Acoustic impedance inversion of the Nisku Formation in a proposed CO_2 storage site in the Wabamun area, Alberta

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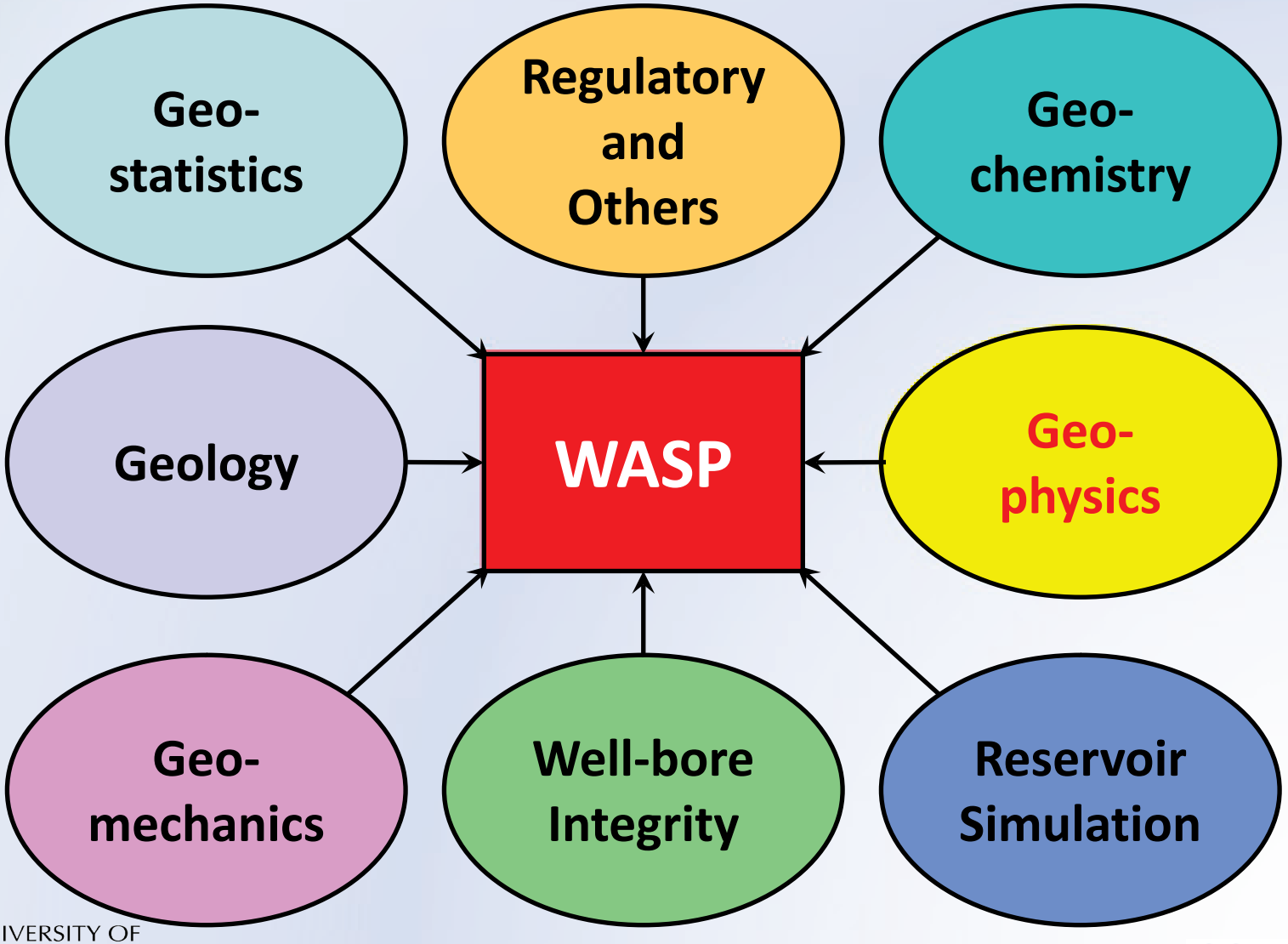
Outline

- Overview/Objectives
- Study area
- Acoustic impedance inversion
- Numerical modelling
- Field data results
- Conclusions

Overview

- Wabamun Area CO_2 Sequestration Project (WASP).
- U of C lead multidisciplinary public project funded by NSERC Strategic Grant and AERI with industrial partnership.
- Investigate the feasibility within the Nisku Fm., Wabamun area, for a 1 mt/year CO_2 storage capacity.

Overview


Geo-statistics
Regulatory and Others
Geo-chemistry
Geology
WASP
Geo-physics
Geo-mechanics
Well-bore Integrity
Reservoir Simulation

Objectives

1. Seismic mapping and characterization of the Nisku Fm. within the WASP study area.
2. Identify geologic features that may compromise the Nisku Fm. and caprock integrity, e.g. anomalies and karsting.

Method

Acoustic impedance inversion of the Nisku Fm.

Issue - thin bed tuning

Alberta & study area

NRCan (2009)

WASP Large-scale Study Area (LSSA)

WASP High-grade Focus Area (HGFA)

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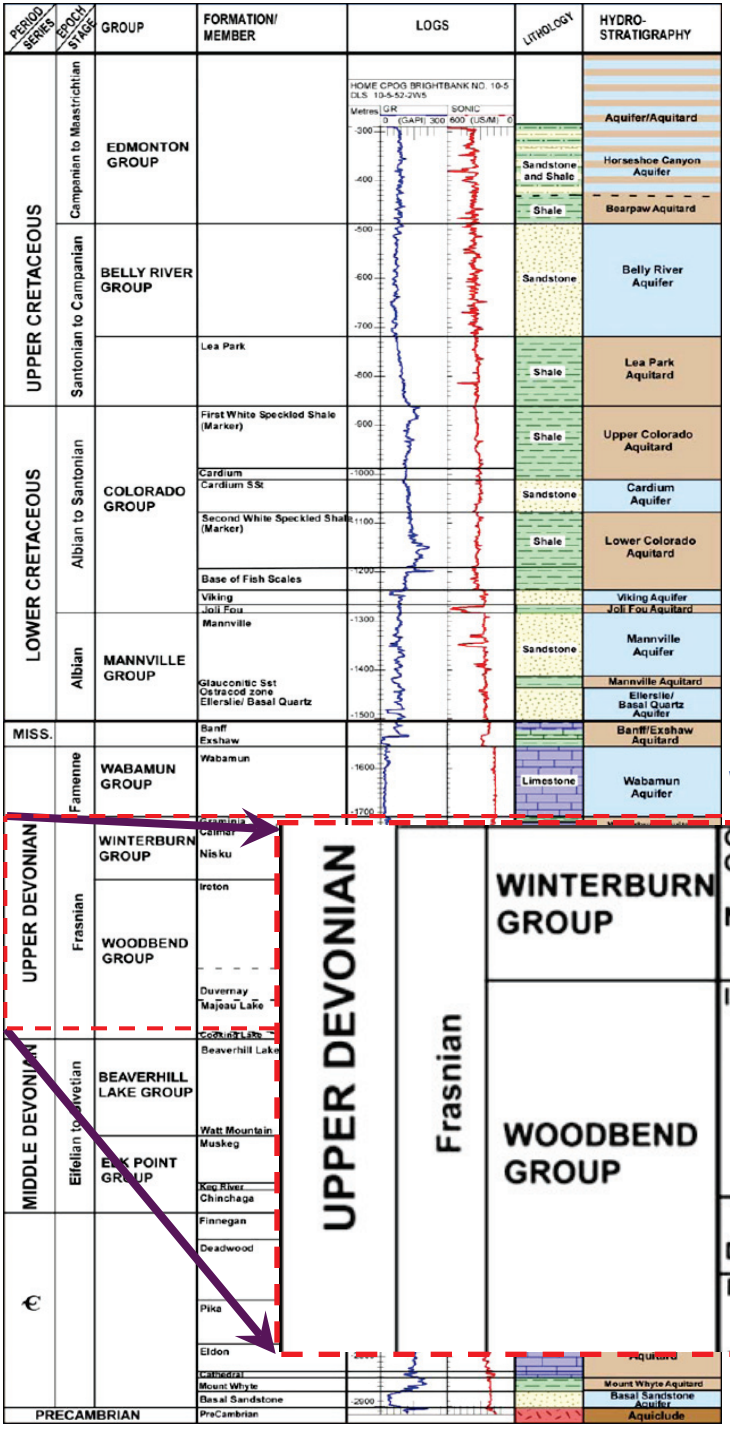
Stratigraphic model: Wabamun area (well 10-05-052-2W5)



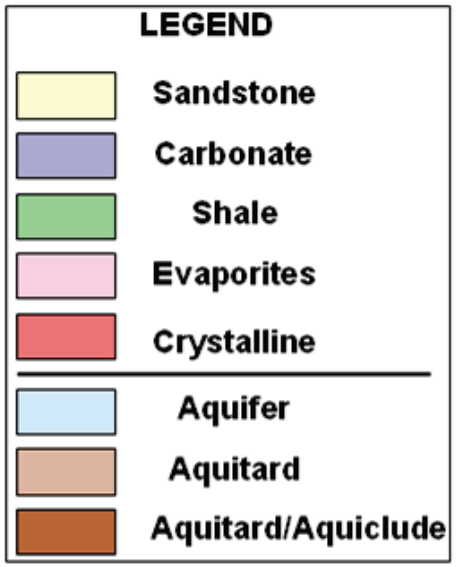
Belly River ~ 490 m

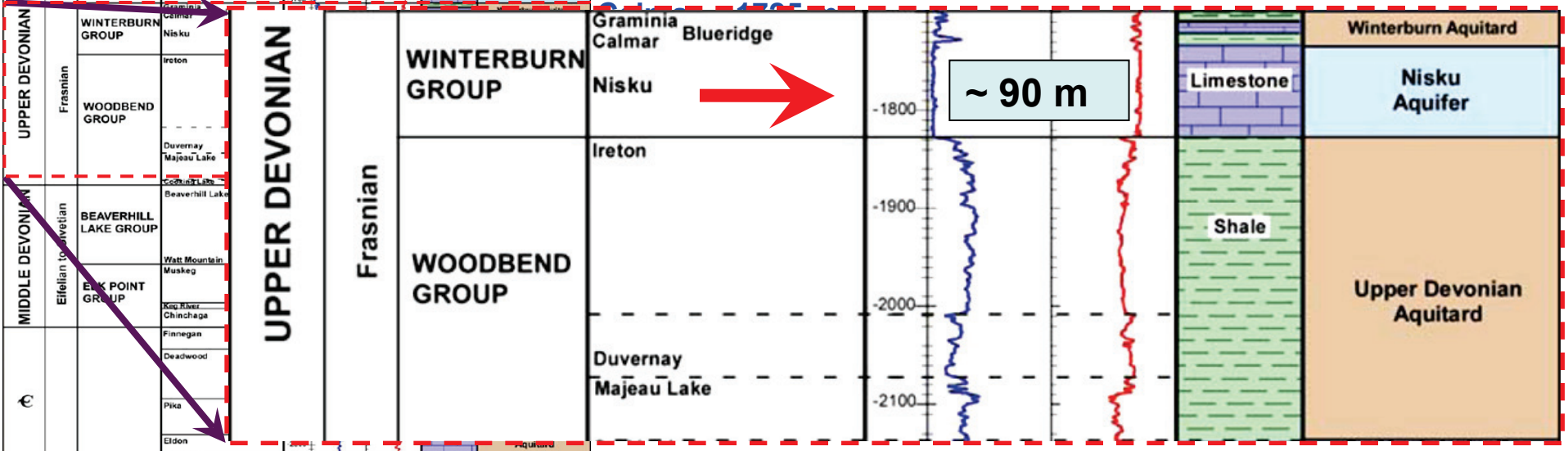
Cardium ~ 989 m

Mannville ~ 1282 m

Wabamun ~ 1555 m

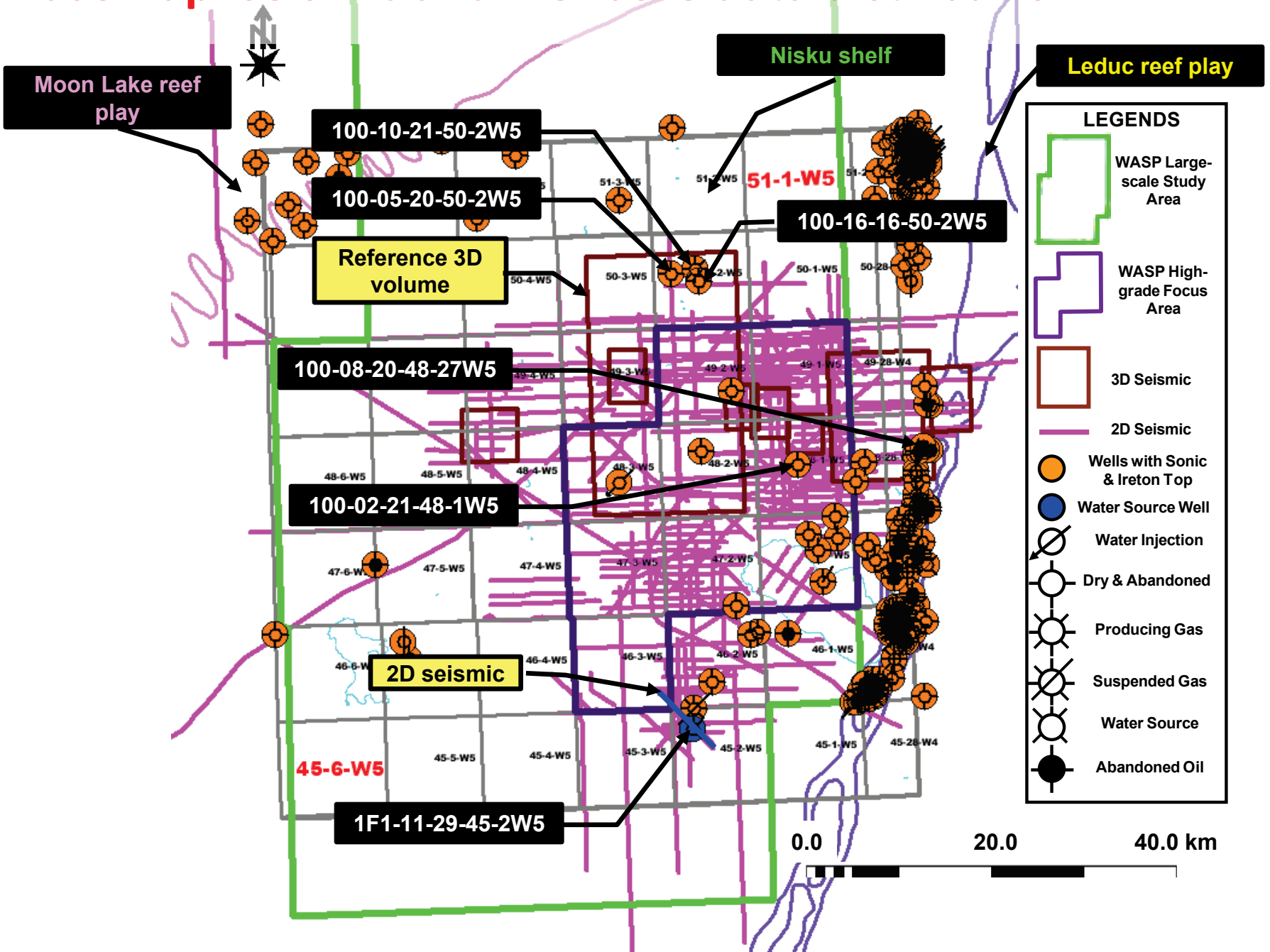
Basal Sandstone ~ 2868 m



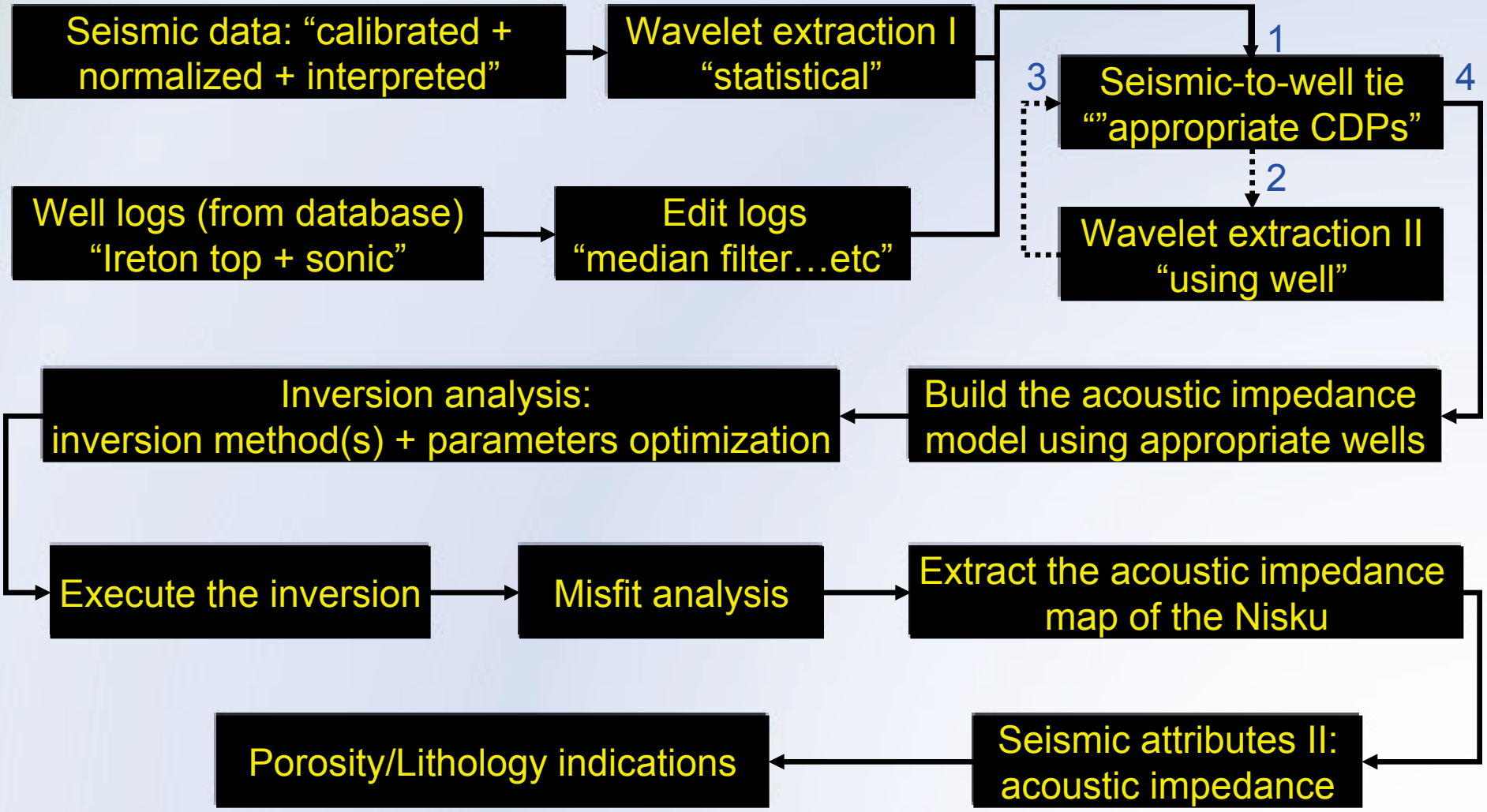


(modified after Bachu and Bennion, 2009)

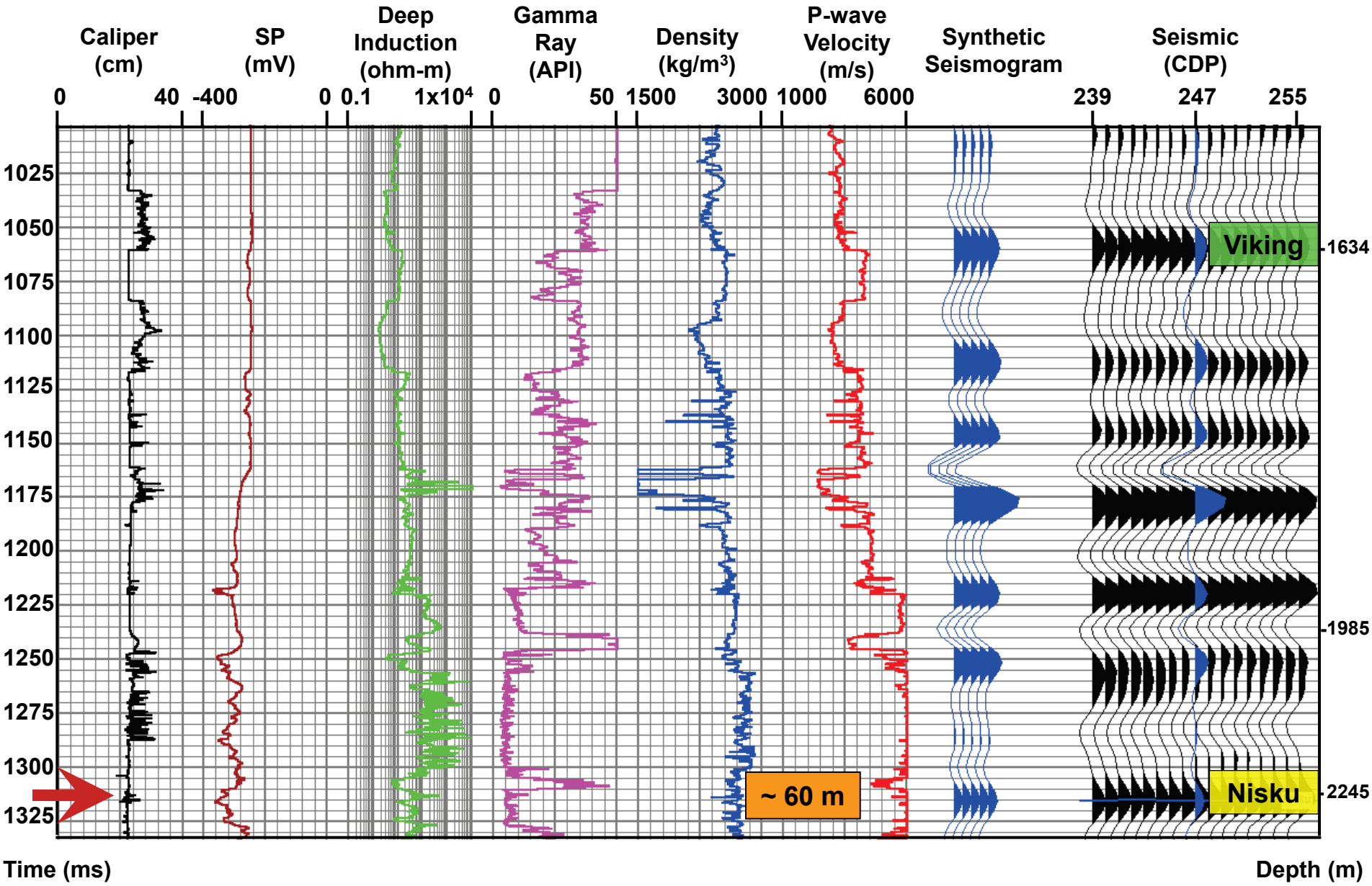
Basemap: seismic and wellbore data distribution



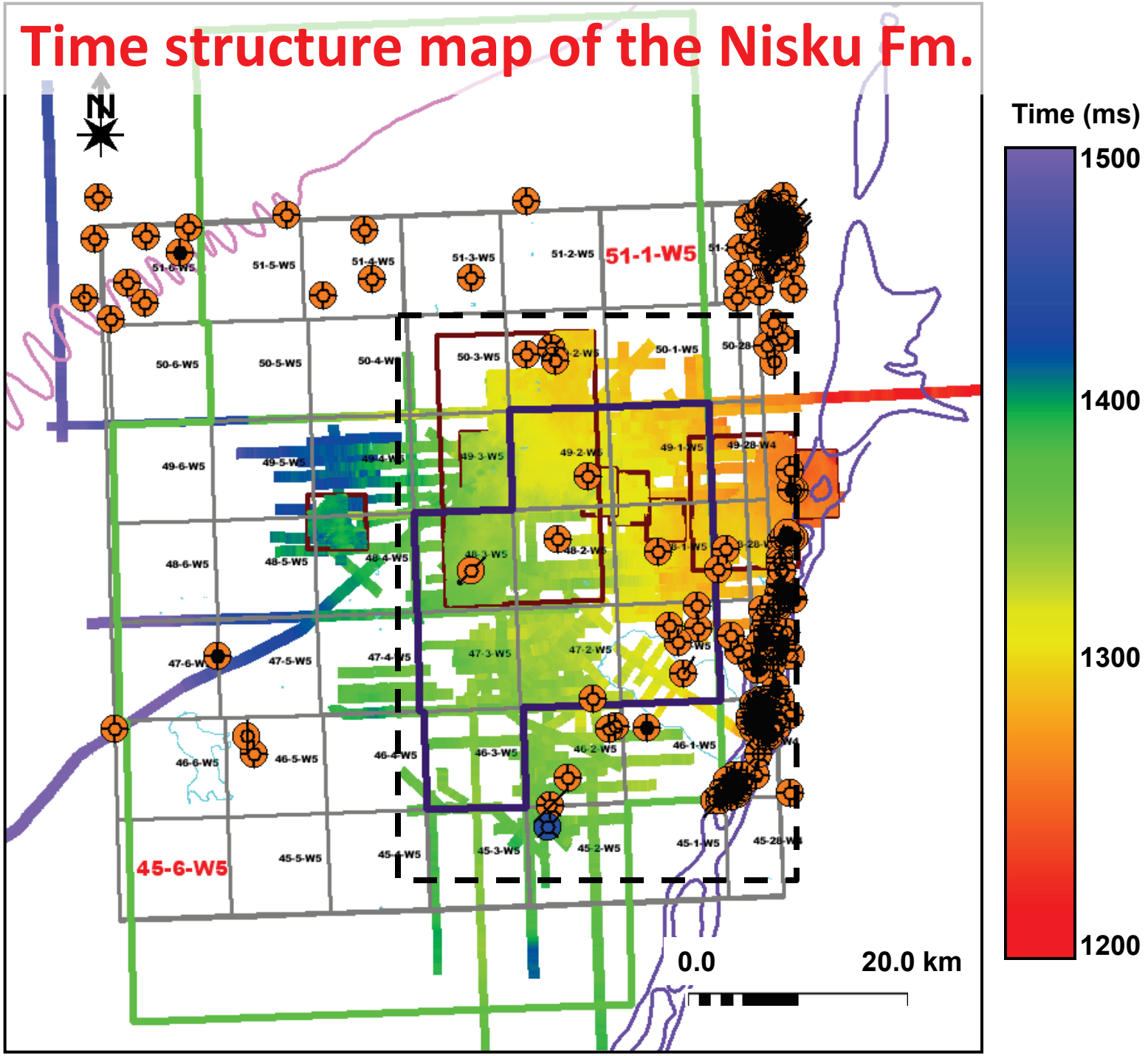
Acoustic impedance inversion

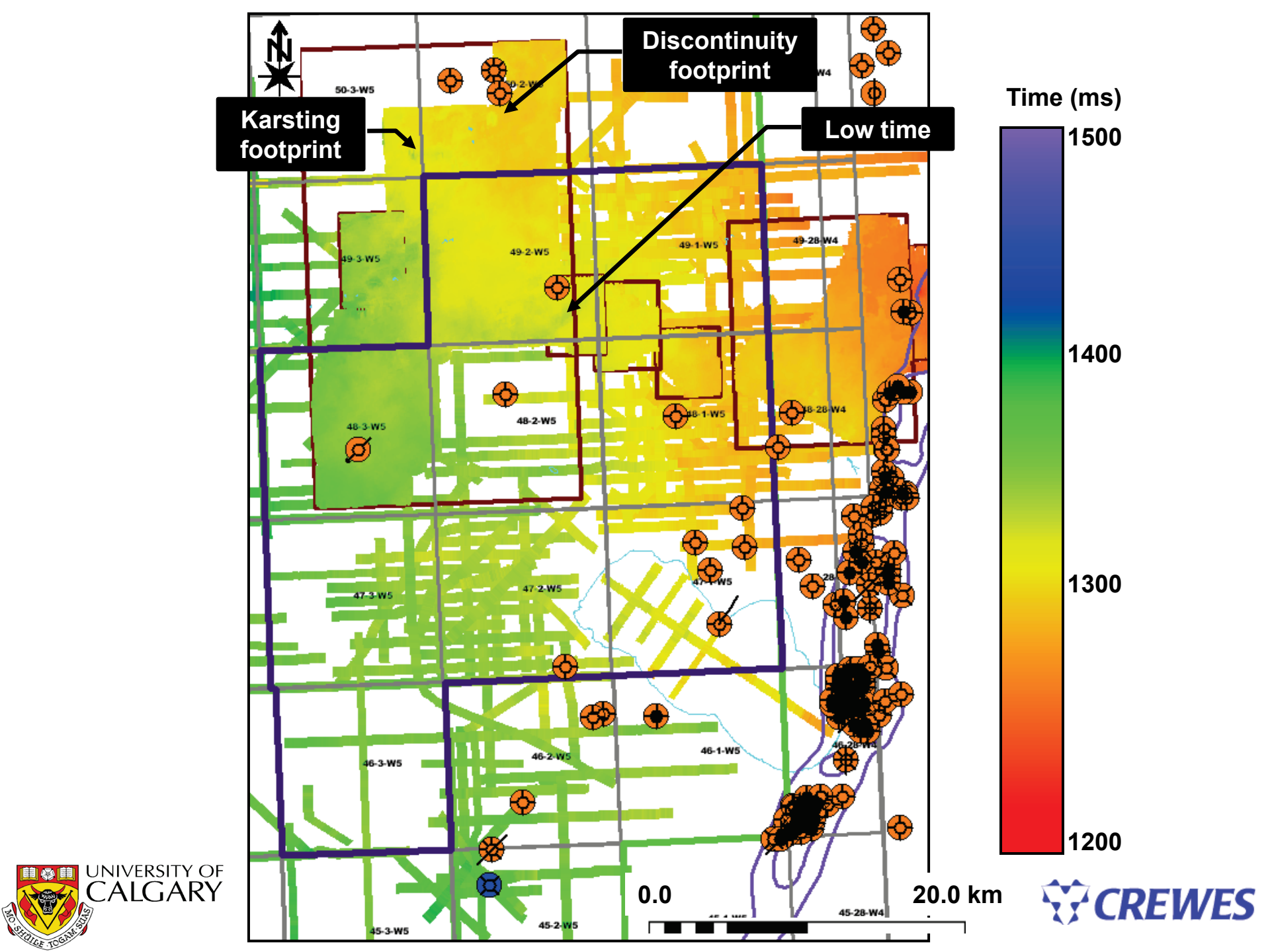


Example: seismic-to-well tie (1F1-11-29-45-2W5)



Time structure map of the Nisku Fm.




Discontinuity footprint
Karsting footprint
Low time
Time (ms)
1500
1400
1300
1200
50-3-W5
49-3-W5
49-2-W5
49-1-W5
49-28-W4
48-3-W5
48-2-W5
48-1-W5
48-28-W4
47-3-W5
47-2-W5
47-1-W5
46-3-W5
46-2-W5
46-1-W5
46-28-W4
45-3-W5
45-2-W5
45-28-W4
0.0
20.0 km
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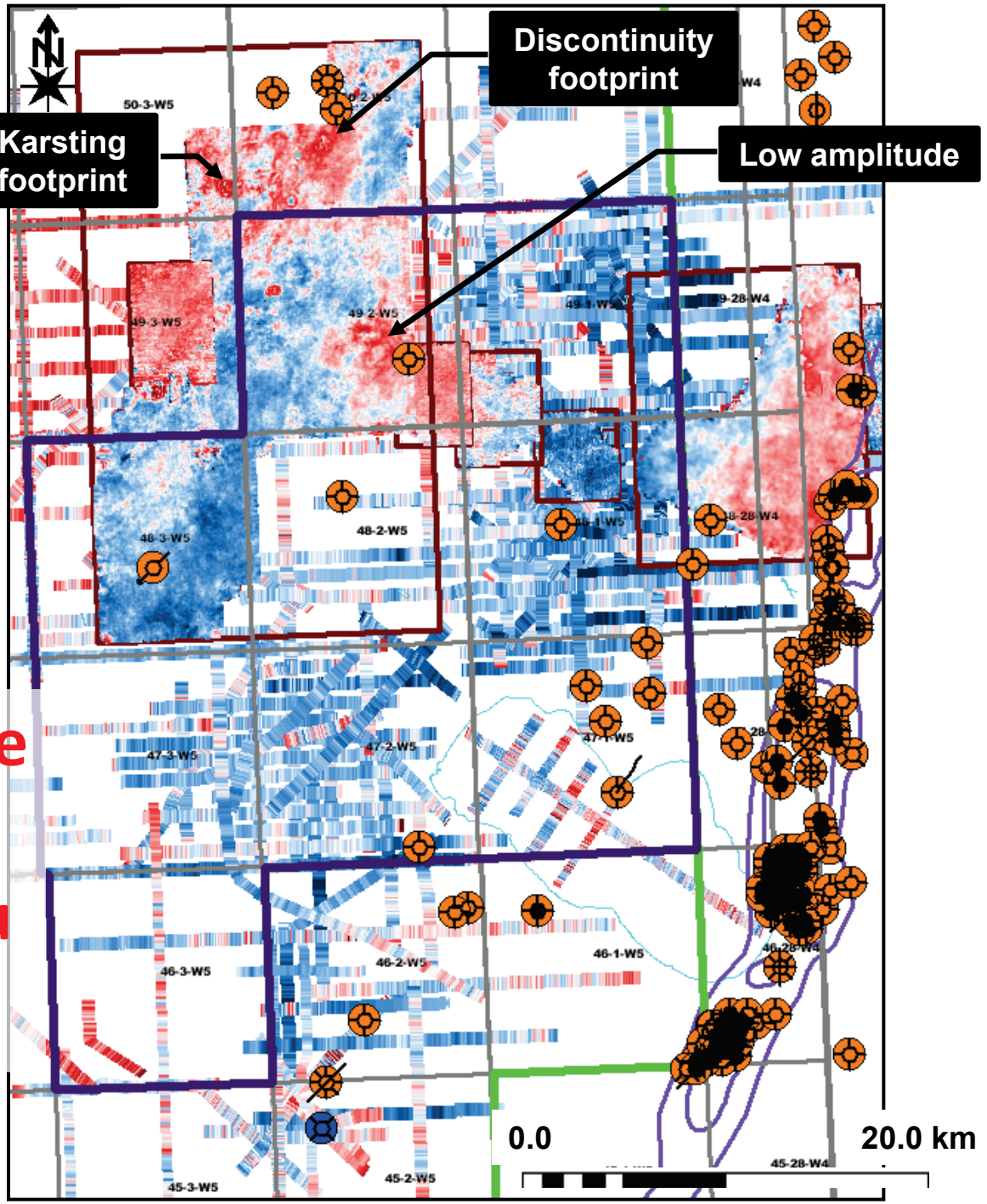

Amplitude map of the Nisku Fm.

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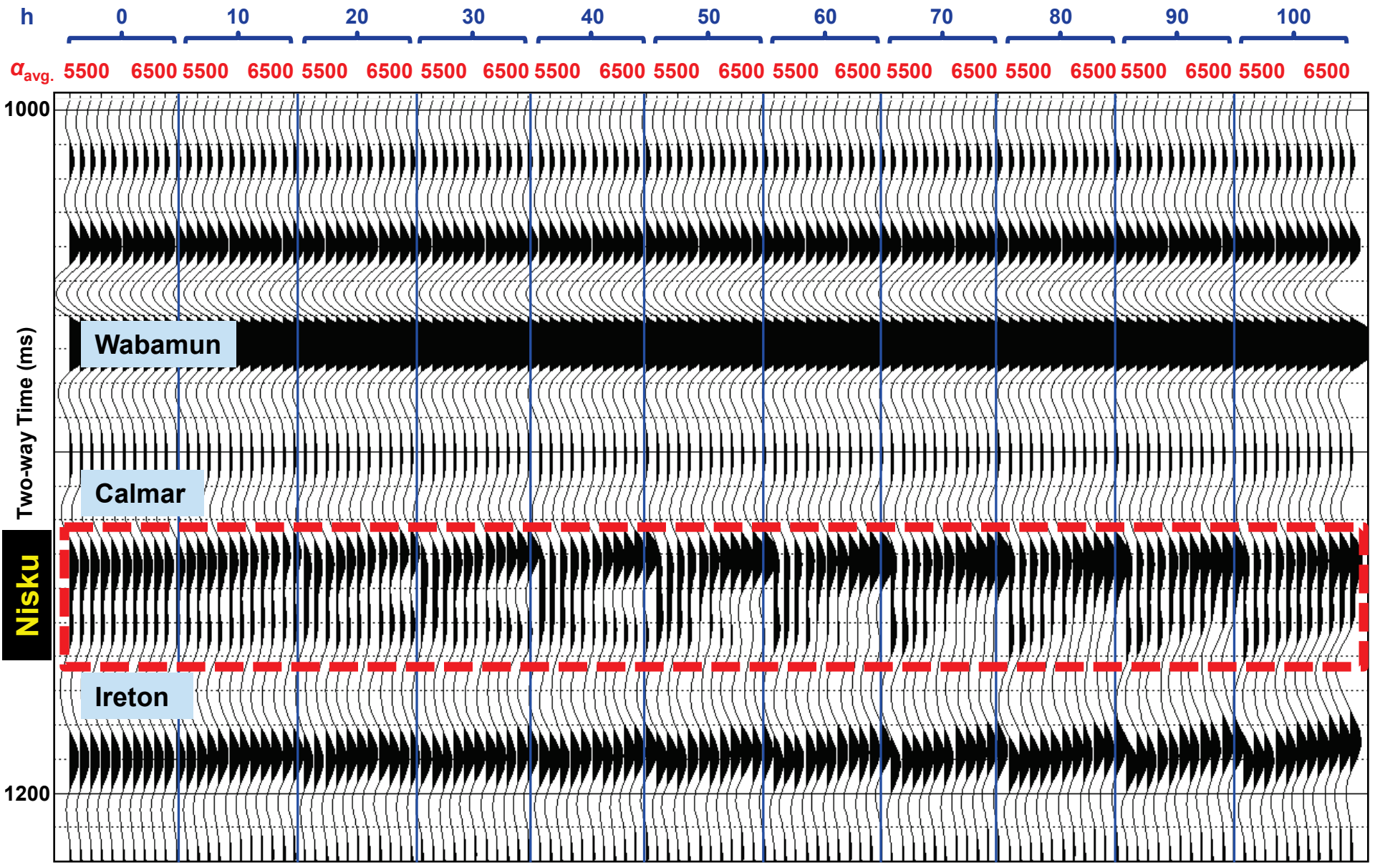
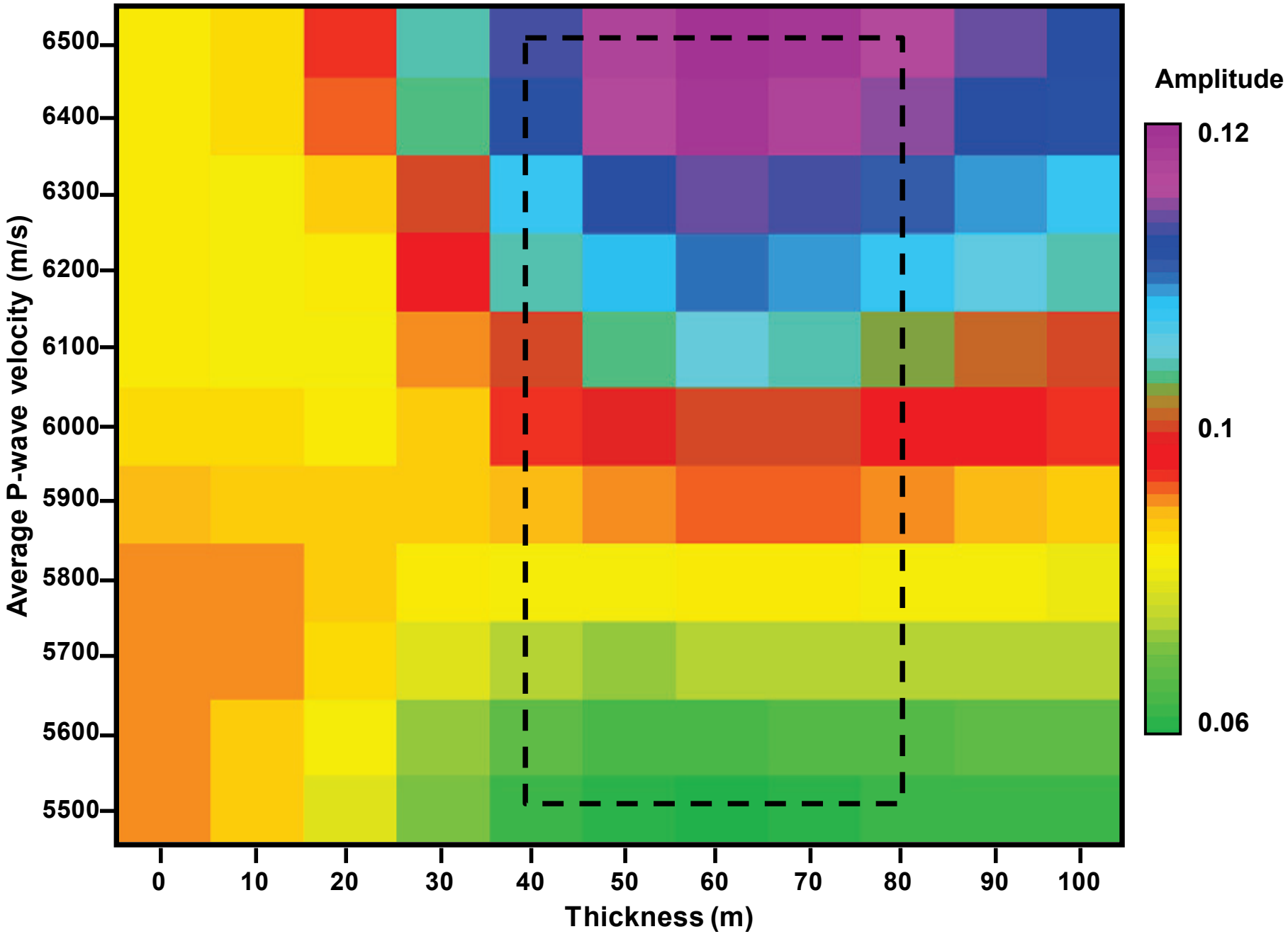
ZO synthetic seismogram: thickness vs. average P-wave velocity



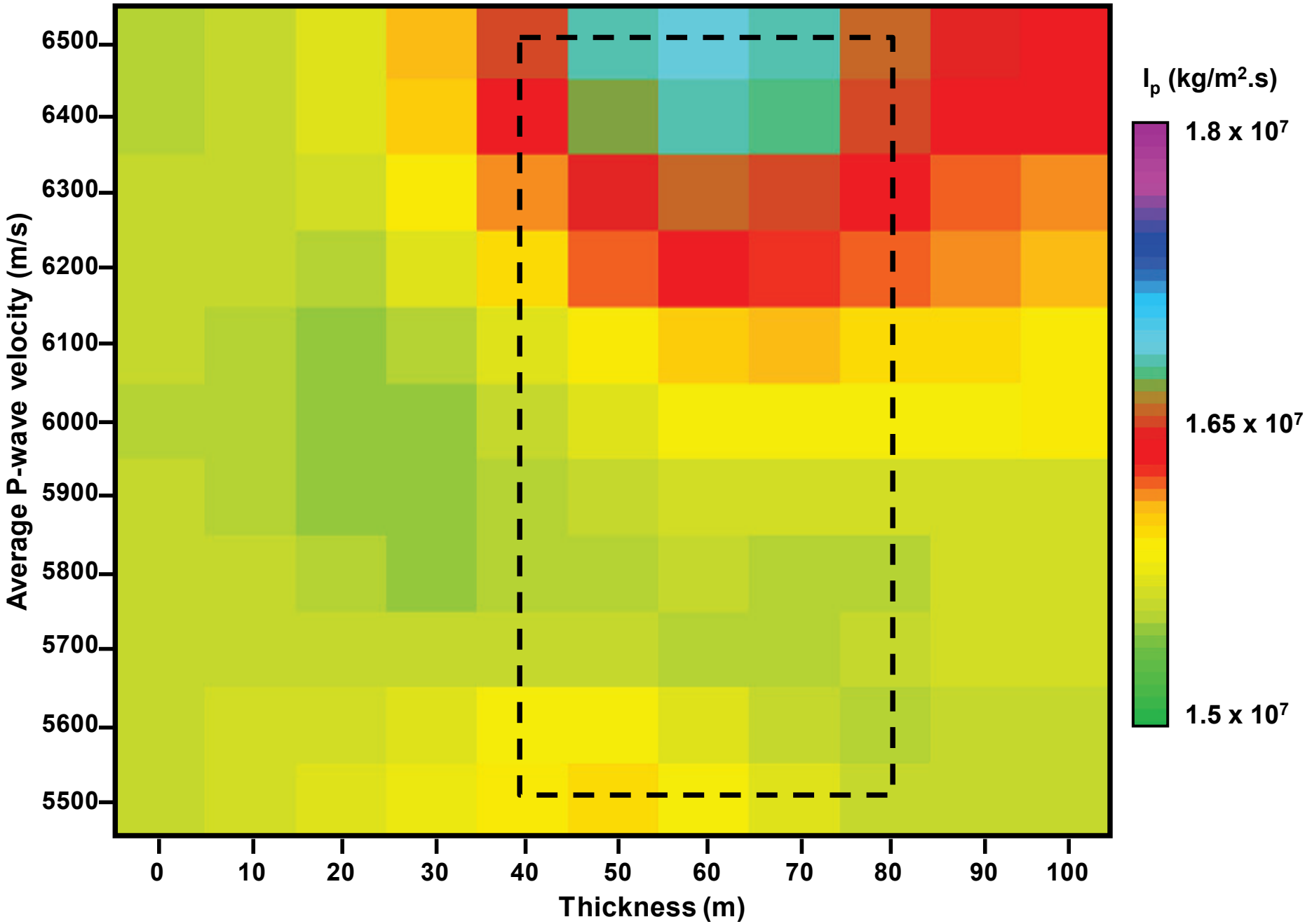
h: thickness in m.

$\alpha_{avg.}$: average P-wave velocity in m/s.

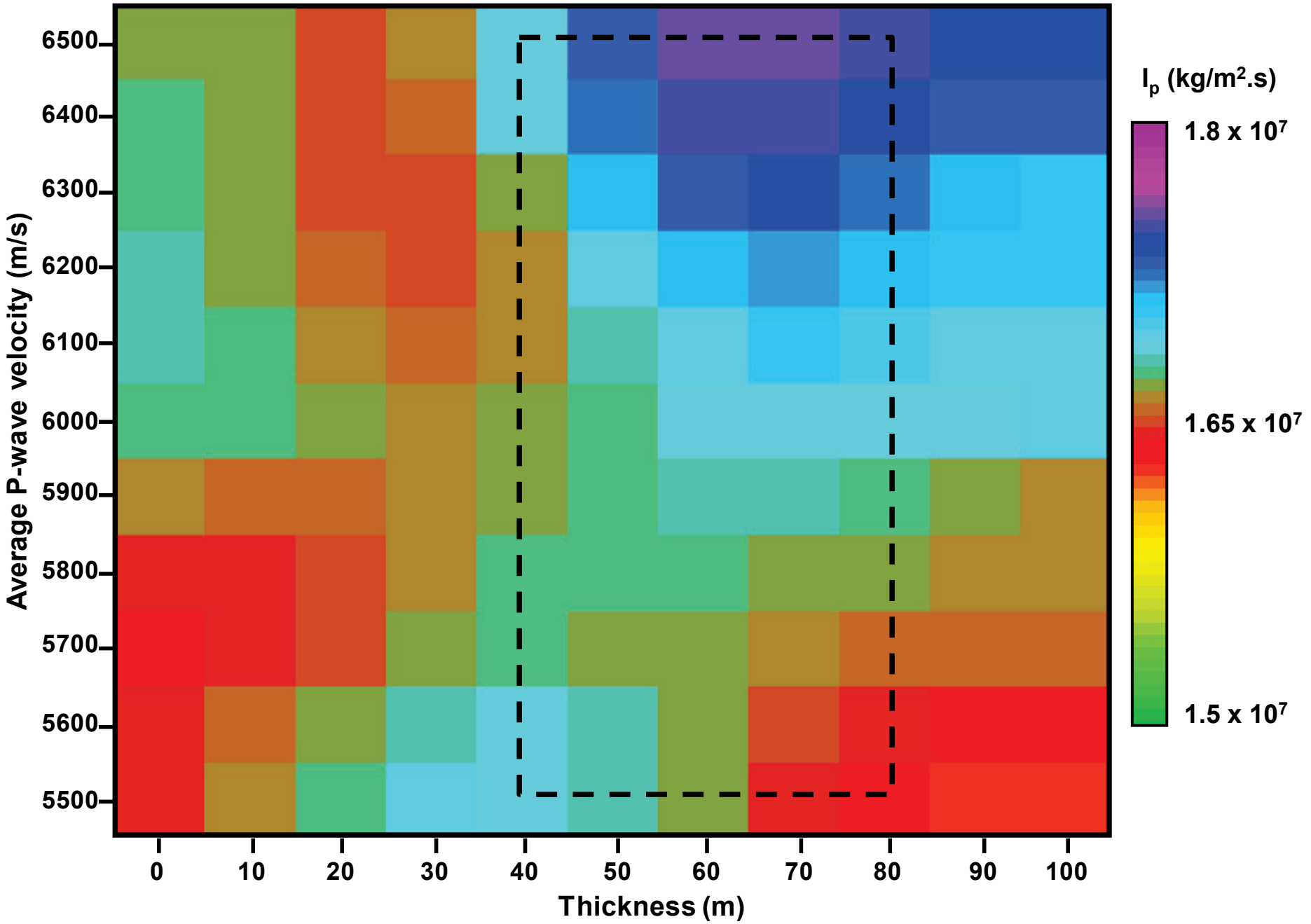
Synthetic data: Nisku event amplitude



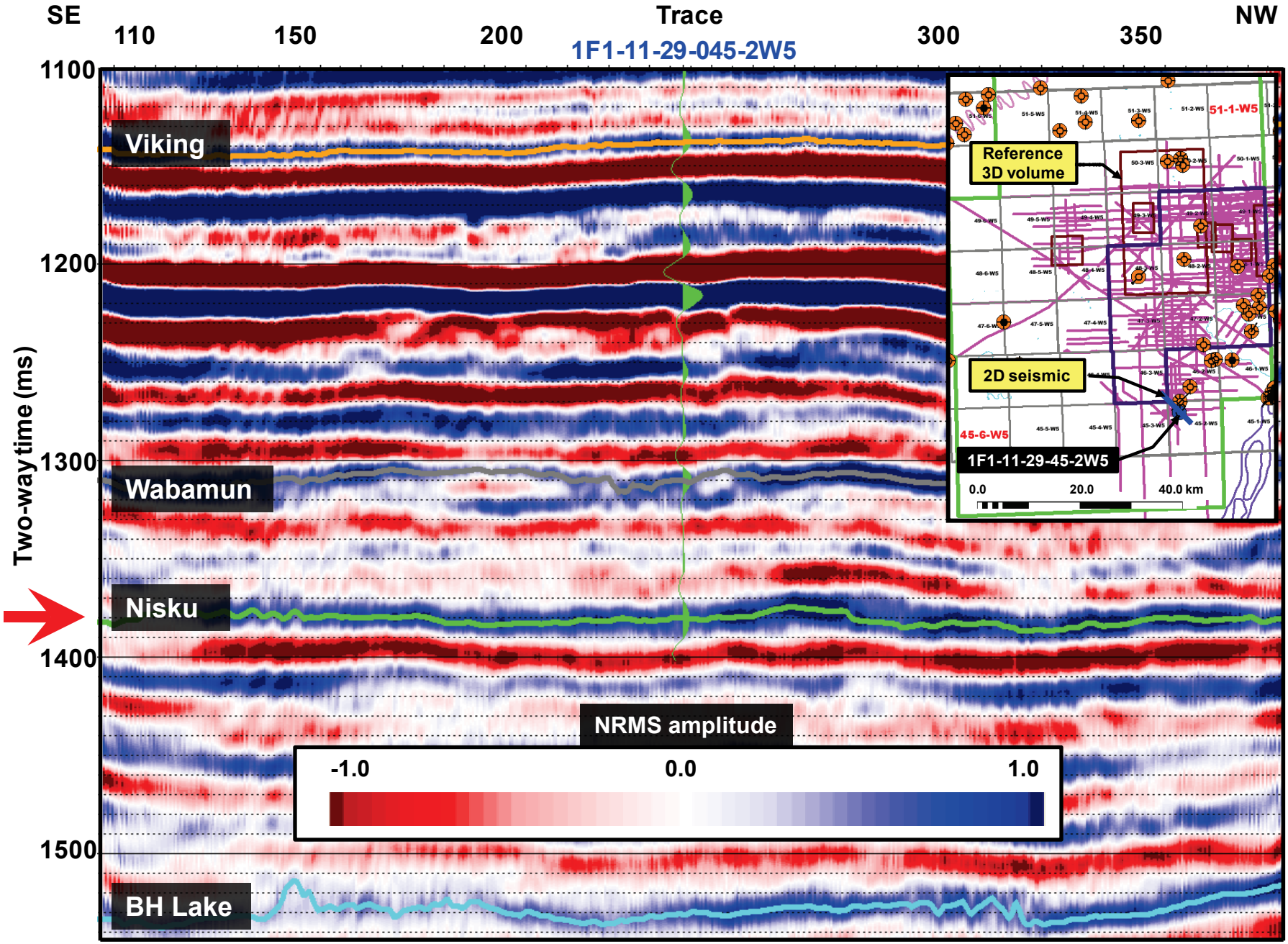
Synthetic data: Nisku event (recursive inversion)



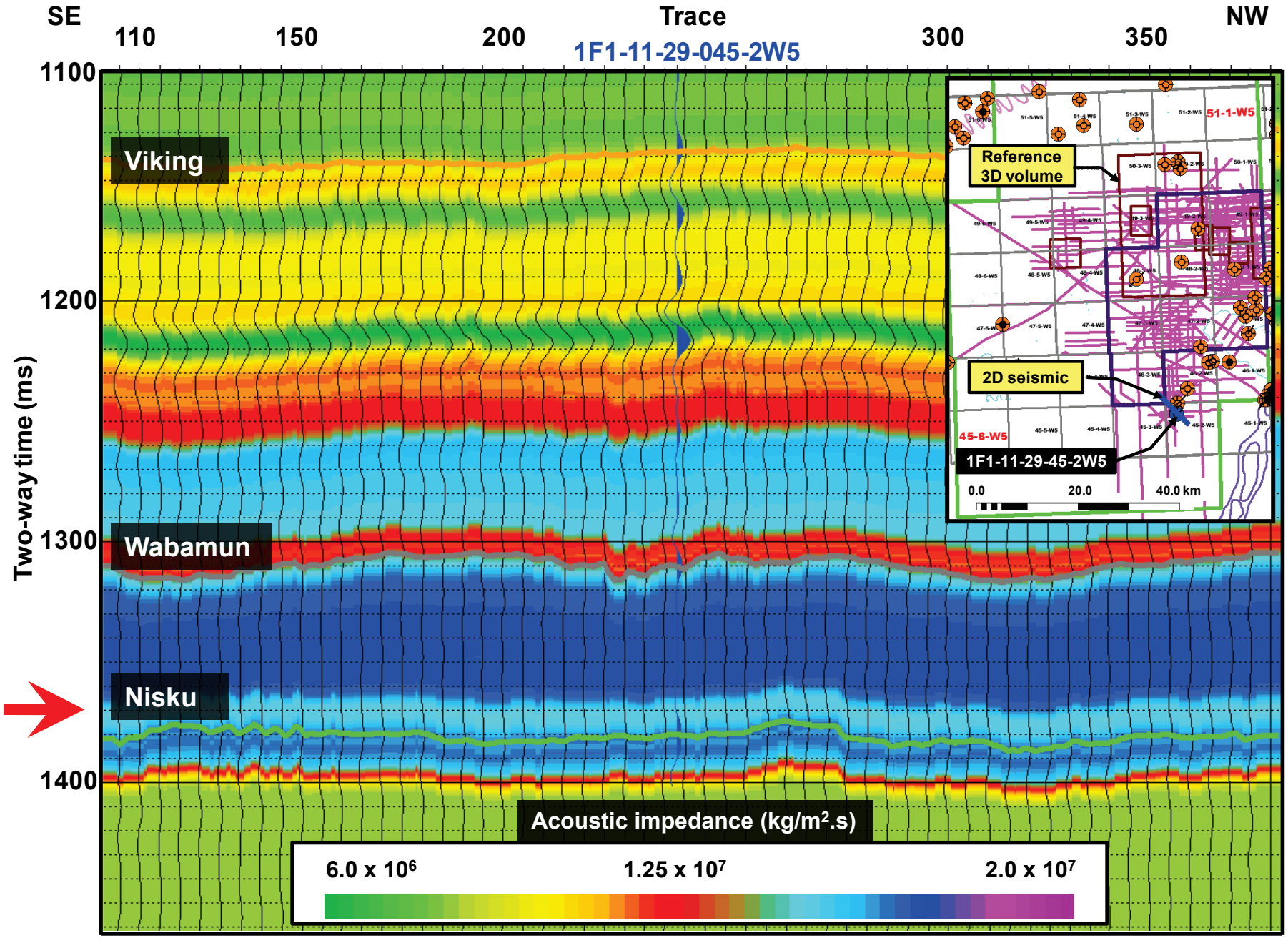
Synthetic data: Nisku event (model-based inversion)



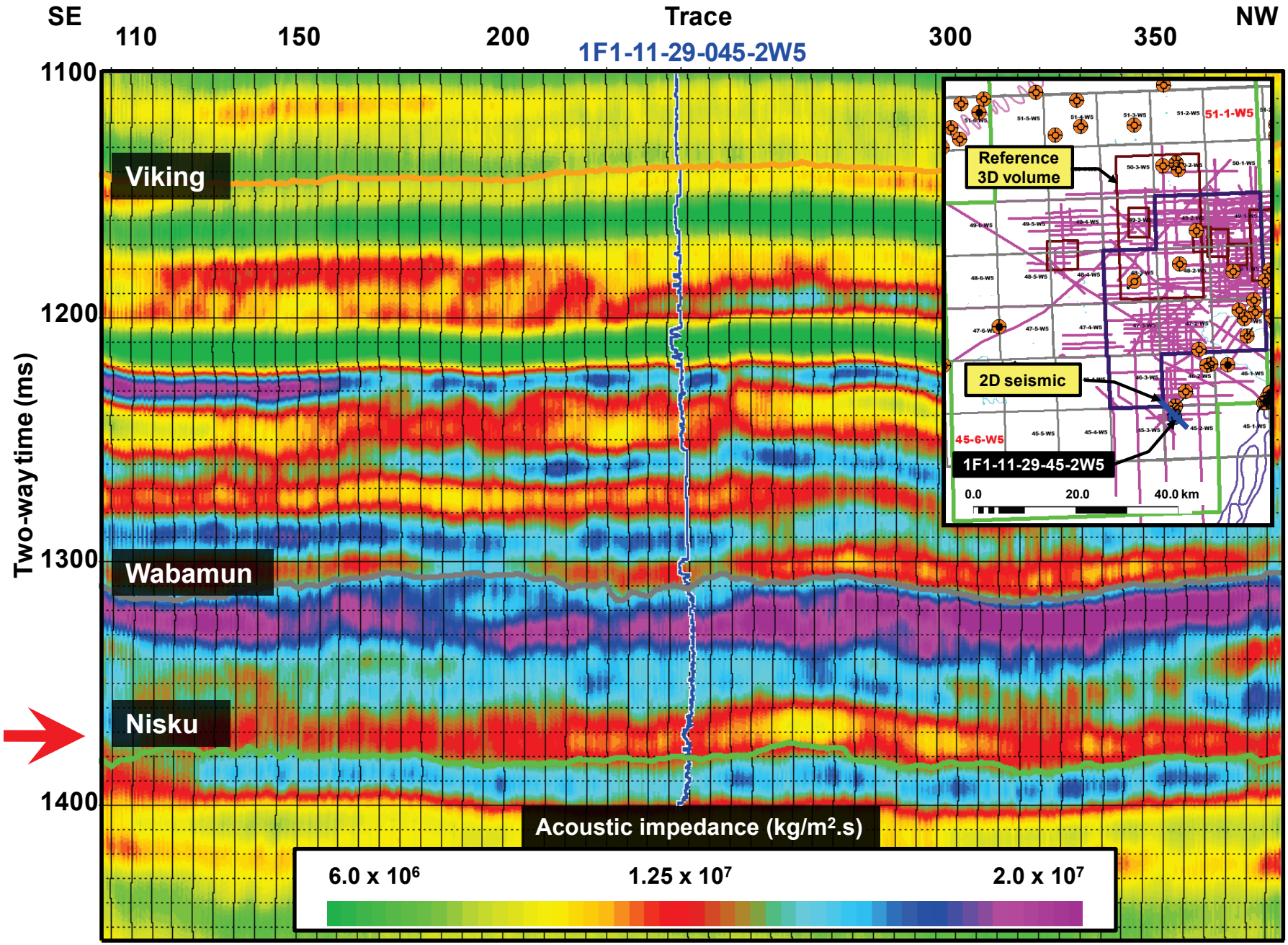
2D seismic section near the water source well



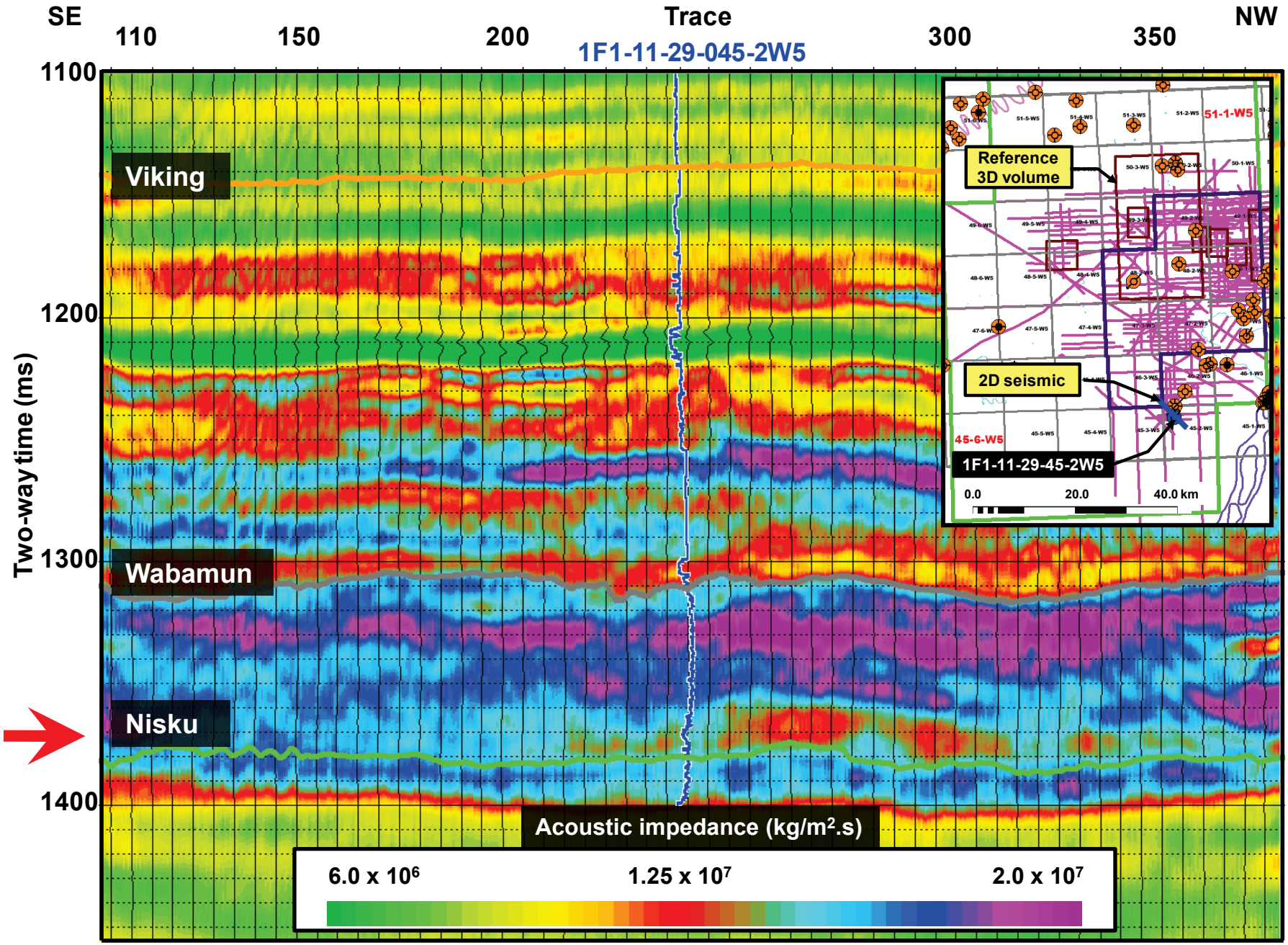
Field data: initial model

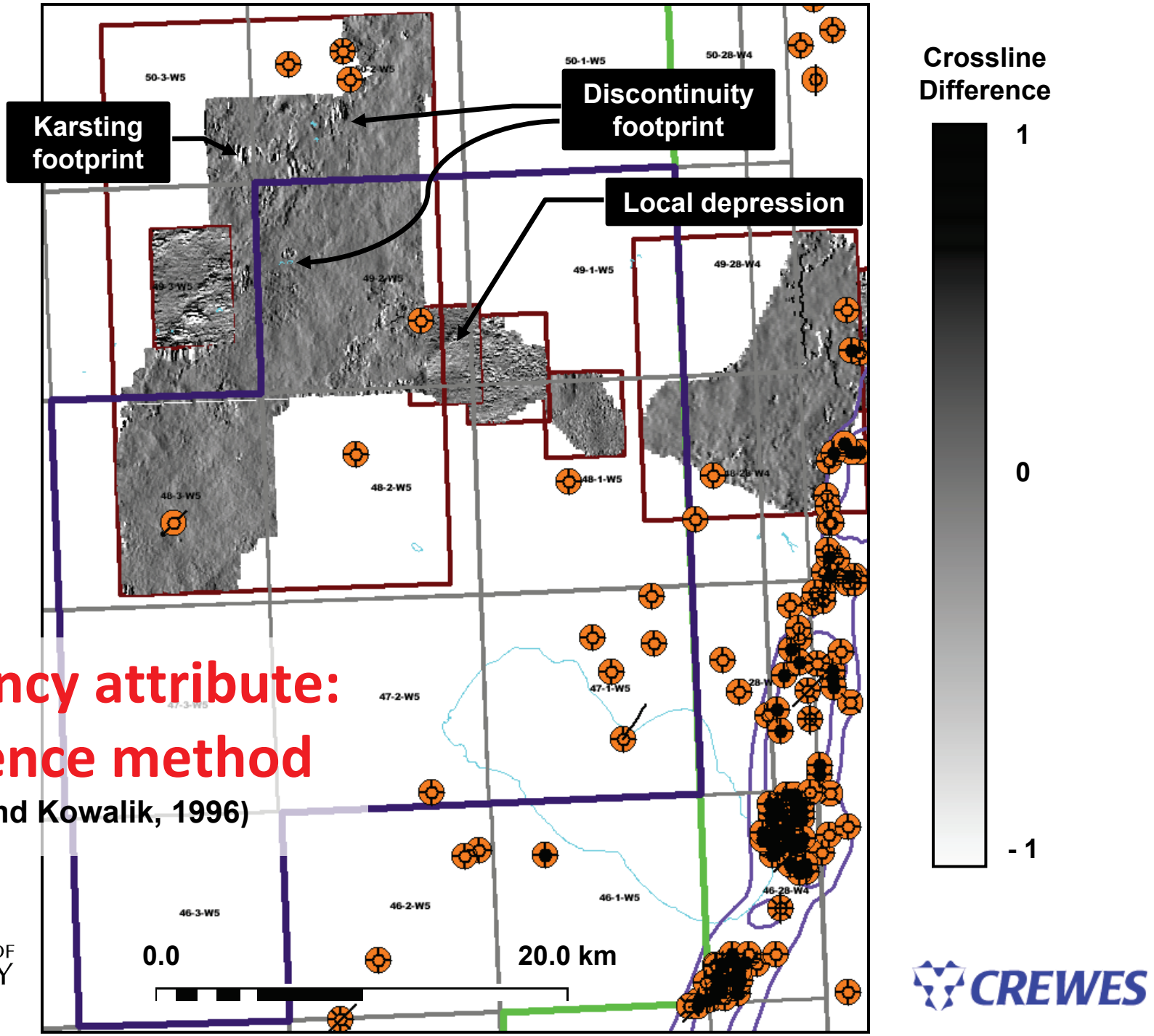


Field data: recursive inversion



Field data: model-based inversion





Coherency attribute: difference method

(Luo and Kowalik, 1996)

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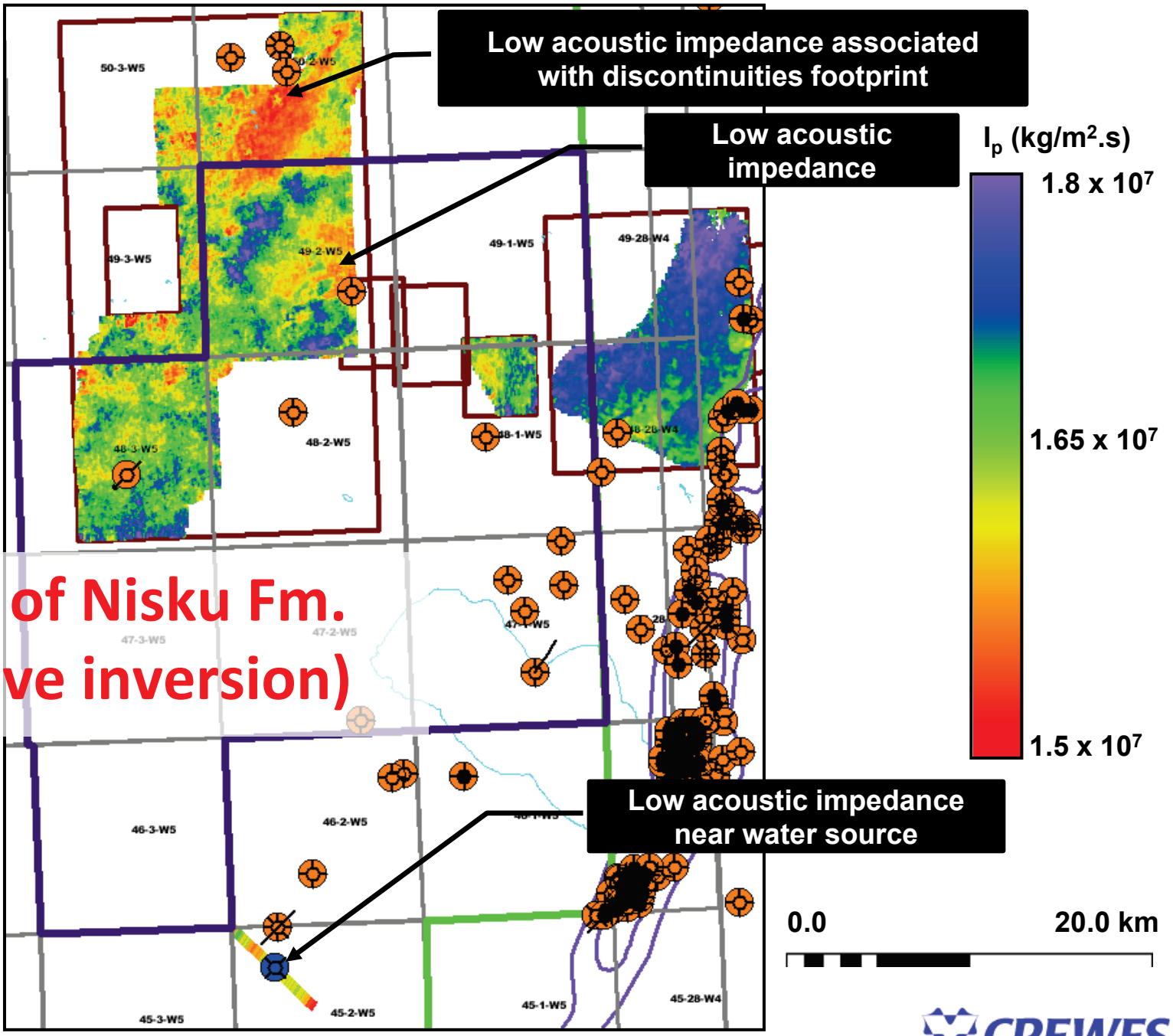

AI map of Nisku Fm. (recursive inversion)

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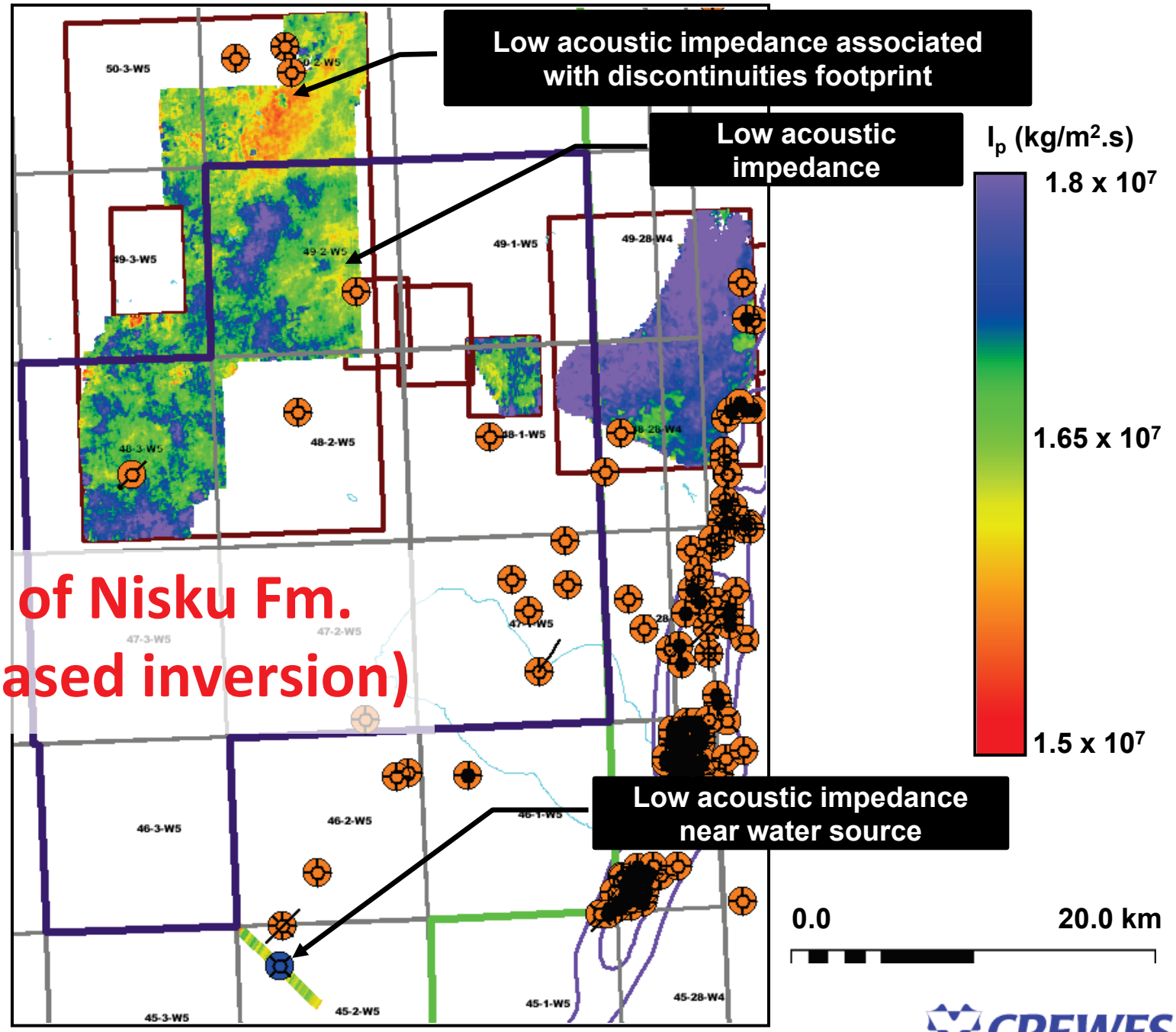

AI map of Nisku Fm. (model-based inversion)

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Conclusions

- AI of the Nisku Fm. In the WASP study area has been mapped using available seismic and borehole data.
- Modelling shows that the AI variations of the Nisku reflection are governed by lithological/porosity variations.
- AI map has revealed favourable low impedance areas for CO_2 injection in the WASP study area.

Conclusions

- Differentiate between anomalies associated with discontinuities vs. lithology/porosity.
- However, differentiating between low impedance associated with lithology vs. porosity is uncertain.

Acknowledgments

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HAMPSON-RUSSELL A CGGVeritas Company inversion & interpretation software

SeisWare Industrial Strength Interpretation interpretation software

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