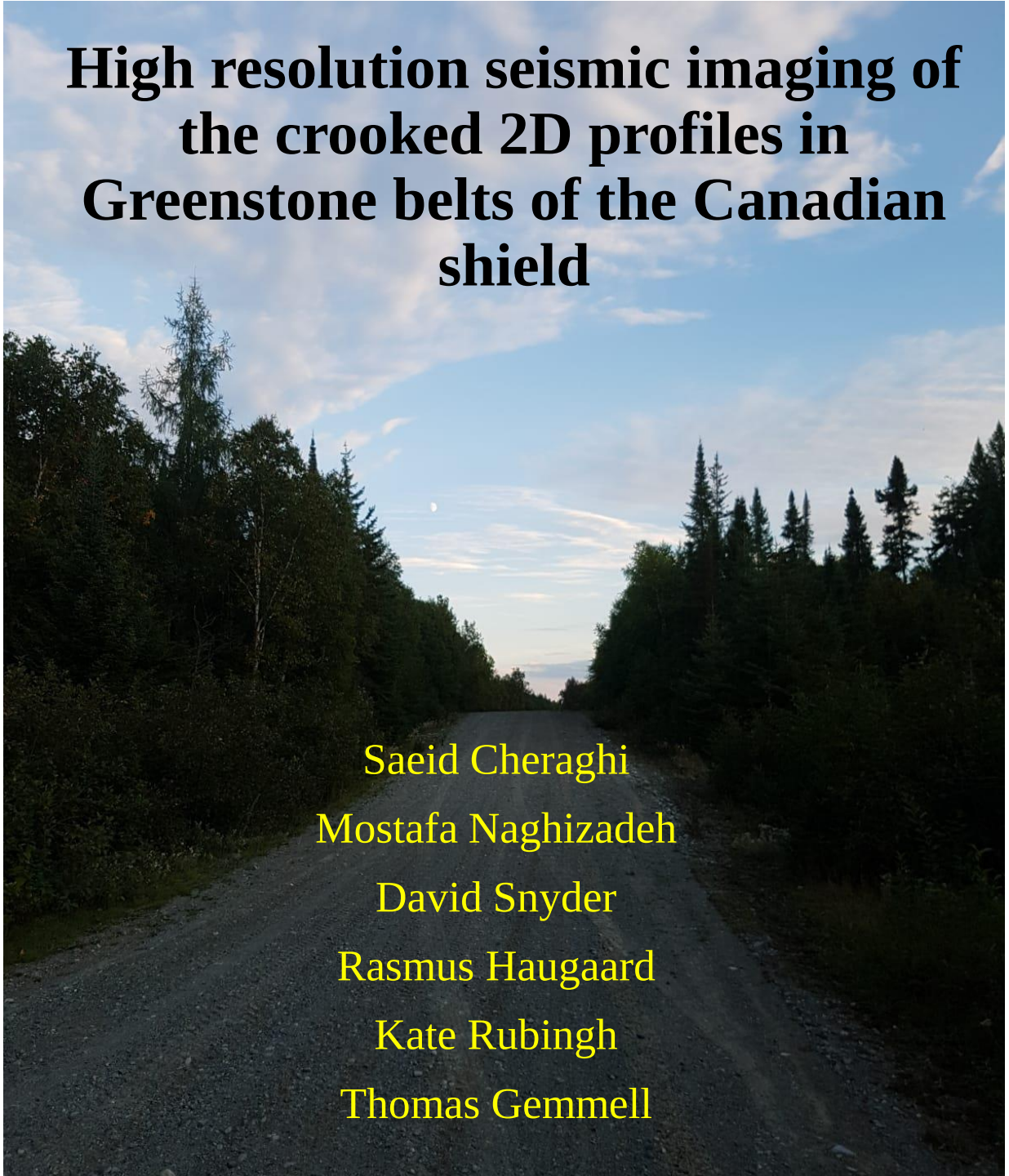
High resolution seismic imaging of the crooked 2D profiles in Greenstone belts of the Canadian shield



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METAL EARTH

A new Canadian research initiative funded by Canada First Research Excellence Fund.

CANADA FIRST RESEARCH EXCELLENCE FUND

Canada

Laurentian University / Université Laurentienne

HARQUAIL SCHOOL OF EARTH SCIENCES / ÉCOLE DES SCIENCES DE LA TERRE

MERC Mineral Exploration Research Centre

Outline

- Seismic surveys in the Swayze and Larder Lake area
- Evaluating the survey geometry
- Conventional processing applied to crooked surveys
- 3D swath processing
- Future work

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Introduction

- **Regional seismic surveys in hard rock environment**

a) Lithoprobe (Canada)
b) COCORP (the USA)
c) AGSO (Australia)
d) Europrobe (Europe)
e) National Geophysics Program (South Africa)

- **Canada: exploration done by industry, academic research, TGI programs**

- ***Highlight: acquiring 3D dataset: Sudbury, Brunswick No. 6, Half-mile Lake, Flin Flon, Millennium, Lalor***

- **Regional surveys (R1):**

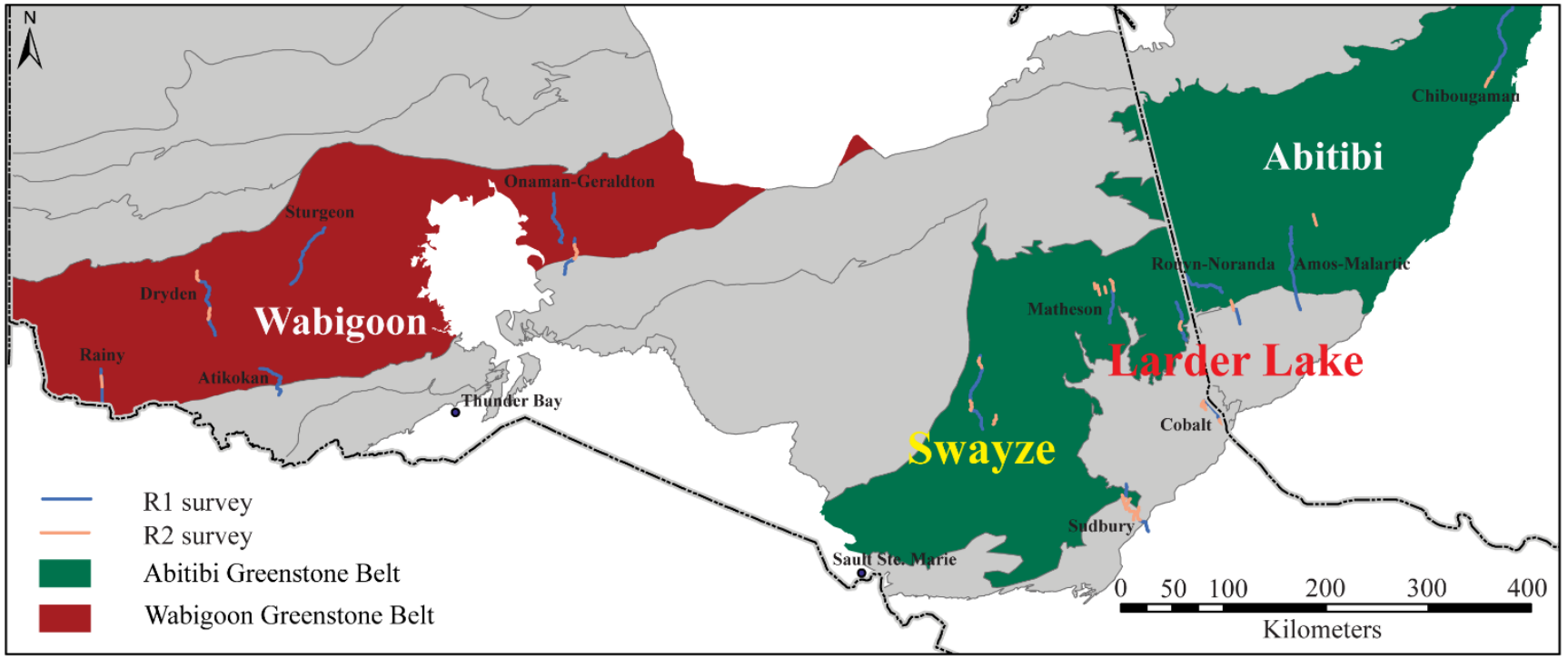
Shot-spacing: 50 m

Receiver-spacing: 25 m

- **High-resolution surveys (R2):**

Shot-spacing: 6.25 m

Receiver-spacing: 12.5 m



- Acquired regional and high-resolution surveys for Metal Earth (13 transacts, ~ 1000 km R1 and ~ 200 km R2)

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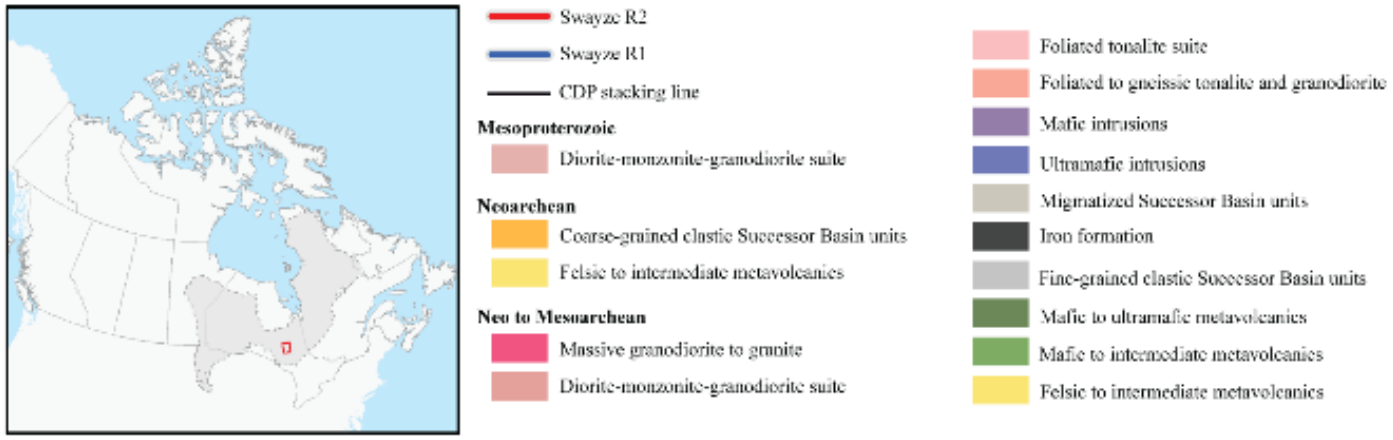
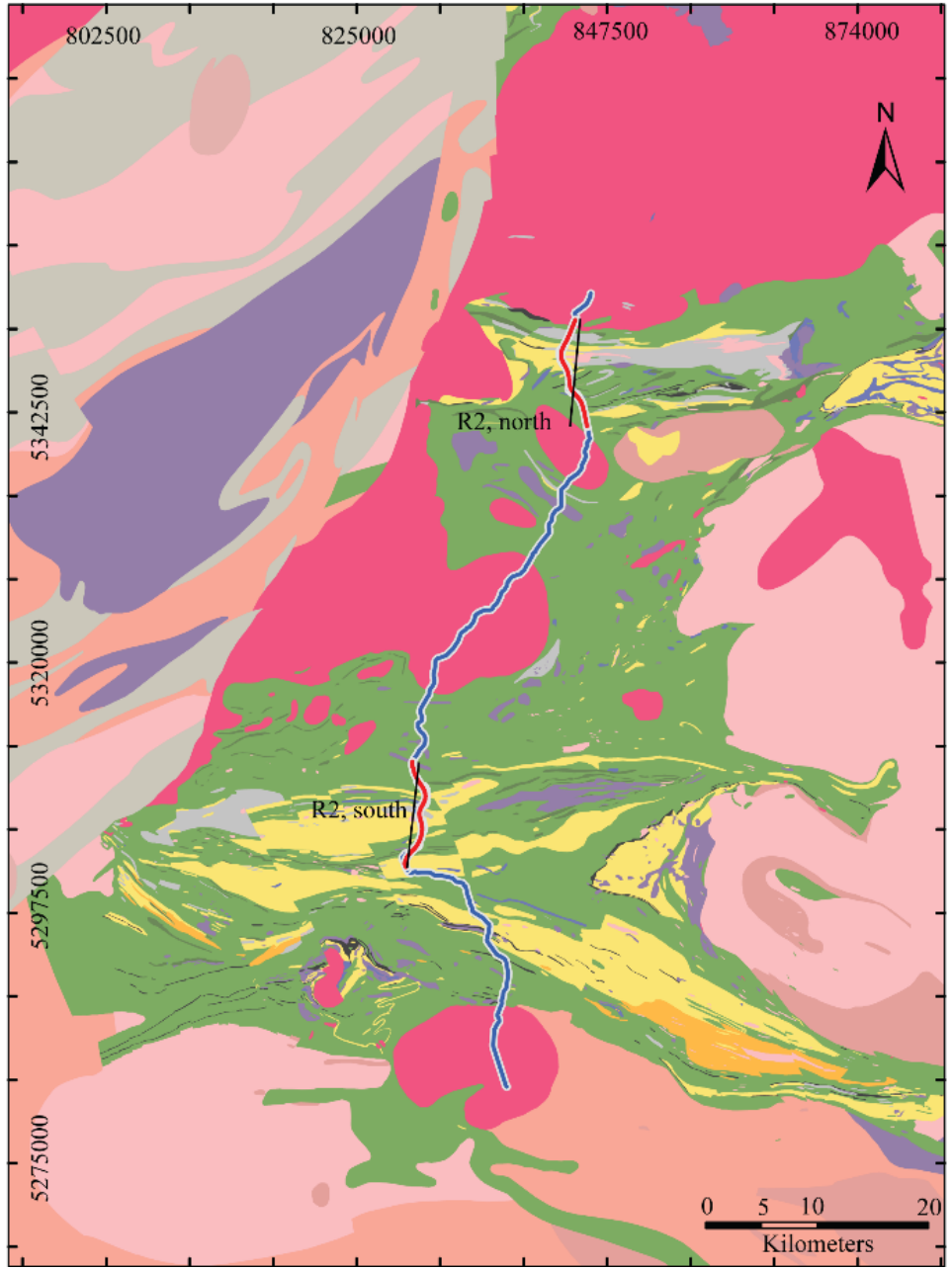
R2 surveys in Swayze area

Swayze north

Swayze south

- Each survey is about 10 km
- The survey is acquired on the complex geology
- The survey follows local roads /forest trail





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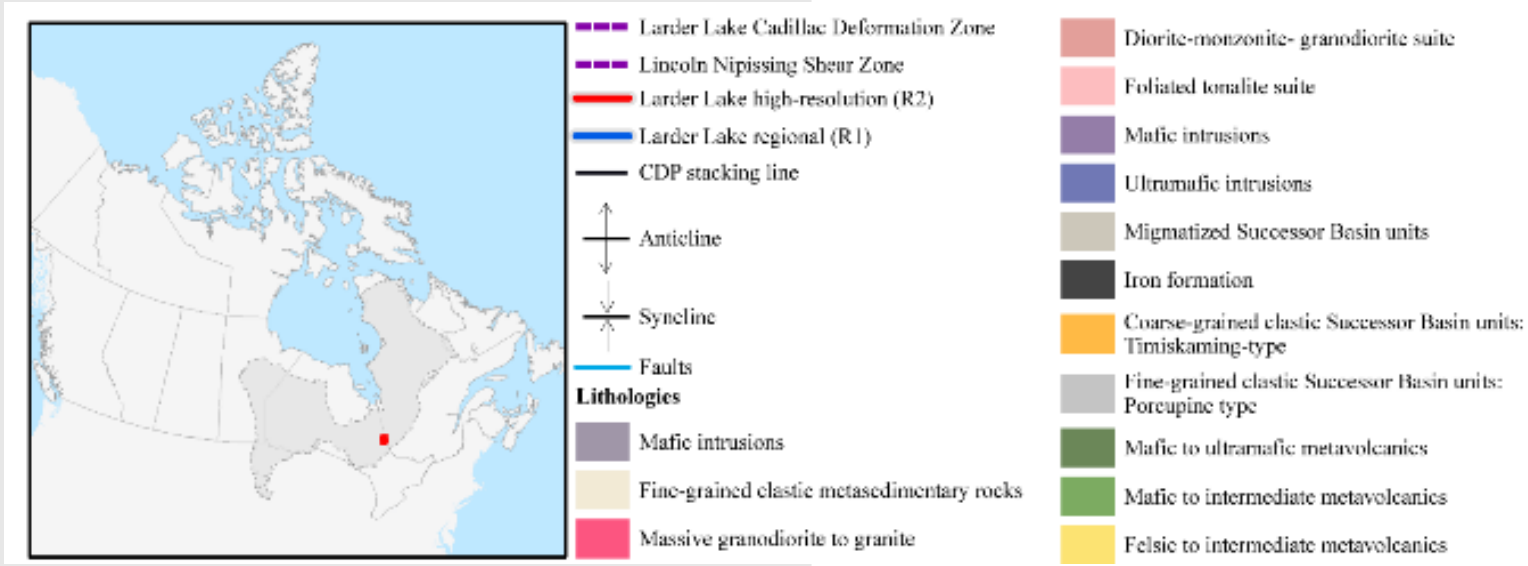
R2 survey in Larder Lake area

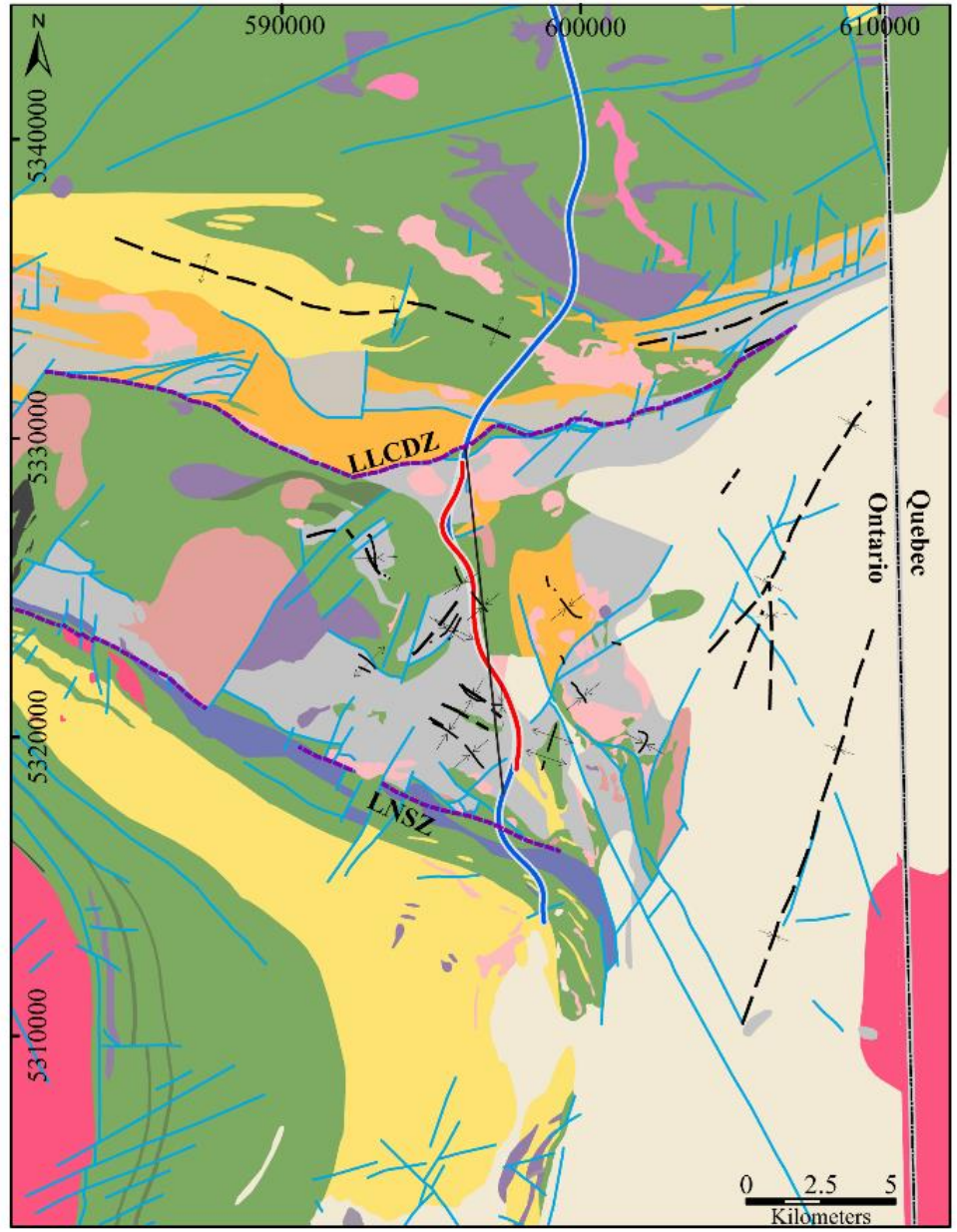
10 km high resolution survey is acquired between:

Larder-Cadillac deformation zone (LLCDZ) and

Lincoln Nipissing shear zone (LNSZ)

- Complex geology
- Crooked survey





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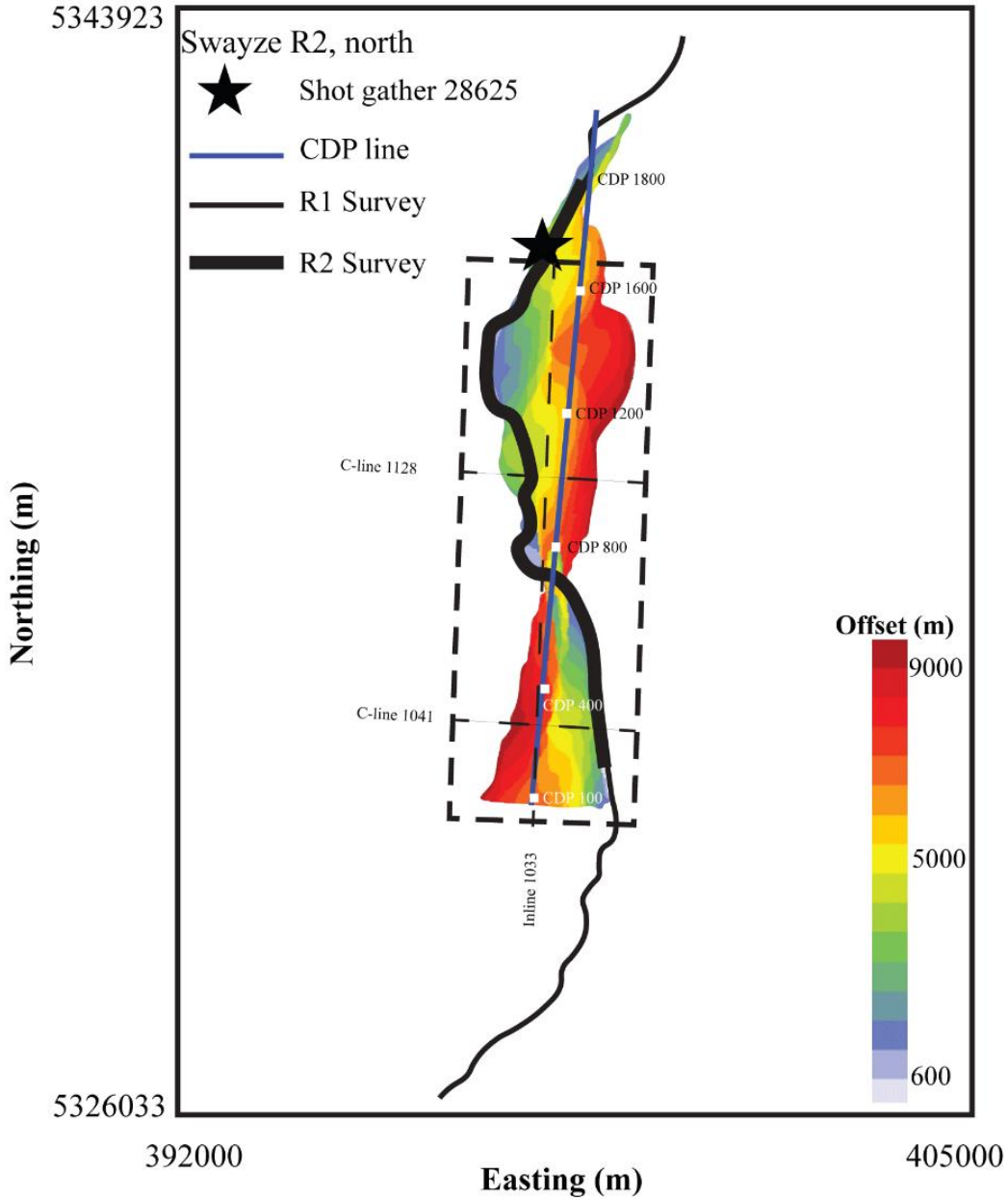
2D and 3D processing

- CDP spacing: 6.5 m (2D)
- CDP bins: 50 m by 50 m (3D)



METAL EARTH

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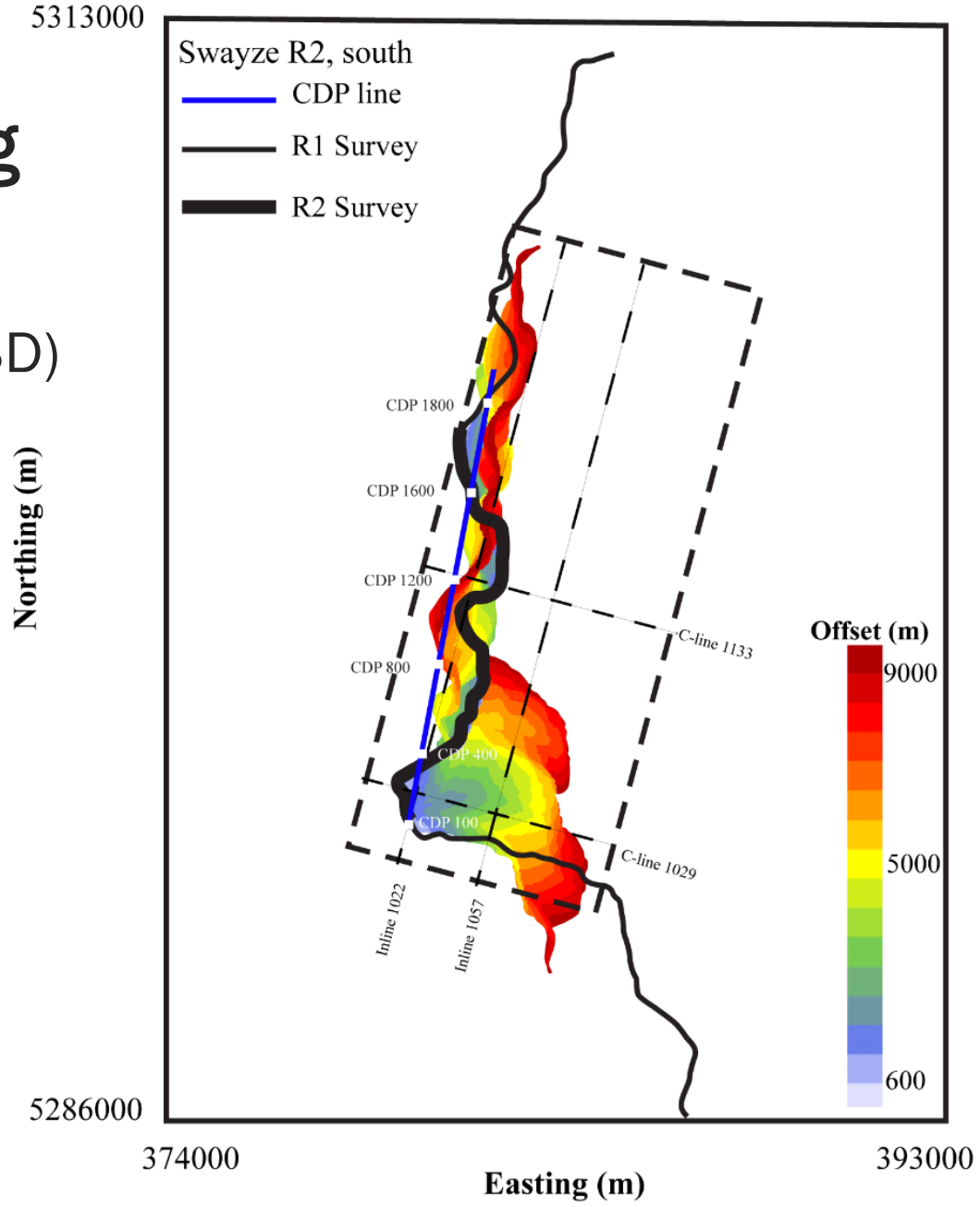

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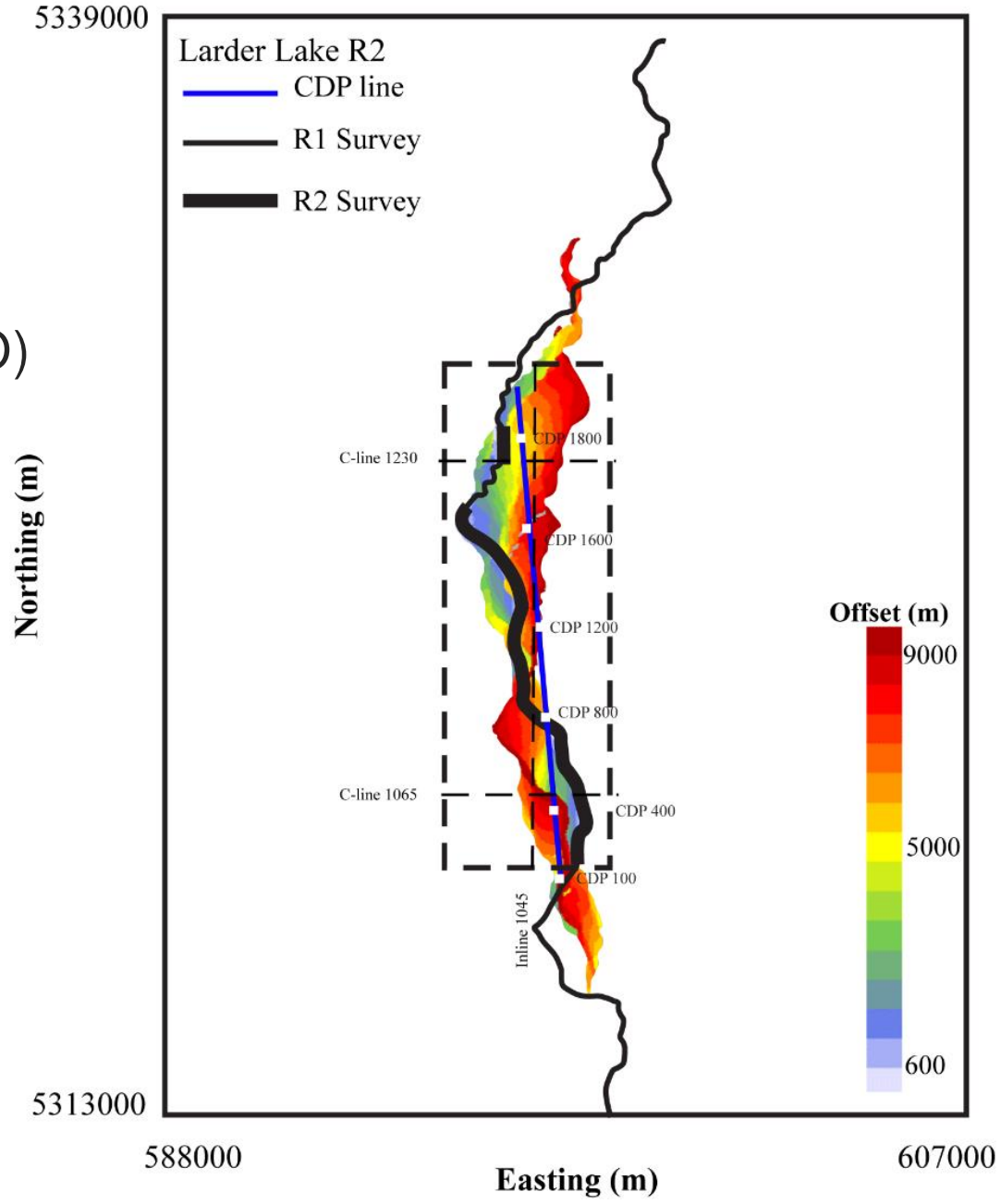
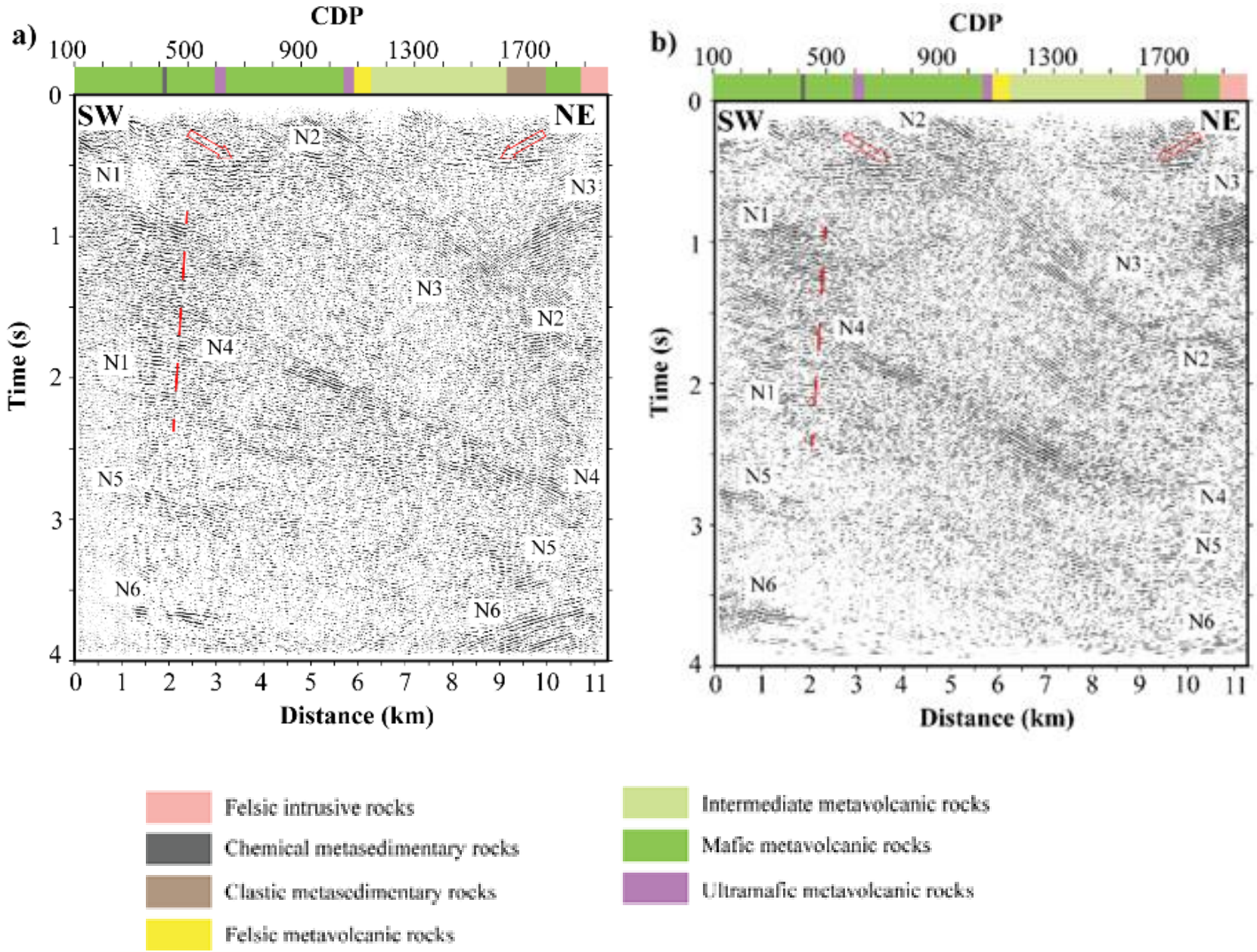


Swayze-north	Swayze-south	Larder Lake
Reading data in SEGD format and converting them to SEGY format	Reading data in SEGD format and converting them to SEGY format	Reading data in SEGD format and converting them to SEGY format
Setup geometry	Setup geometry	Setup geometry
Trace editing (manual)	Trace editing (manual)	Trace editing (manual)
First arrival picking (near and far offsets)	First arrival picking (near and far offsets)	First arrival picking (near and far offsets)
Elevation and refraction static corrections (replacement velocity 5200 m/s, V0 1000 m/s)	Elevation and refraction static corrections (replacement velocity 5200 m/s, V0 1000 m/s)	Elevation and refraction static corrections (replacement velocity 5200 m/s, V0 1000 m/s)
Spherical divergence compensation (velocity power of 2 and travel time power of 1, V^2t)	Spherical divergence compensation (velocity power of 2 travel time power of 1, V^2t)	Spherical divergence compensation (velocity power of 2 travel time power of 1,V^2t)
Median velocity filter (1400, 2500, 3000 m/s)	Median velocity filter (1400, 2500, 3000 m/s)	Median velocity filter (1400, 2500, 3000 m/s)
Band pass filter (20-35-100-120 Hz)	Band pass filter (20-35-100-125 Hz)	Band pass filter (20-35-100-125 Hz)
Airwave filter	Airwave filter	Airwave filter
Surface-consistent deconvolution (filter length of 100 ms and gap of 25 ms)	Surface-consistent deconvolution (filter length of 100 ms and gap of 25 ms)	Surface-consistent r deconvolution (filter length of 100 ms and gap of 17 ms)
Trace balancing	Trace balancing	Trace balancing
AGC (window of 150 ms)	AGC (window of 150 ms)	AGC (window of 150 ms)
Velocity analysis	Velocity analysis	Velocity analysis
DMO corrections	DMO corrections	DMO corrections
Residual static corrections	Residual static corrections	Residual static corrections
Top-muting	Top-muting	Top-muting
Stacking	Stacking	Stacking
Coherency filter (F-X deconvolution, filter length of 19 traces)	Coherency filter (F-X deconvolution, filter length of 19 traces)	Coherency filter (F-X deconvolution, filter length of 19 traces)
Trace balancing	Trace balancing	Trace balancing
Phase shift time migration (5000 m/s)	Phase shift time migration (5000 m/s)	Phase shift time migration (5000 m/s)

Swayze north:

a) DMO-stacked

b) Migrated-stacked

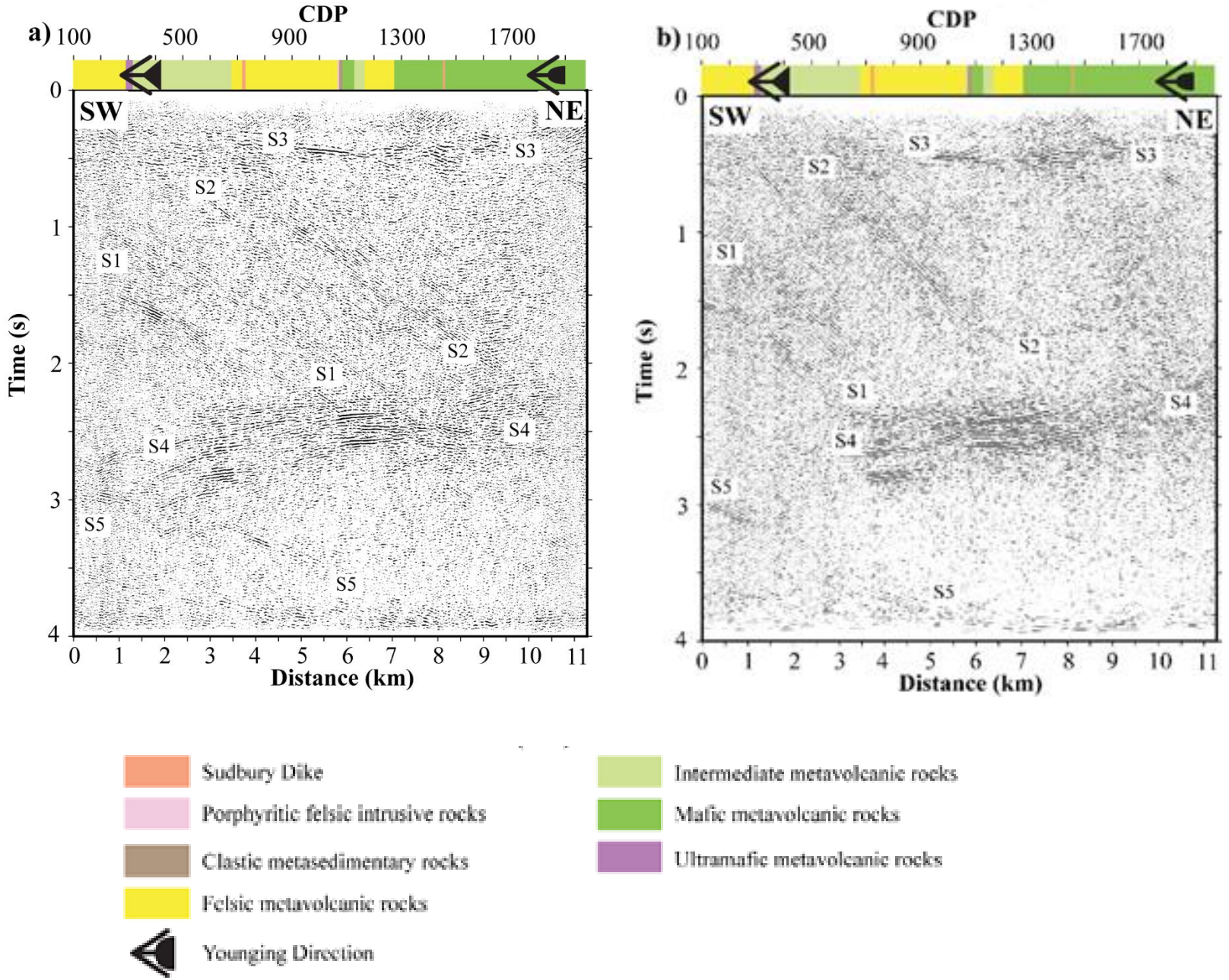


METAL EARTH

Swayze south:

a) DMO-stacked

b) Migrated-stacked



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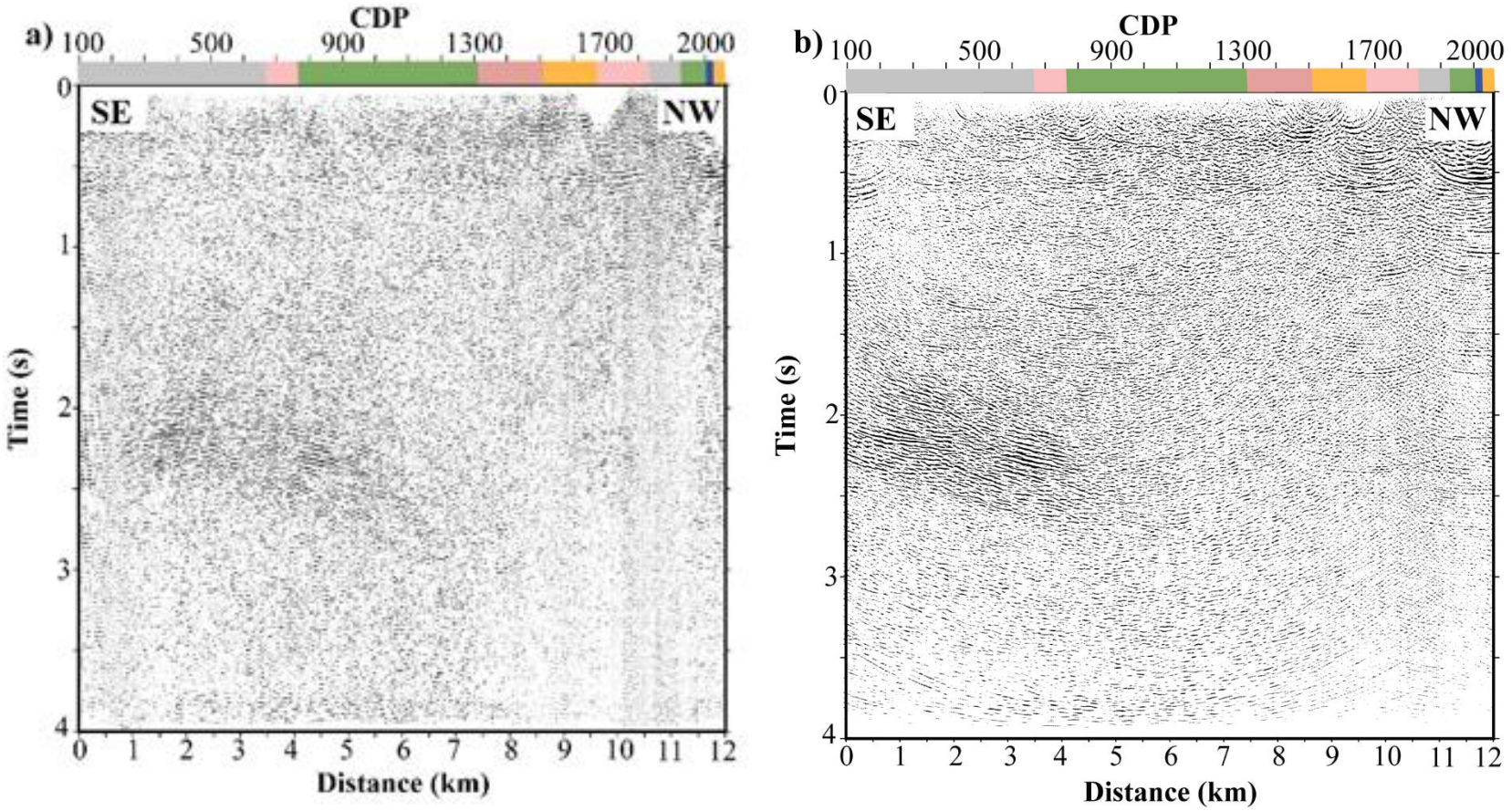
Larder Lake:

a) DMO-stacked

b) Migrated-stacked



Granitoid Rocks

Diorite - monzonite - granodiorite

Foliated tonalite suite

Metasedimentary units

Coarse clastic successor basin units: Timiskaming-type

Fine clastic successor basin units: Porcupine-type

Mafic to intermediate metavolcanic rocks

Larder-Cadillac Deformation Zone

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3D swath processing

- Crooked nature of the acquired surveys causes the distribution of midpoints in both inline and crossline of the survey.
- CDP binning of 50 m by 50 m was considered.
- Processed 2D shots + 3D geometry
- Velocity analysis to find the best velocity model
- Stacking
- Migration

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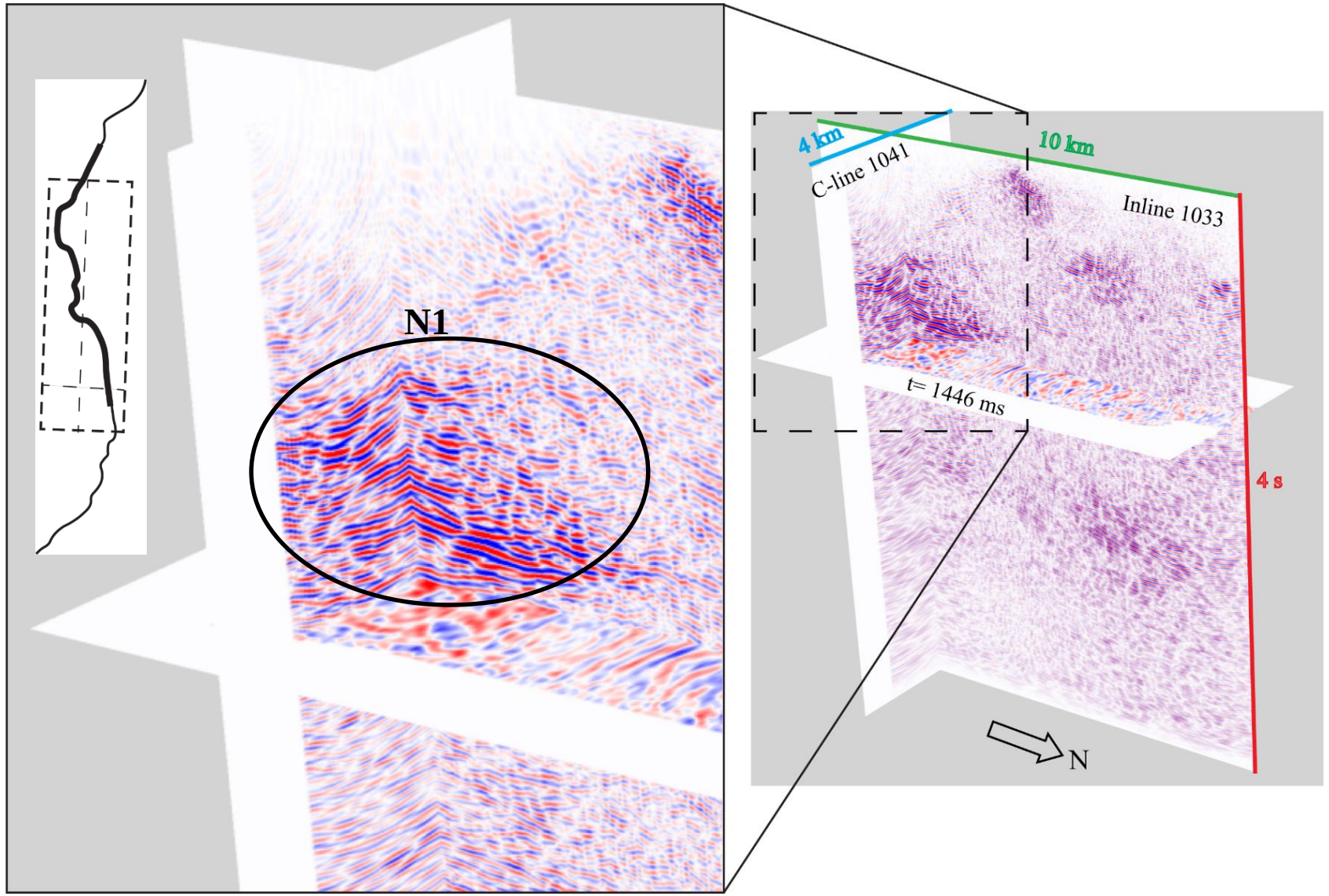
3D swath processing

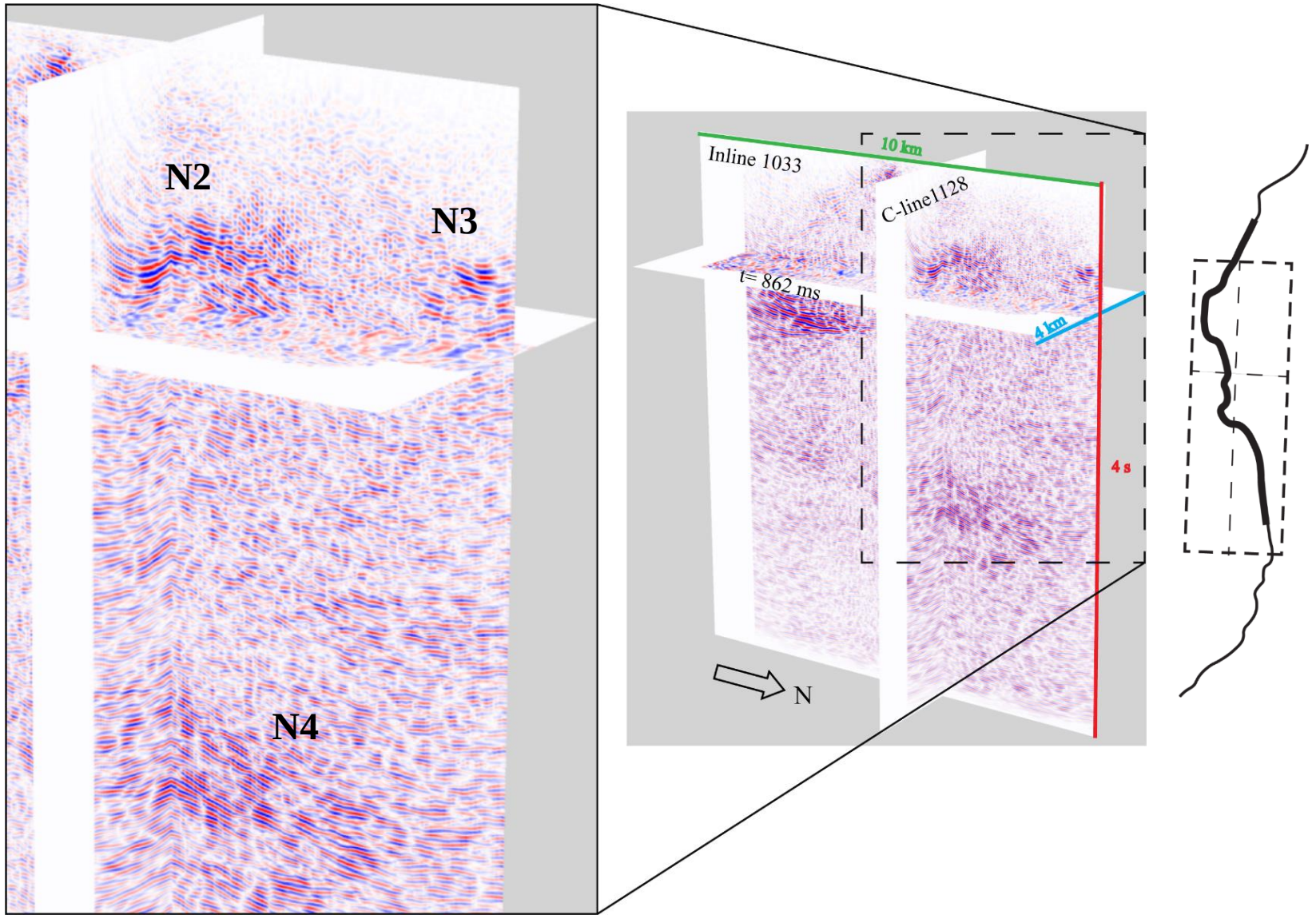
Swayze north



METAL EARTH

3D swath processing

Swayze north



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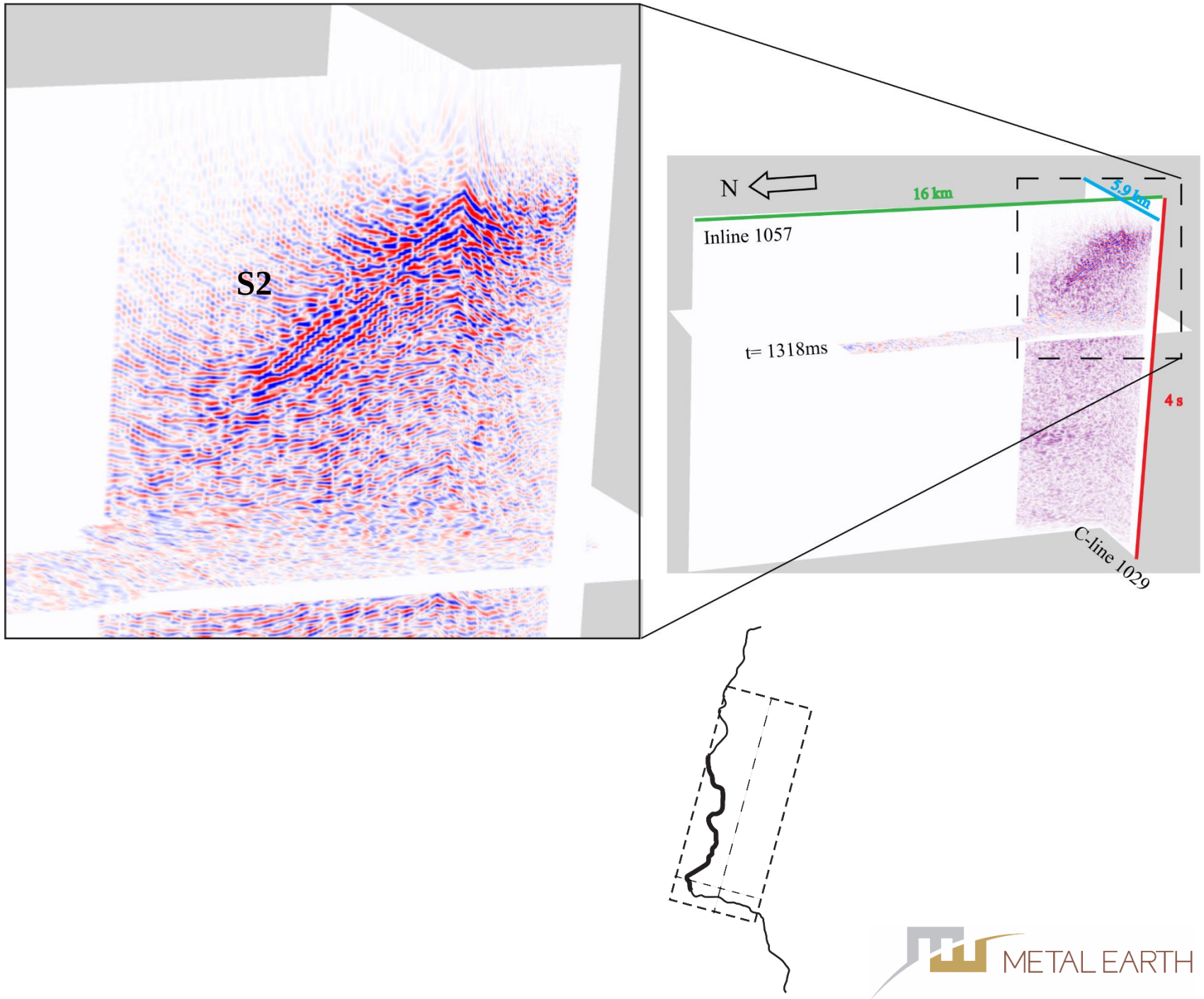
3D swath processing

Swayze south



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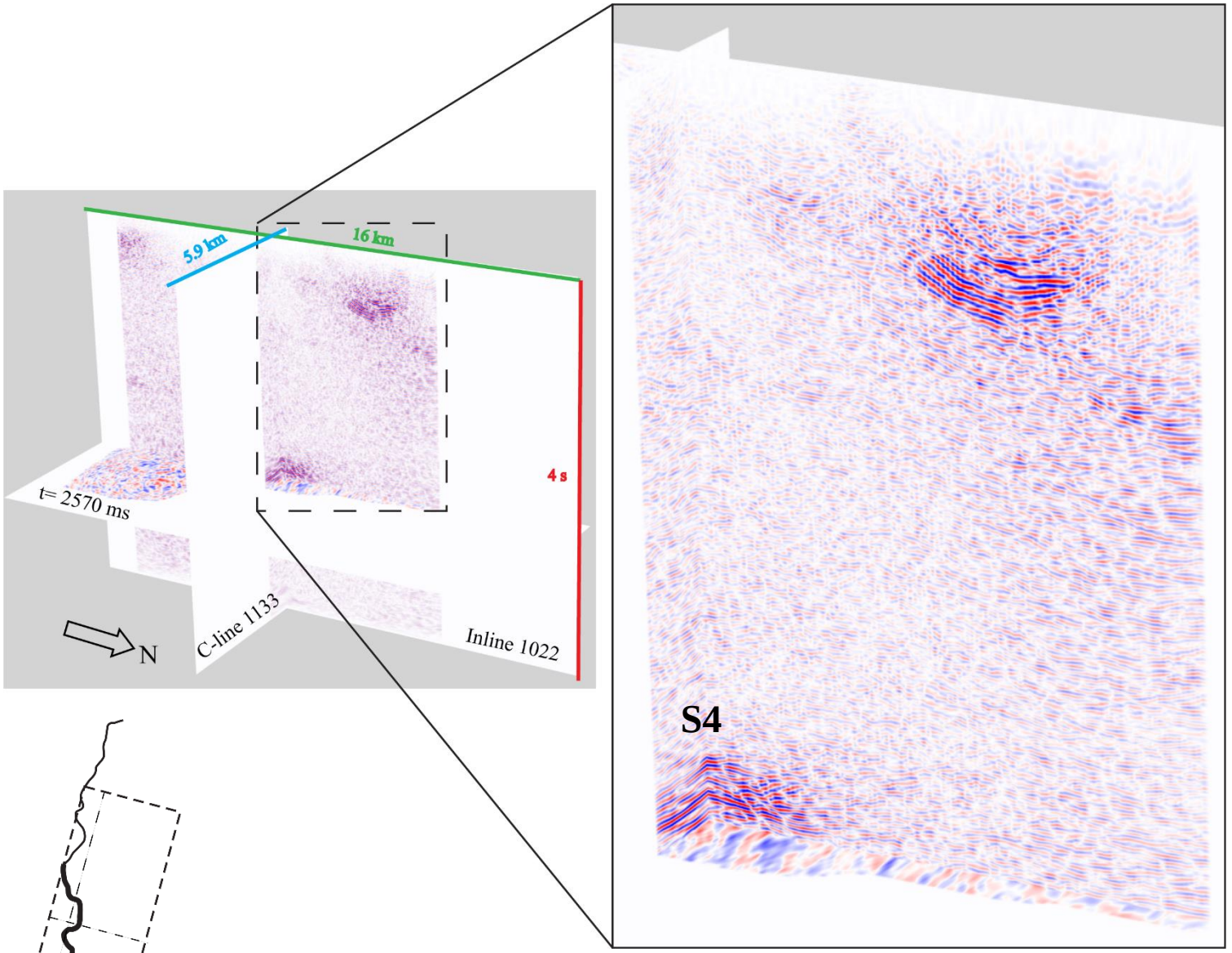
3D swath processing

Swayze south



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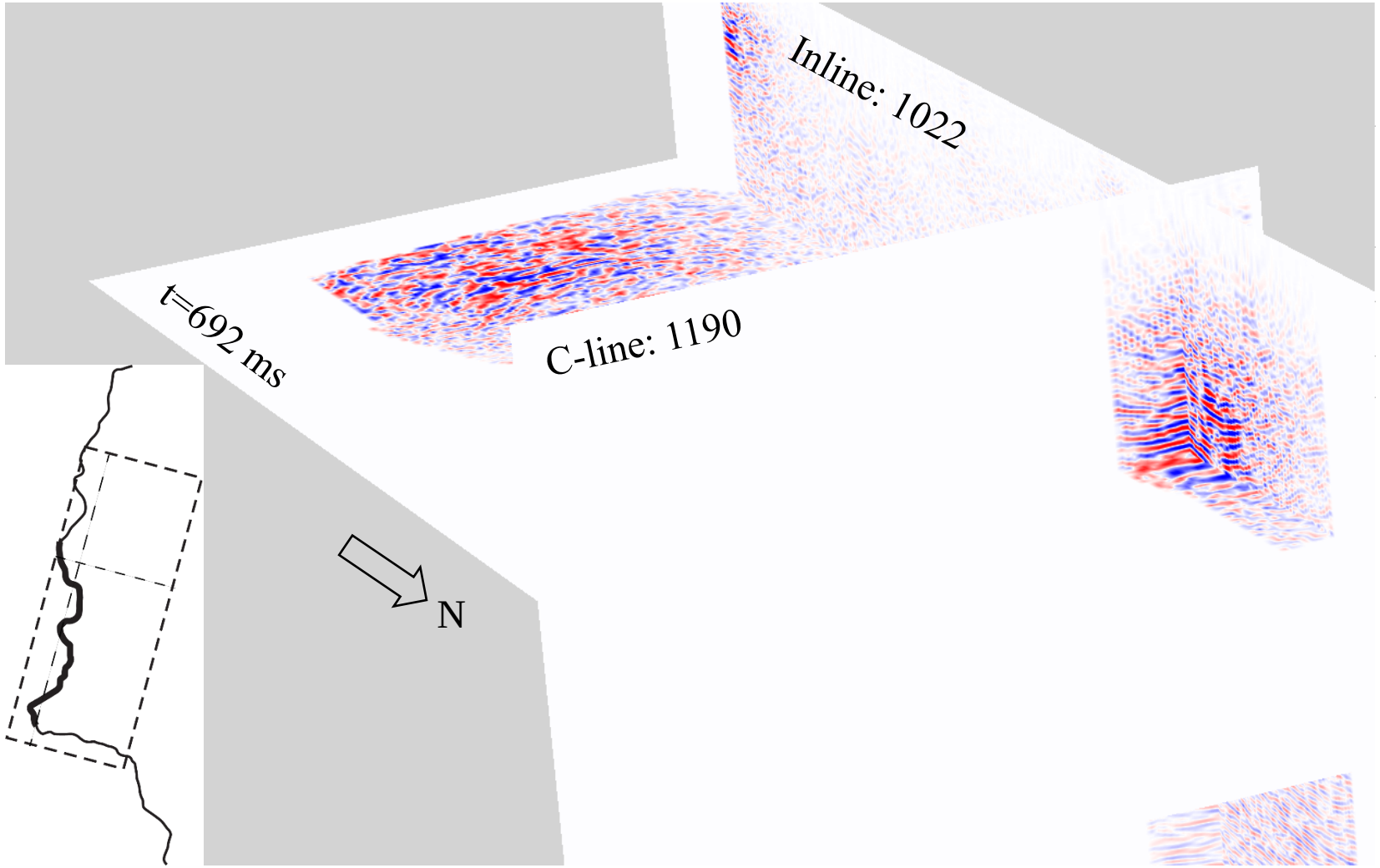
3D swath processing

Swayze south



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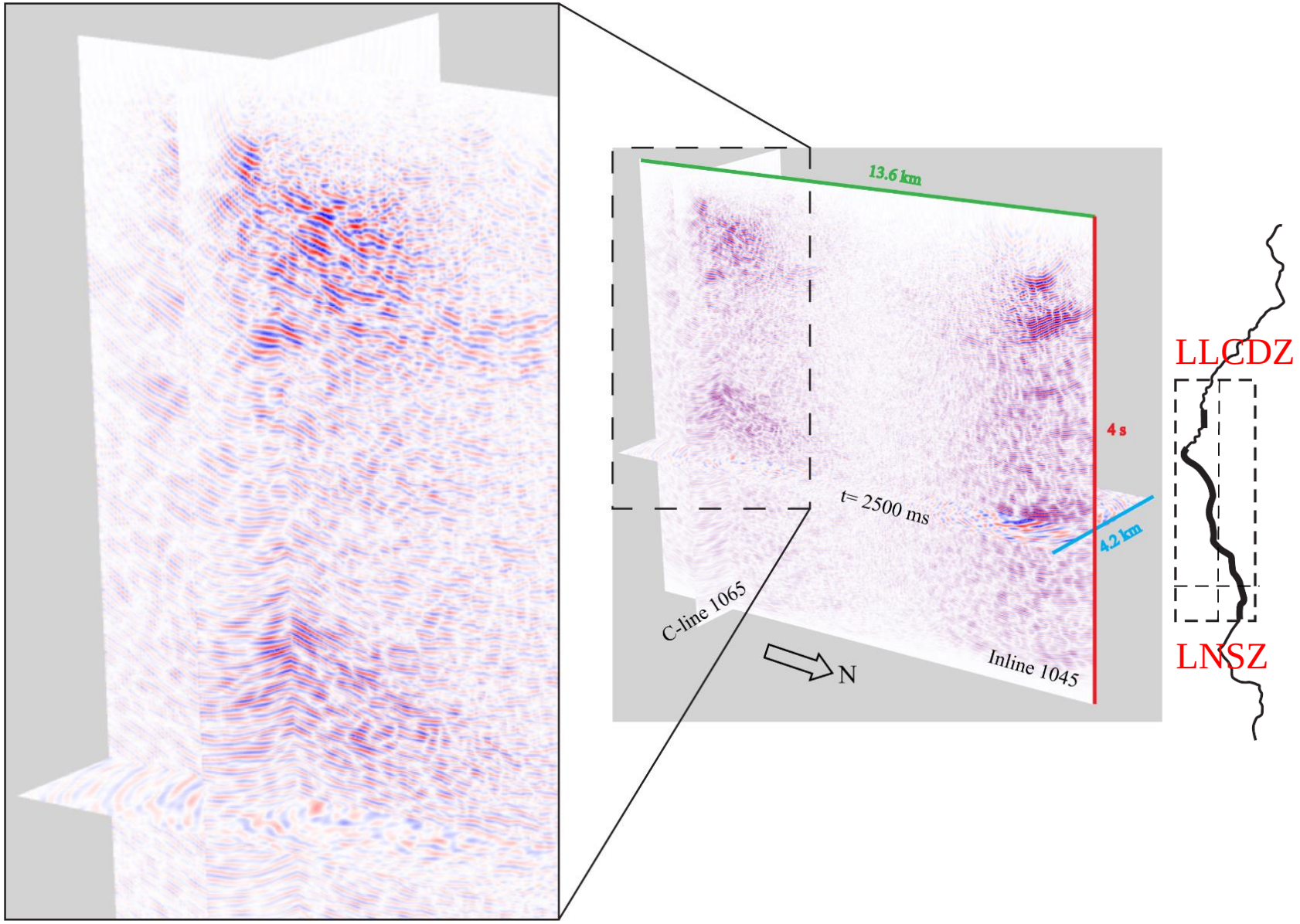
3D swath processing

Larder Lake



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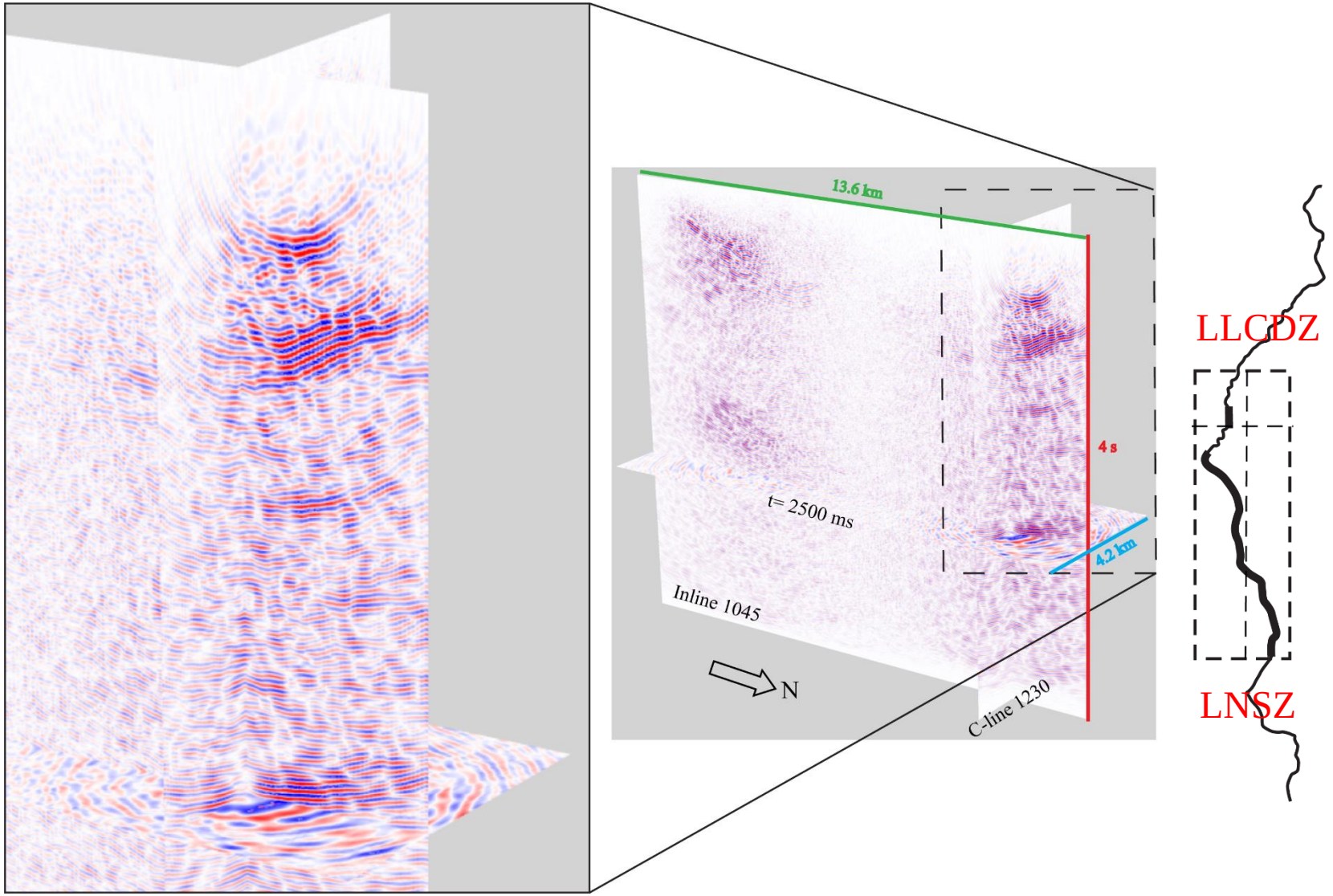

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Future work

Crooked surveys demand to test several imaging methods:

- Conventional processing (DMO corrections and migrations)
- Application of Pre-stack time migration
- Amplitude-versus-offset (AVO)
- Cross-dip analysis

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Thank you.

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