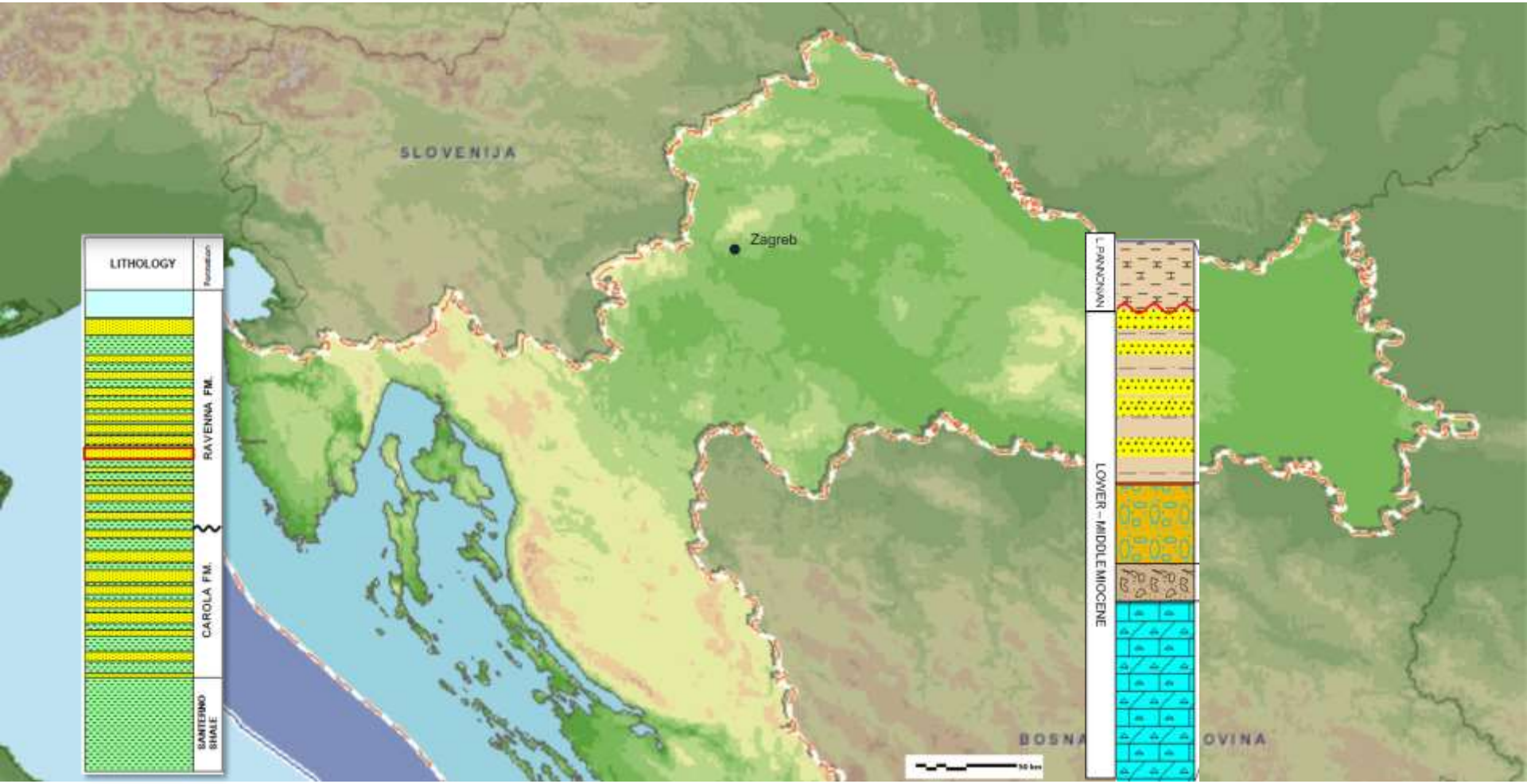
Methodology

- Seismic inversion use borehole and seismic data in order to define geological features which have caused some geophysical response.

- Seismic inversion process starts with Model Building. Model incorporate well log data (P-wave and density), horizons which makes distribution of values in the area.

- Extraction the wavelet will estimate the amplitude spectrum from the seismic data, but we must make an assumption about the phase: typically we assume the data are zero-phase.

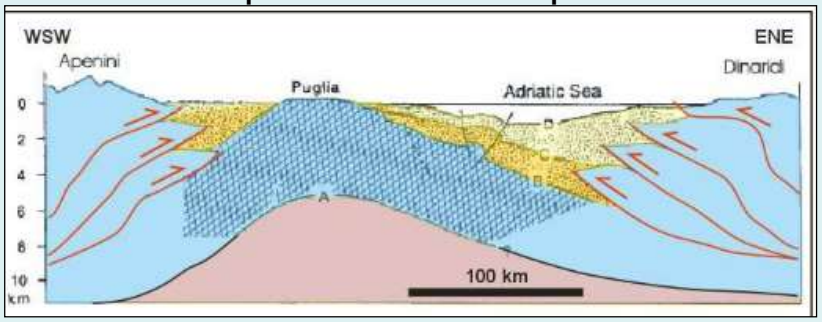
Geological setting



Geological setting

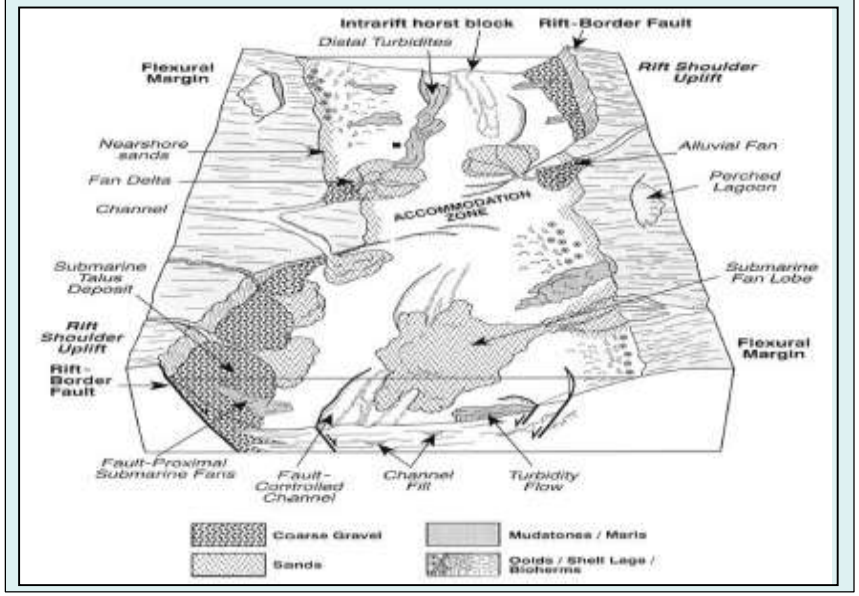
Offshore case study

- Block is situated at the edge of Istrian carbonate platform.
- Deposits belong to Middle Pleistocene Ravenna formation and those sediments completed the final filling of the basin.
- The lower part of Ravenna Fm. is characterized by a rapid progradation of prodelta bodies, but in upper part delta front-delta plain conditions prevail.



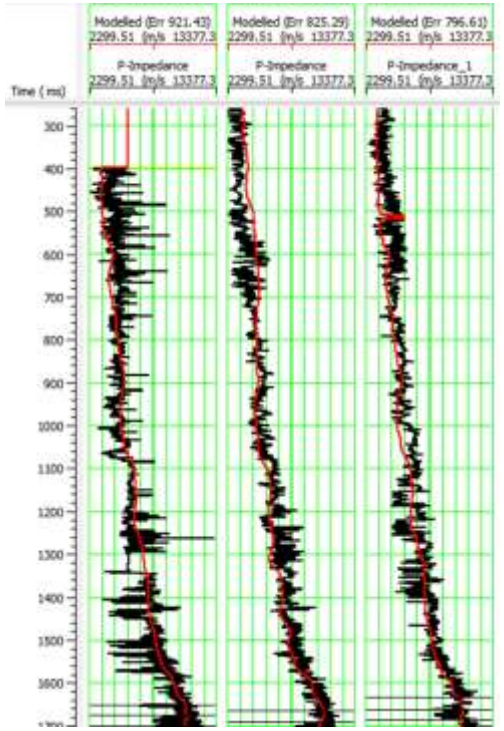
Onshore case study

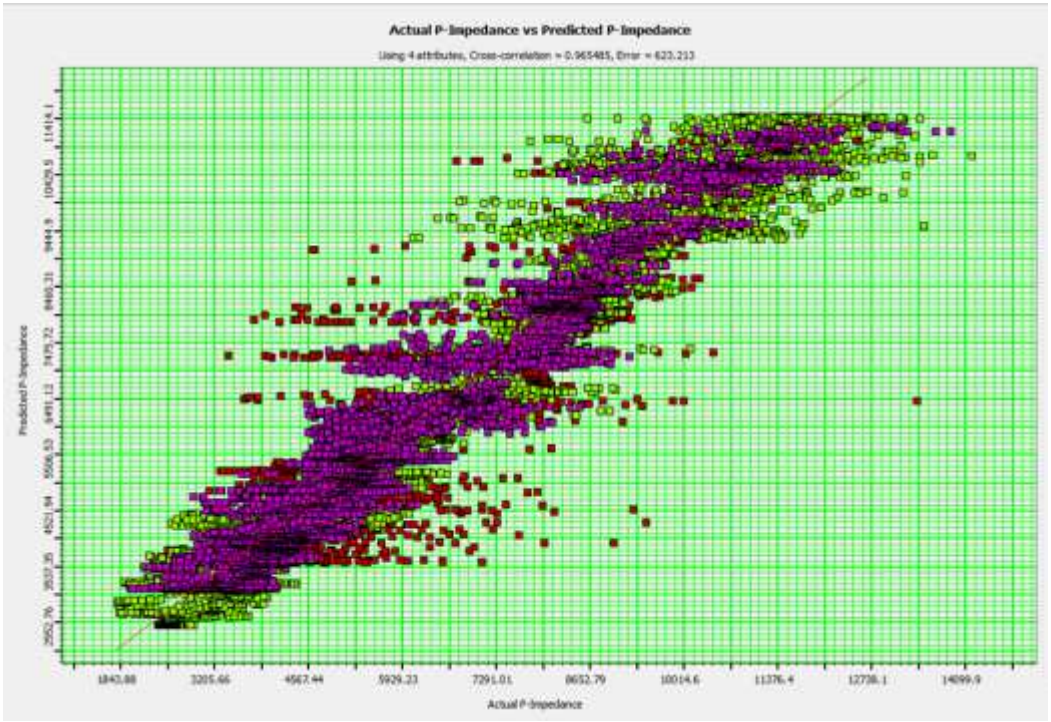
- Extensional fault systems
- Structural-stratigraphic traps
- Lithofacies unit represented by limestone-dolomitic conglomerates.



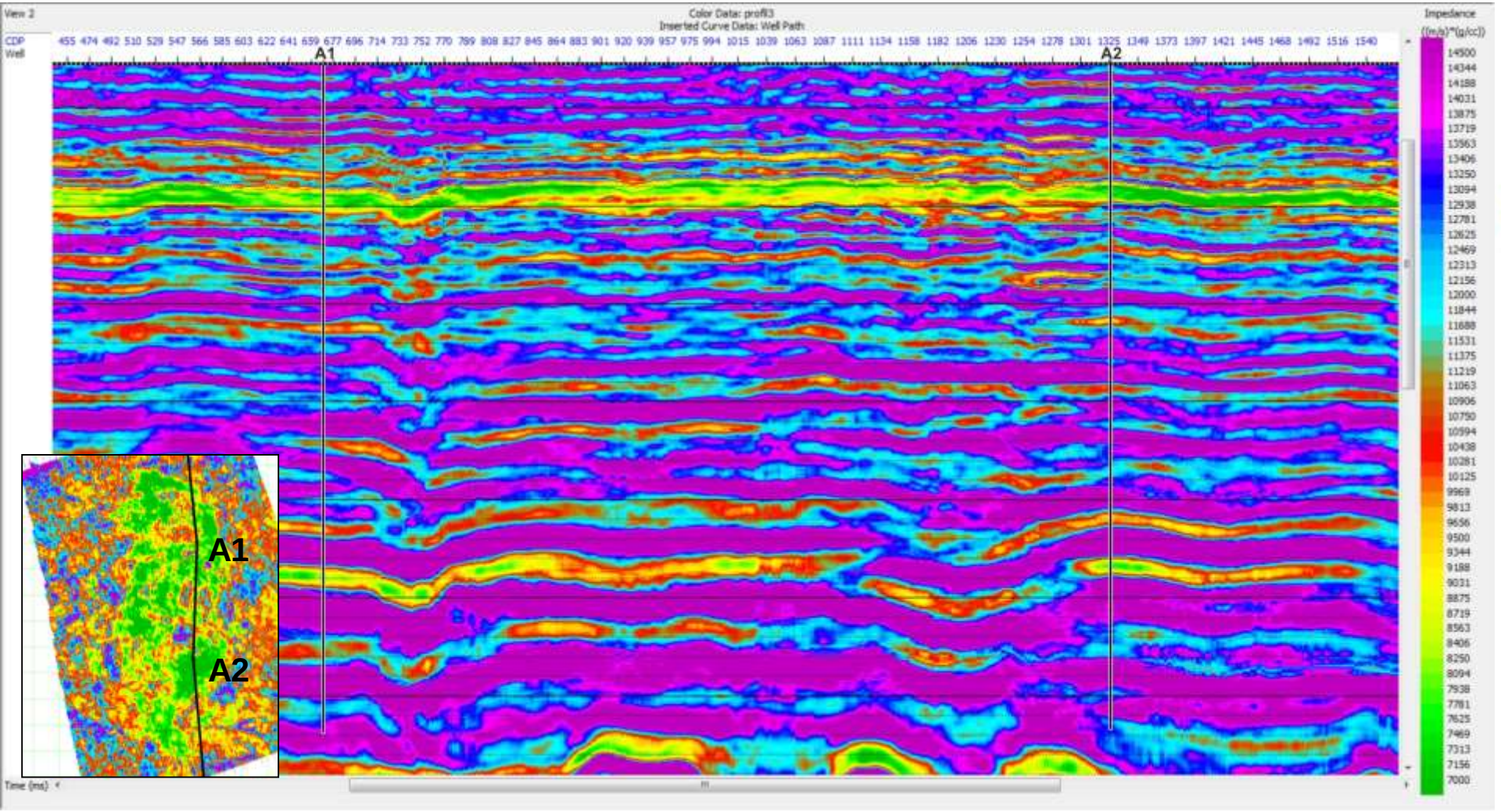
Geological setting

- Main tasks
  - Seismic reservoir characterization based on seismic inversion
  - Determine reservoir continuity between wells
  - Proposing new wells and new perspective areas
  - Prediction porosity and density distribution using inversion impedance model

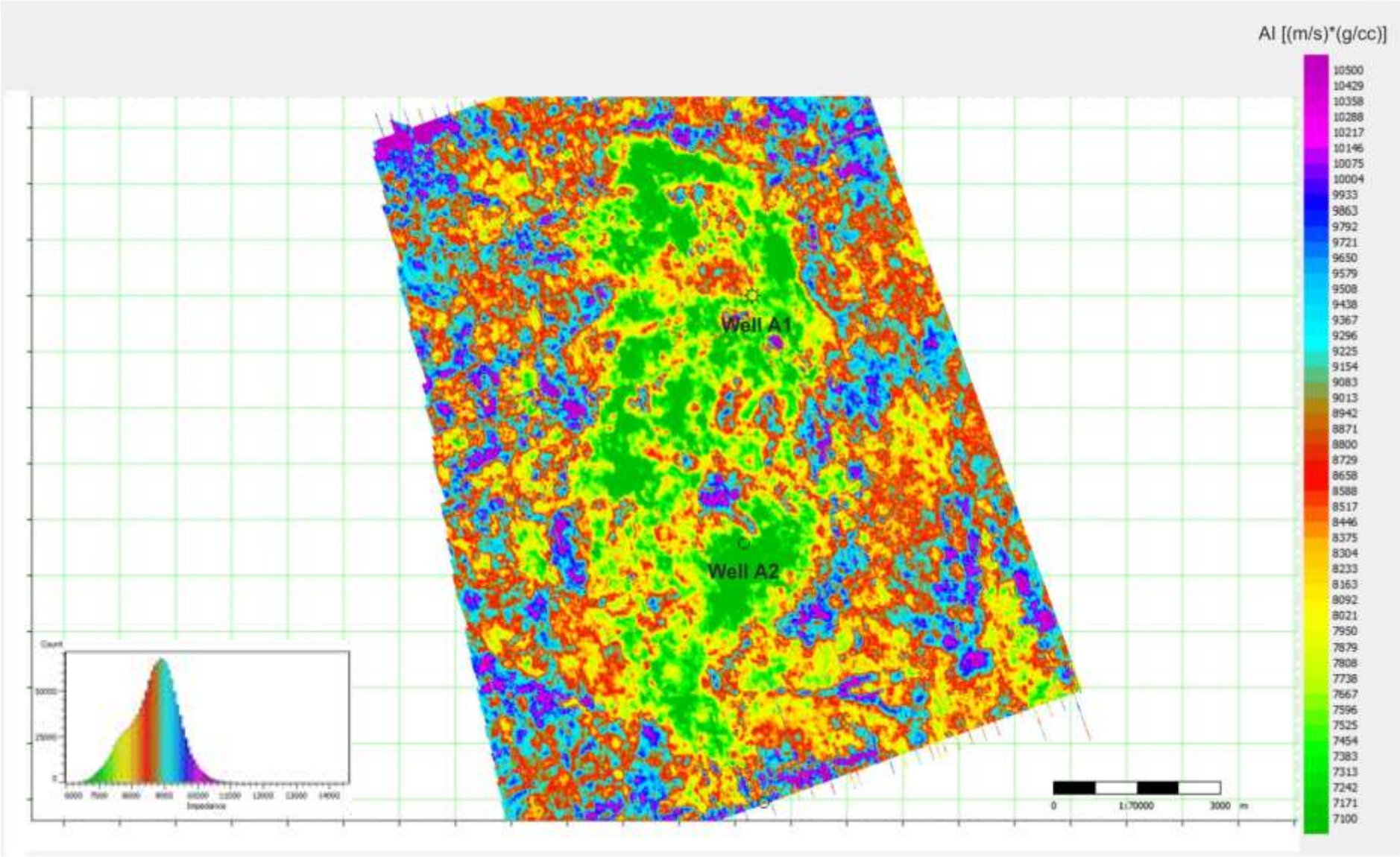




Offshore case study

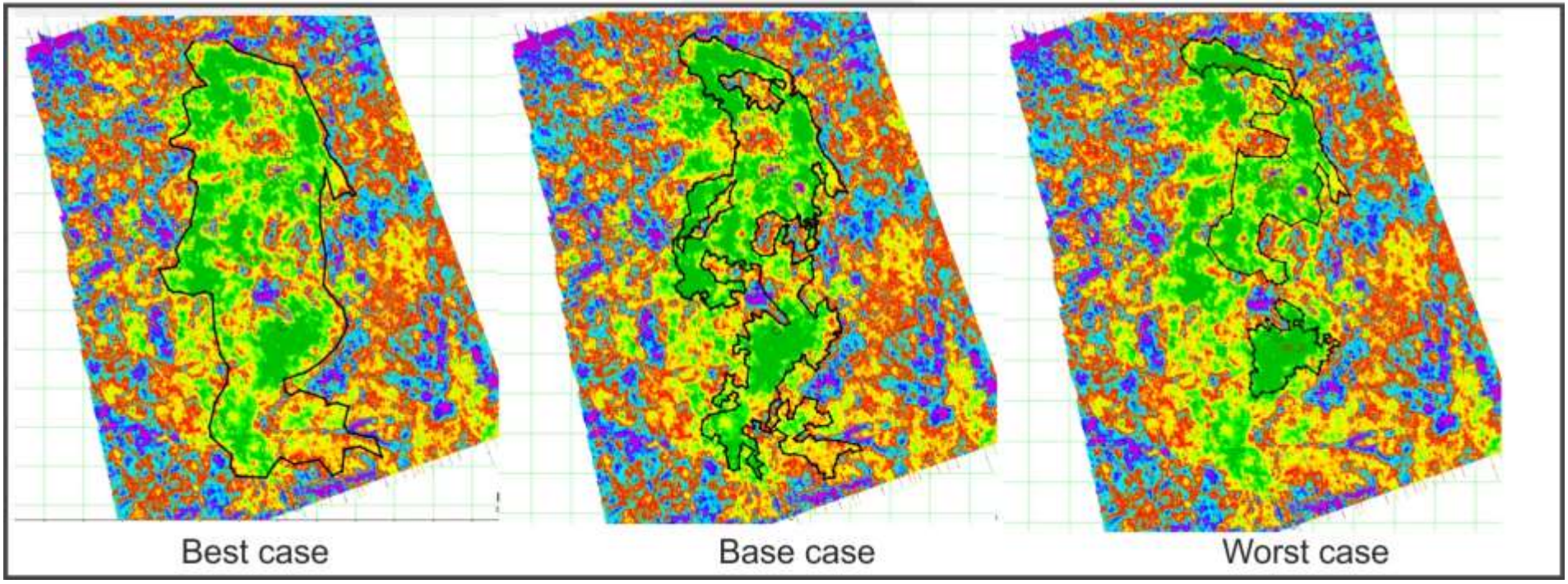


Offshore case study

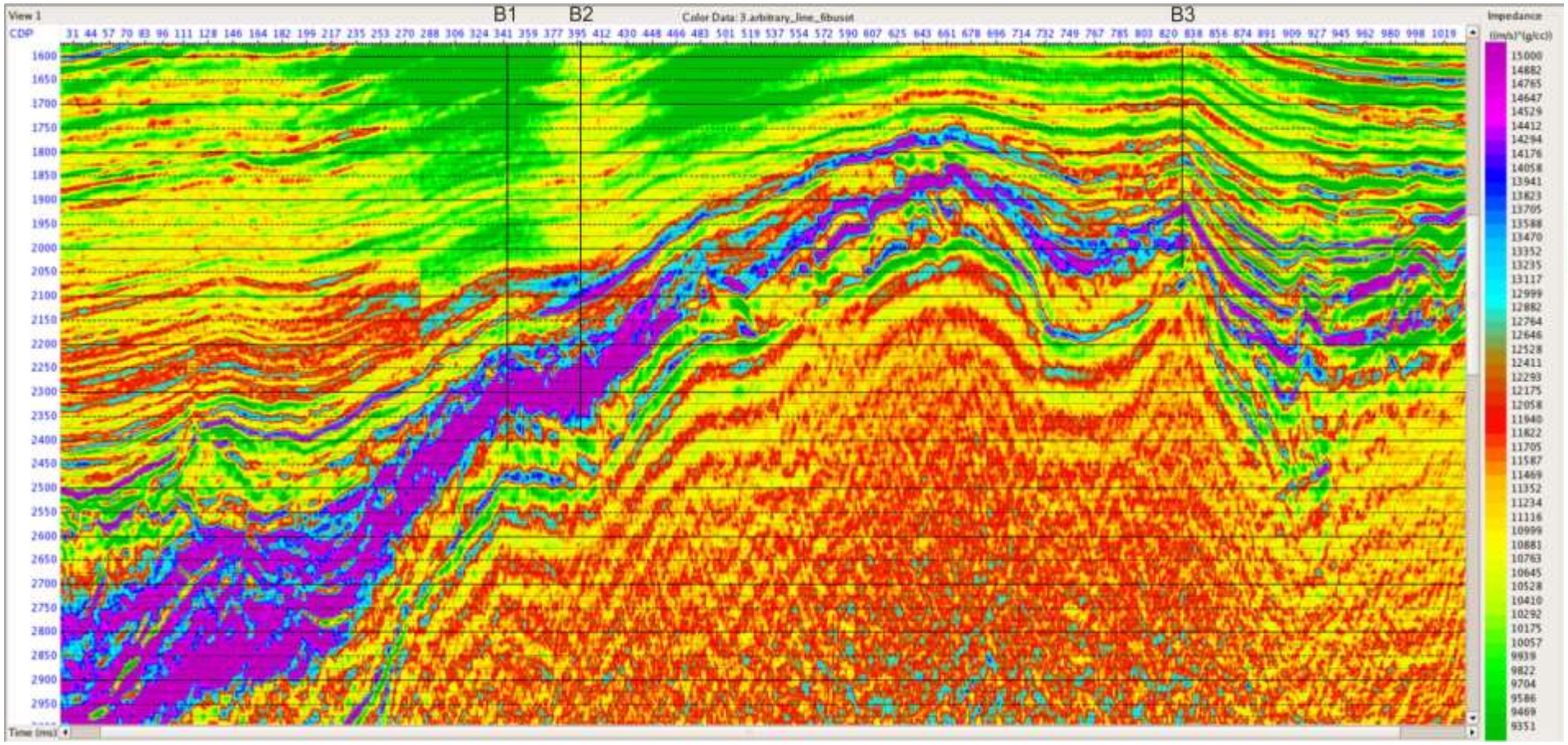


Offshore case study

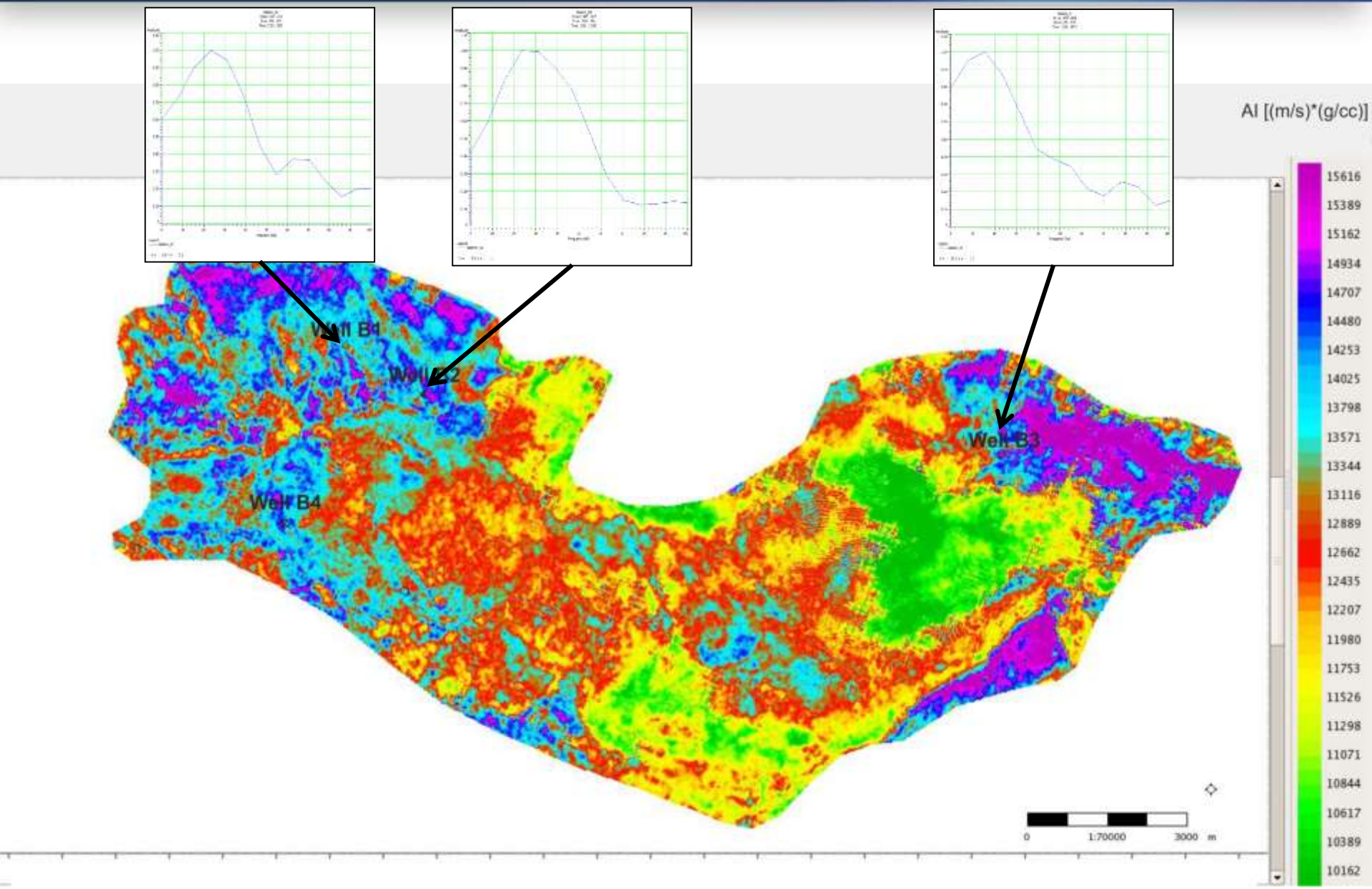
- Acoustic impedance (AI) map is shown in time window of 12 ms. AI values distributed around A1 and A2 wells are in range of 6500 to 8500. Anomaly continuity it is also visible with connection located north-west from A2 proposed well.
- Lower values of AI (lower density, lower velocity) indicate better reservoir properties as porosity.
- AI map is used for proposed reservoir polygons based on seismic anomaly. Worst case polygon delineates best property areas (green) of AI anomaly. Best case polygon contains whole AI anomaly area.



Onshore case study



Onshore case study

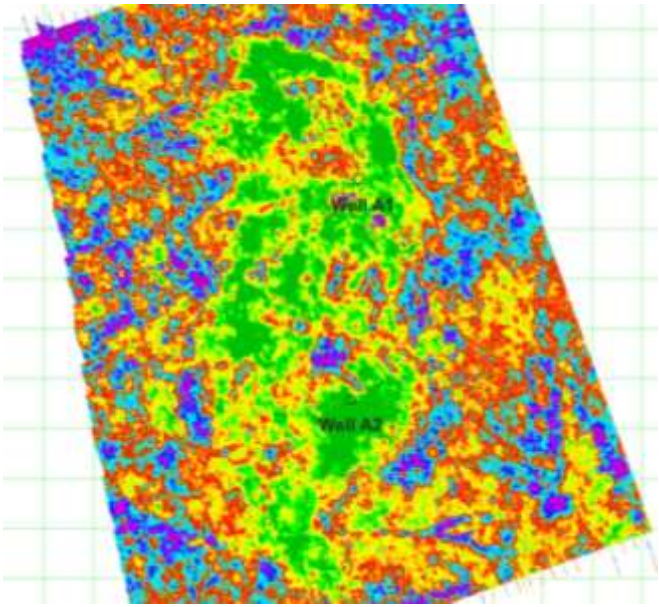


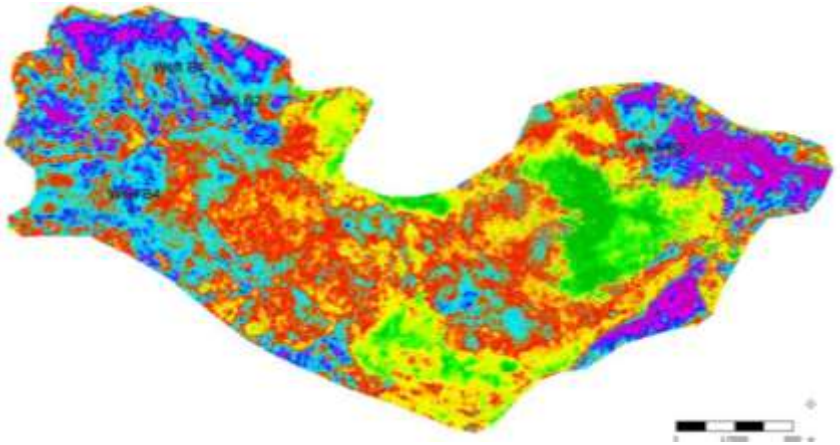
Onshore case study

- Acoustic impedance (AI) on studied layer are in range from 10500 to 13000 (m/s)*(g/cc), while values around wells B1 and B2 are slightly higher than values around proposed well B3, which leads to the assumption that area around proposed well B3 has better reservoir properties.
- Narrow amplitude spectrum around the wells are extracted from seismic volume and analyzed.
- Amplitude spectrum analyses shows similar amplitude spectrum on wells B1, B2 and proposed well B3.

Conclusion

- Impedance map shows distribution of reservoir properties
- Lower AI ⟶ higher porosity
- Acoustic impedance map is base for reservoir parameter distribution and dynamic modelling
- Maps indicate good reservoir properties on new proposed wells location





Conclusion

- Main Issues
  - Seismic data is bandlimited and therefore does not have the original low or high frequency data, unlike well log data.
  - Inversion cannot find a unique solution. One impedance model will make one synthetic seismogram that matches our seismic data.

- Advantages
  - It allows us to incorporate into the seismic interpretation a model, based on the known or suspected geology.
  - This can result in better resolvability and a better link between the seismic data and the actual lithology.
  - Well log data incorporate low and high frequencies missing from the seismic data.

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