Shallow Erosional and Depositional Dynamics in the West of Shetland Basin: Insights from High-Resolution AUV Surveys

Ithaca Energy Tornado to Tormore Route

Wei Wei MacFarlane & Chris Davies, 1 May 2025

Why did this project use an Autonomous Underwater Vehicle (AUV)?

West of Shetland - Deep water(>1000 m)

- AUV minimises signal losses as it operates closer to the seafloor
- AUV has excellent line keeping & positioning

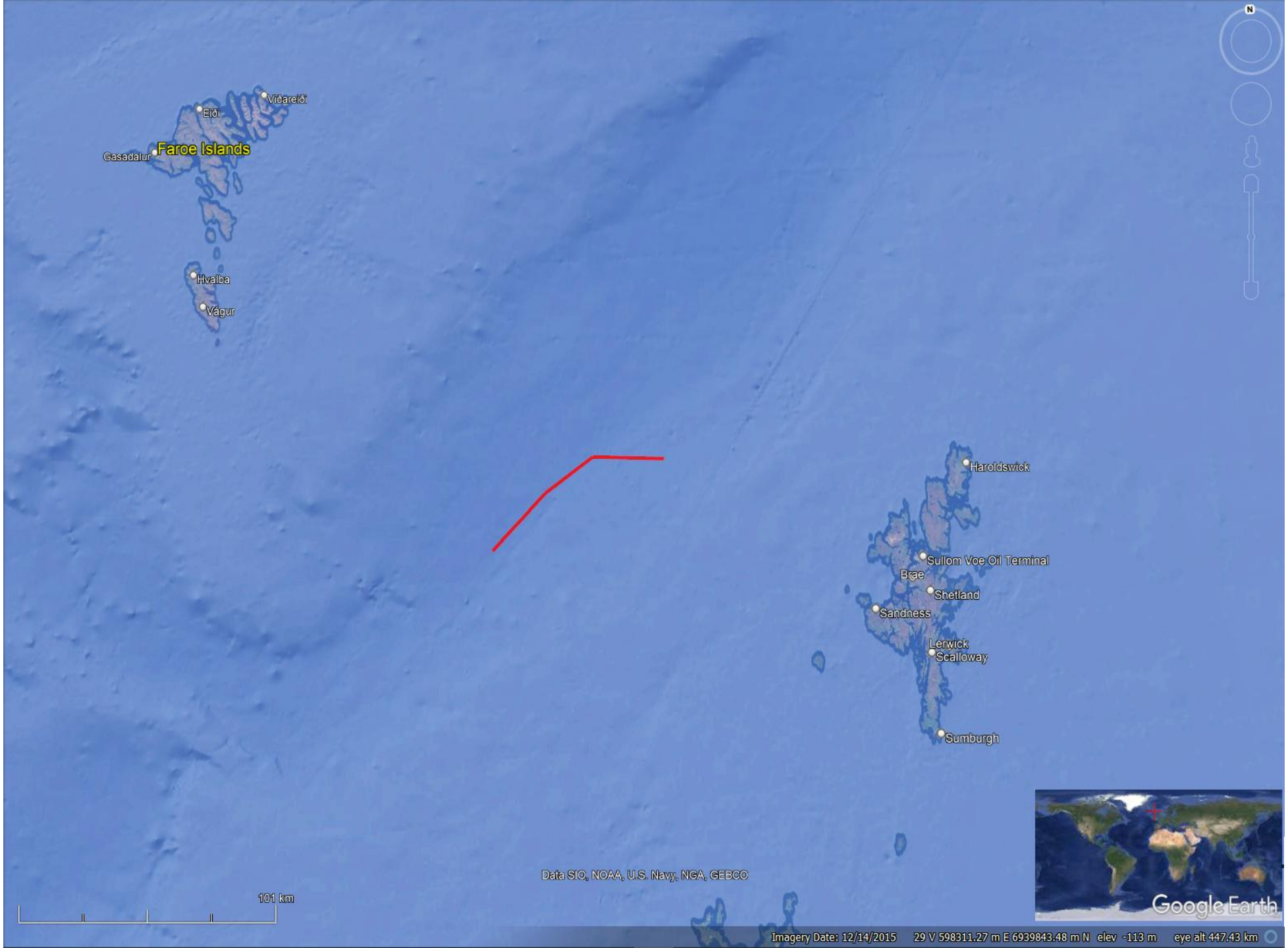
Autonomous Underwater Vehicle (AUV)

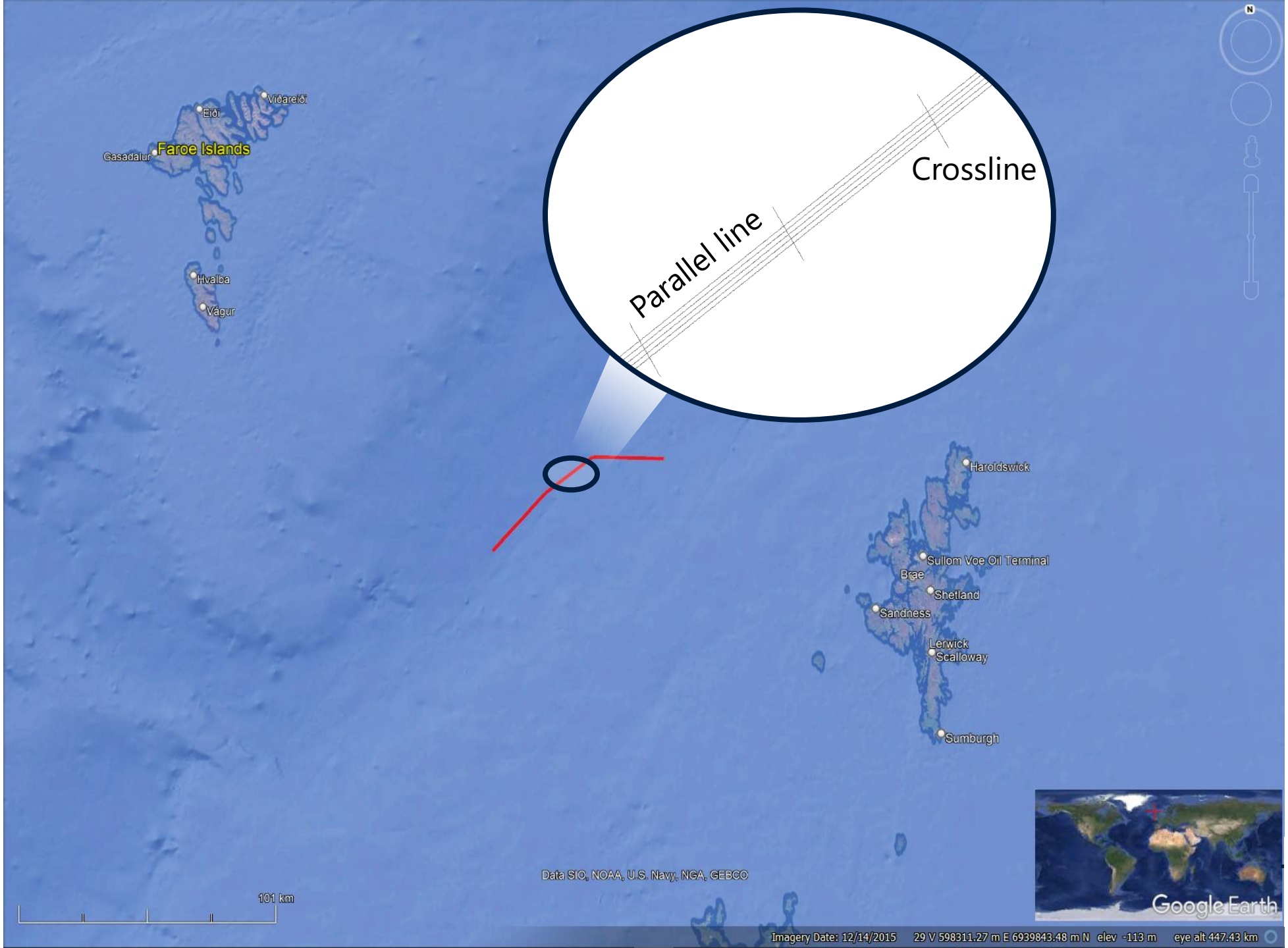
Autonomous Underwater Vehicle (AUV)

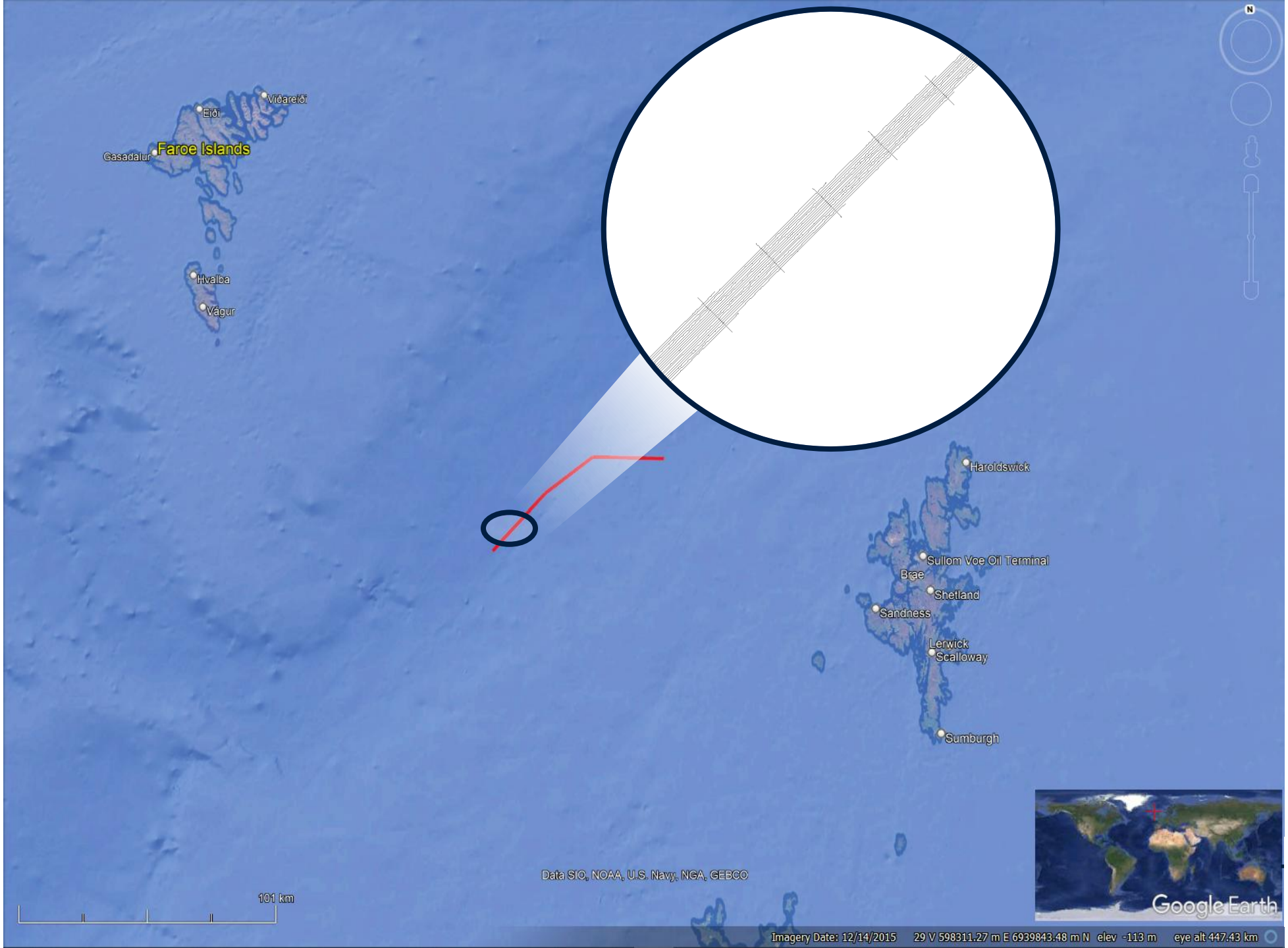
Name	SV Echo Surveyor VI
Model	Kongsberg Hugin 1000
Capability	3000m water depth
	48 hours battery life

Sub-Bottom Profiler

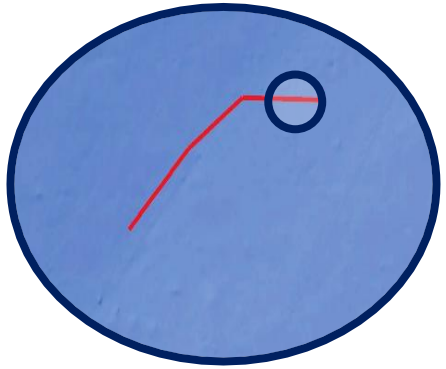
Name	Edgetech DW-106 chirp
Pulse Frequency Bandwidth	1.5 kHz -10.5 kHz
Penetration below seafloor	approximately 35 m
Resolution	approximately 0.2 m


Víðareiði
Eiði
Faroe Islands
Gasadalur
Hvalba
Vágur
Haroldswick
Sullom Voe Oil Terminal
Brae
Shetland
Sandness
Lerwick
Scalloway
Sumburgh
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
101 km
Google Earth
Imagery Date: 12/14/2015 29 V 598311.27 m E 6939843.48 m N elev -113 m eye alt 447.43 km


Crossline
Parallel line
Faroe Islands
Víðareiði
Eiði
Gásadalur
Hvalba
Vágur
Haroldswick
Sullom Voe Oil Terminal
Brae
Shetland
Sandness
Lerwick
Scalloway
Sumburgh
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
101 km
Google Earth
Imagery Date: 12/14/2015 29 V 598311.27 m E 6939843.48 m N elev -113 m eye alt 447.43 km

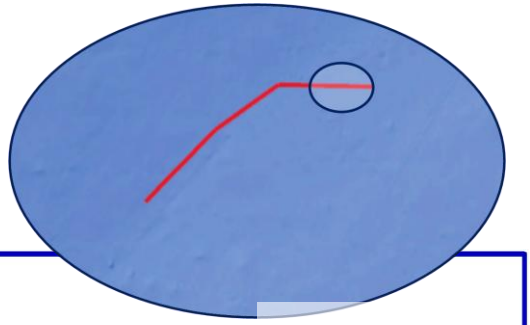

Viðareiði
Eiði
Faroe Islands
Gasadalur
Hvalba
Vágur
Haroldswick
Sullom Voe Oil Terminal
Brae
Shetland
Sandness
Lerwick
Scalloway
Sumburgh
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
101 km
Google Earth
Imagery Date: 12/14/2015 29 V 598311.27 m E 6939843.48 m N elev -113 m eye alt 447.43 km

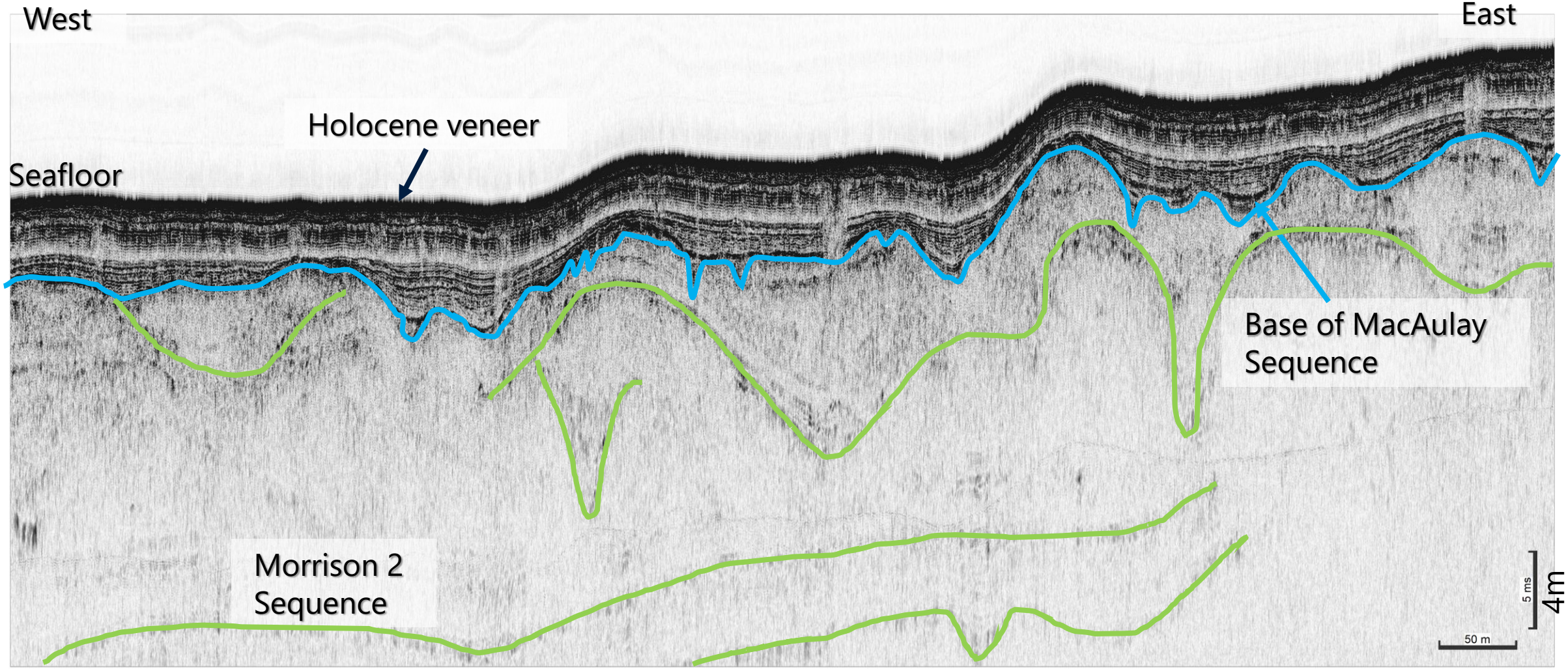
Shallow Geology



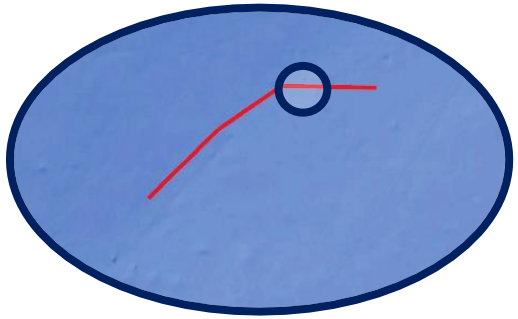
Formation / Age		Lithology
Quaternary	Holocene	slightly gravelly silty sand to silt/clay with cobbles and boulders
Pliocene to Pleistocene	MacAulay Sequence	slightly sandy, slightly gravelly clay
	Morrison 2 Sequence (Debris Flows & well layered)	slightly sandy, slightly gravelly clay with occasional cobbles and boulders and beds of sand

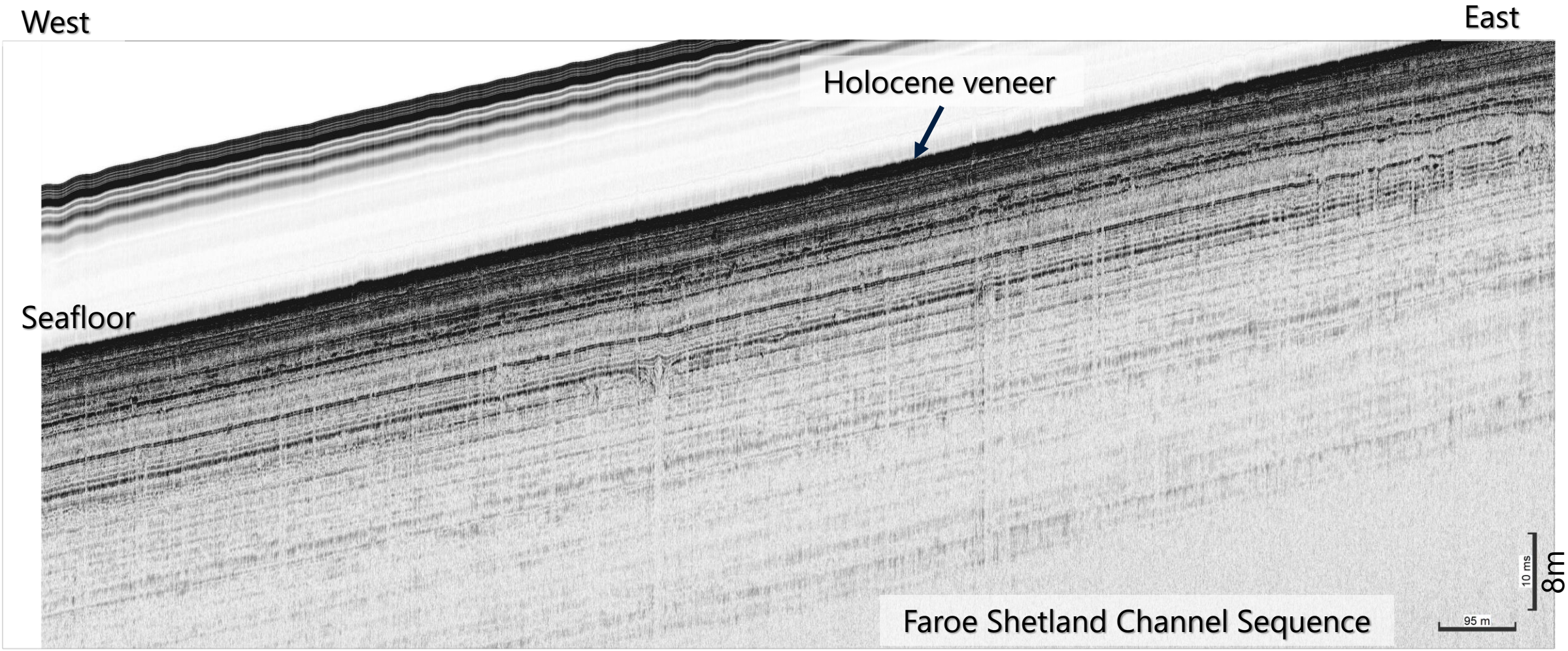
MacAulay Sequence overlying Morrison Sequence

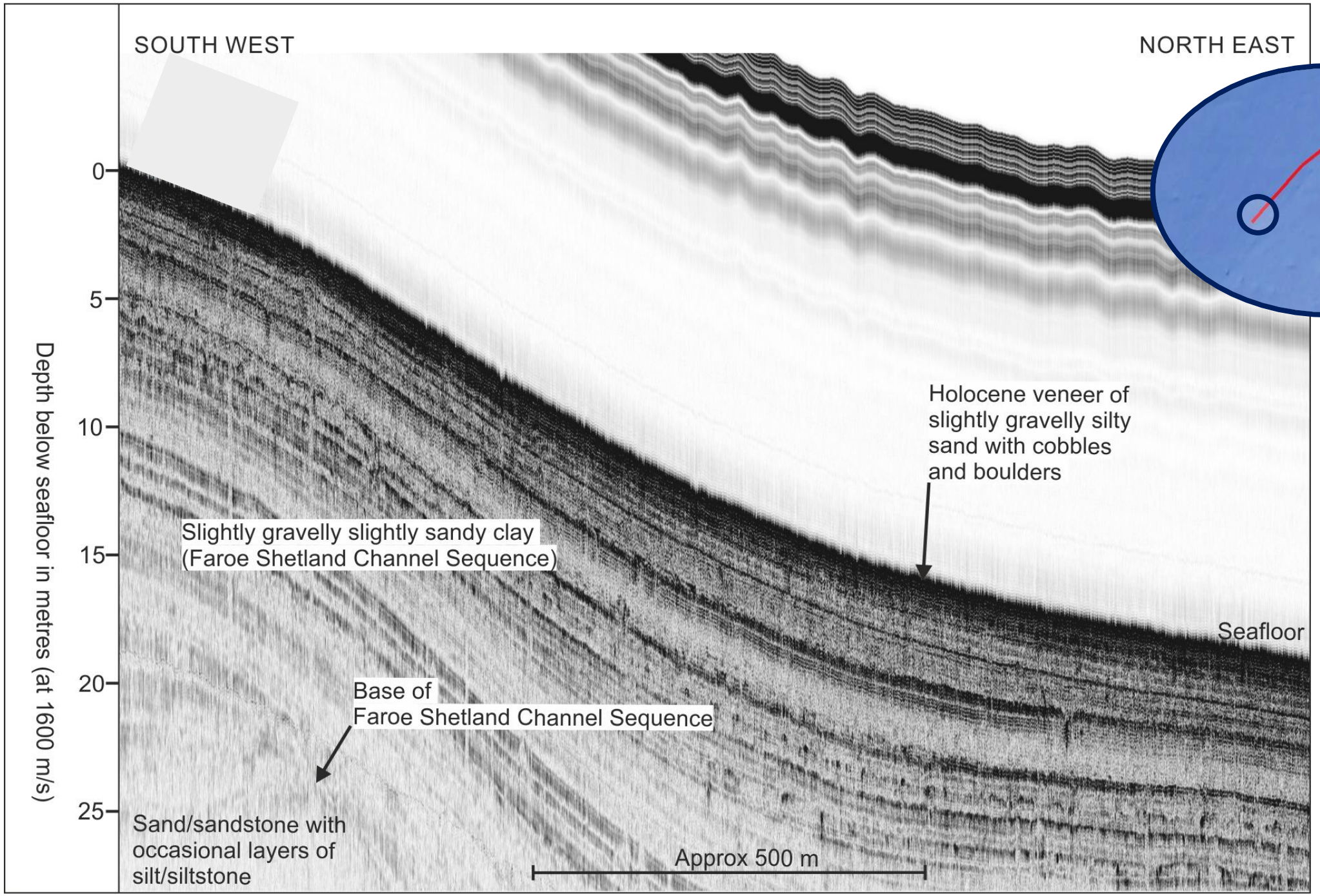




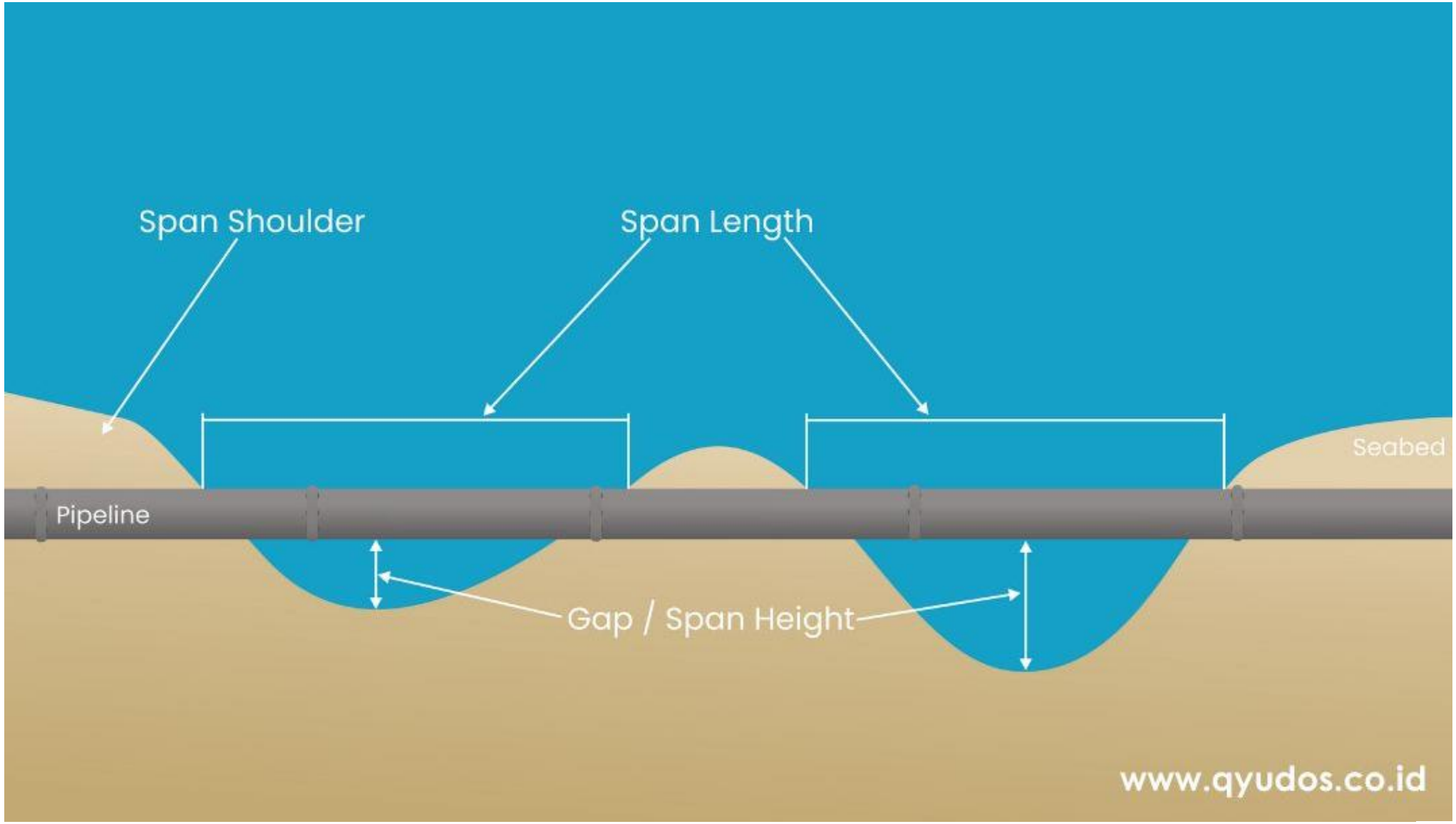
MacAulay Sequence and Morrison Sequence Interdigitates



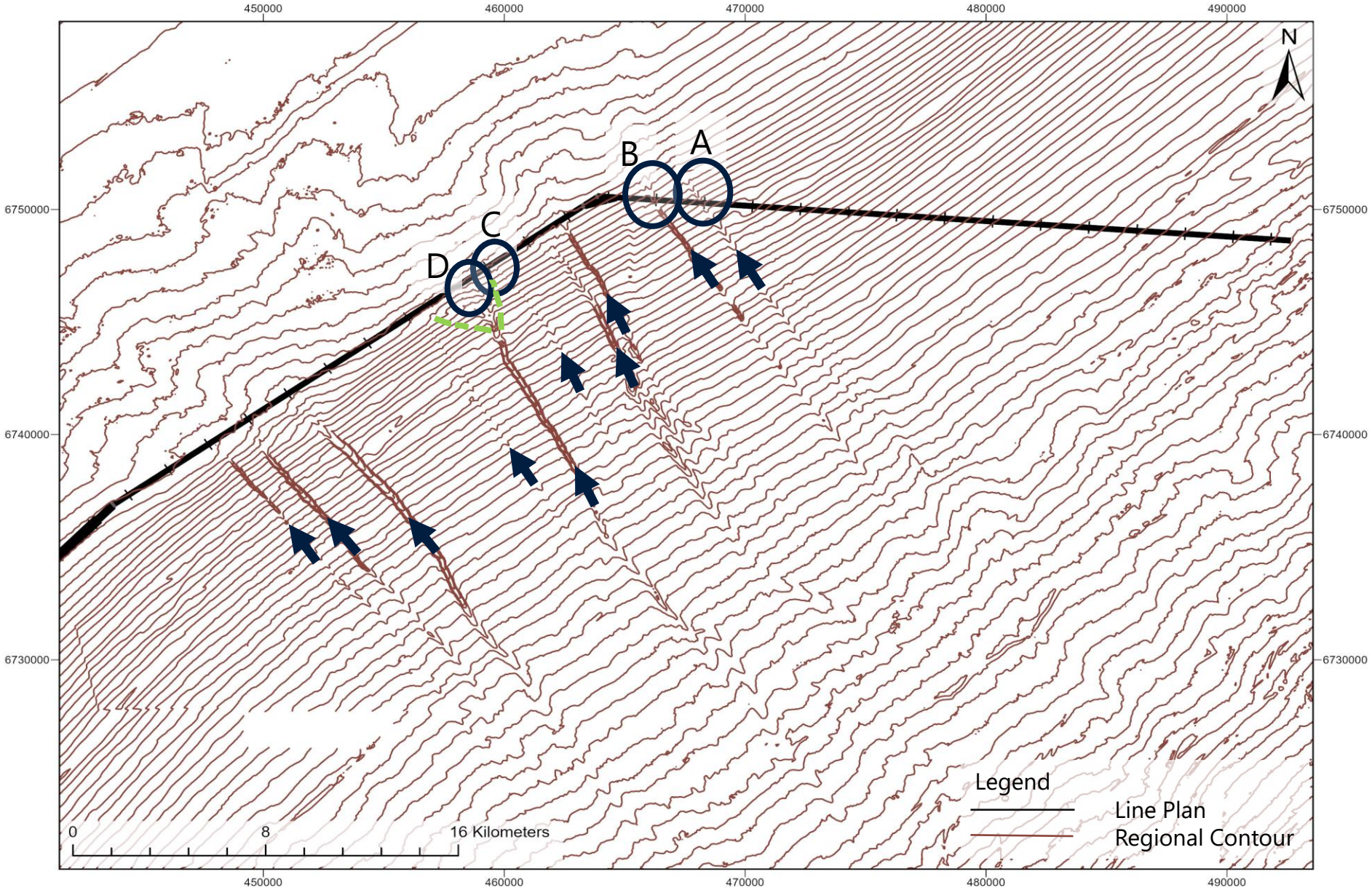



SOUTH WEST
NORTH EAST
Depth below seafloor in metres (at 1600 m/s)
0
5
10
15
20
25
Holocene veneer of slightly gravelly silty sand with cobbles and boulders
Slightly gravelly slightly sandy clay (Faroe Shetland Channel Sequence)
Seafloor
Base of Faroe Shetland Channel Sequence
Sand/sandstone with occasional layers of silt/siltstone
Approx 500 m

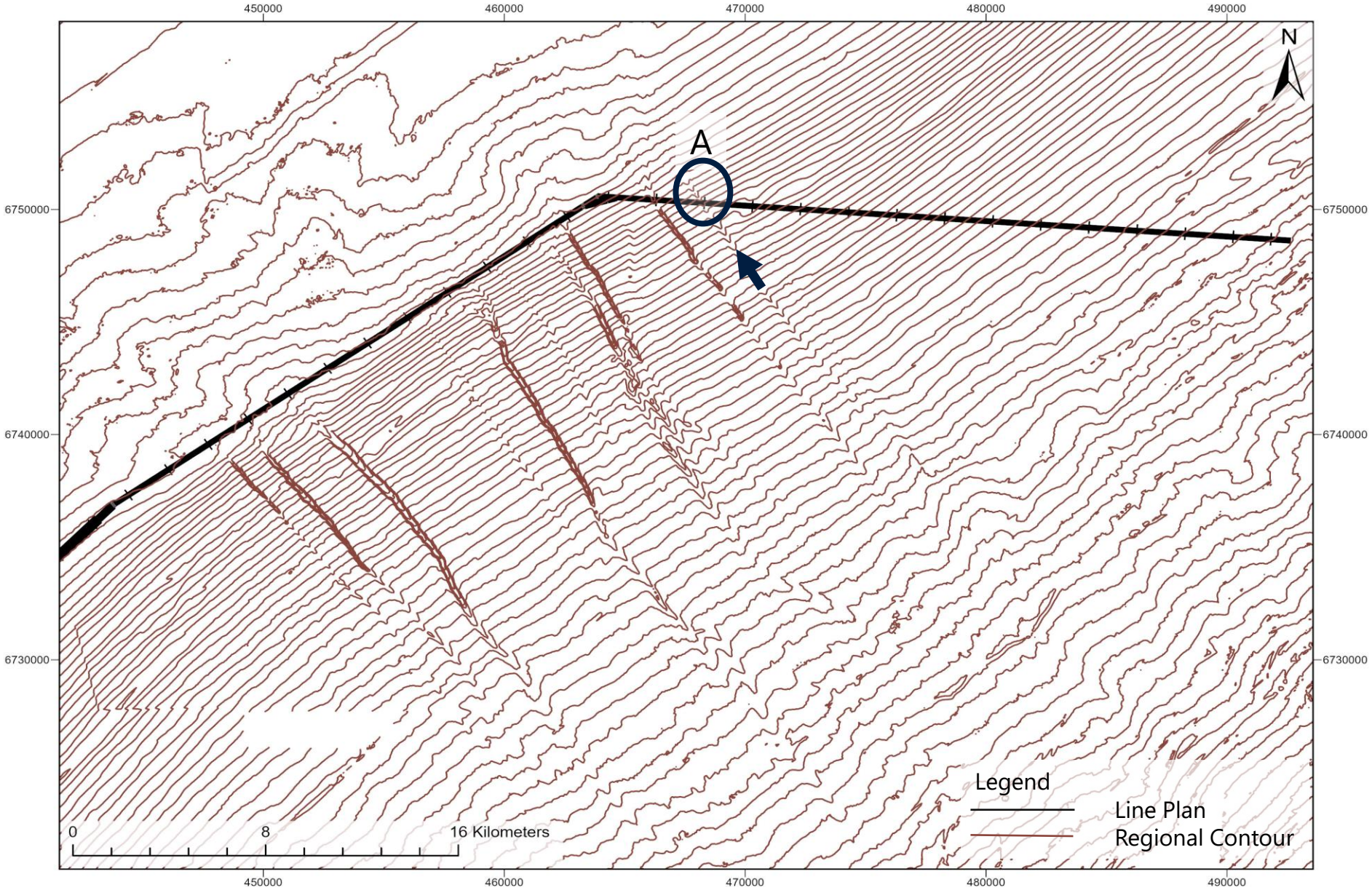
Risk & Mitigation of Gully

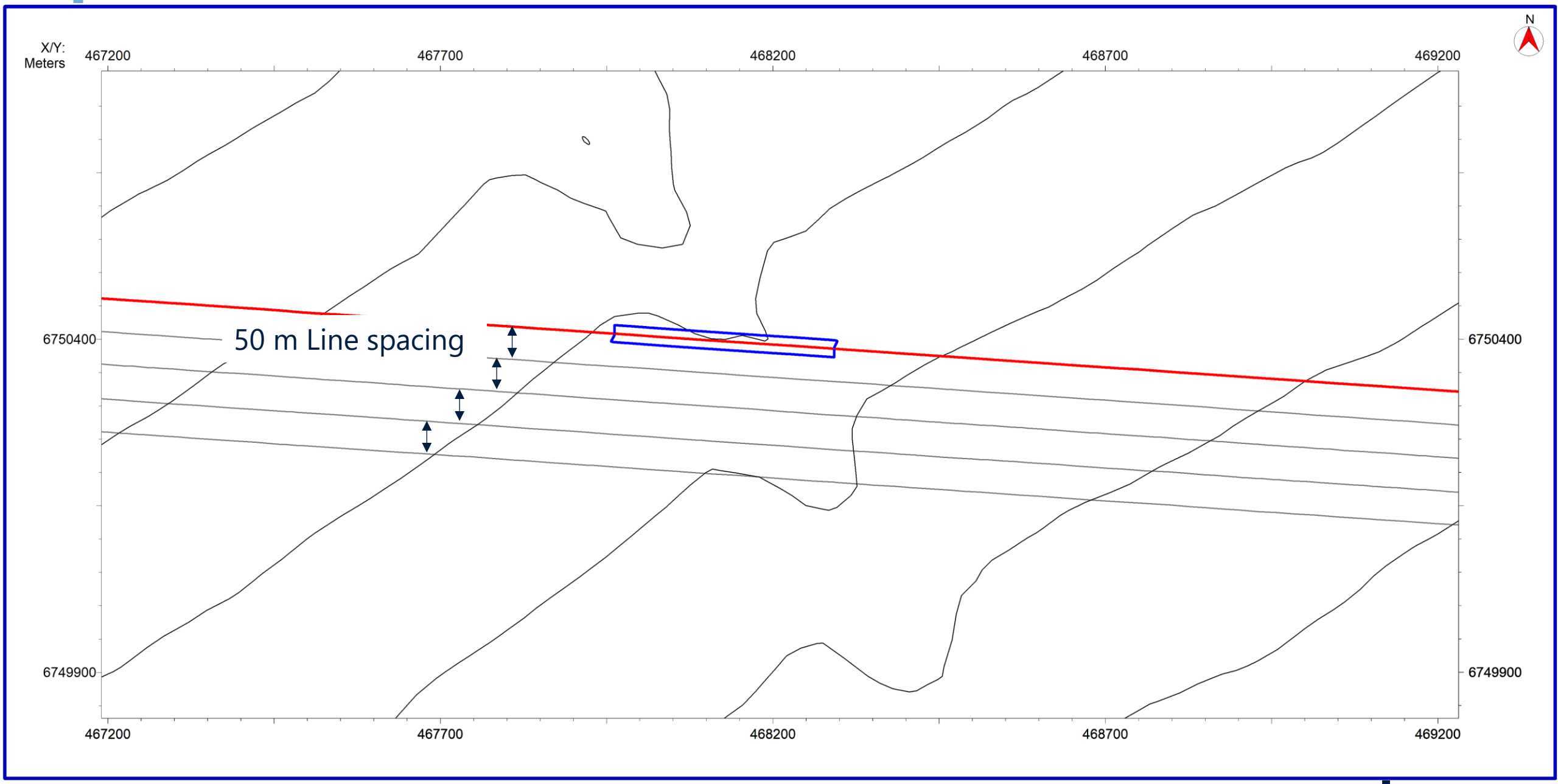


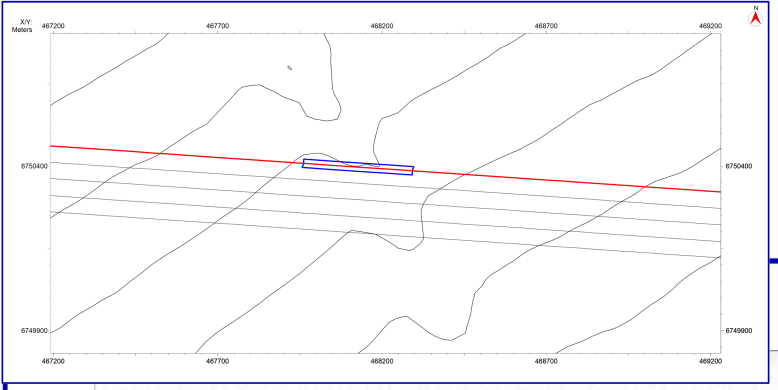
Regional Bathymetric Contours and Line Plan



Gully A


450000
460000
470000
480000
490000
6750000
6740000
6730000
N
A
Legend
Line Plan
Regional Contour
0
8
16 Kilometers


X/Y:
Meters
467200
467700
468200
468700
469200
6750400
6749900
50 m Line spacing
N



Section 1

Width	190m
Depth	22m

Seafloor

C

Well layered infill within gully

B

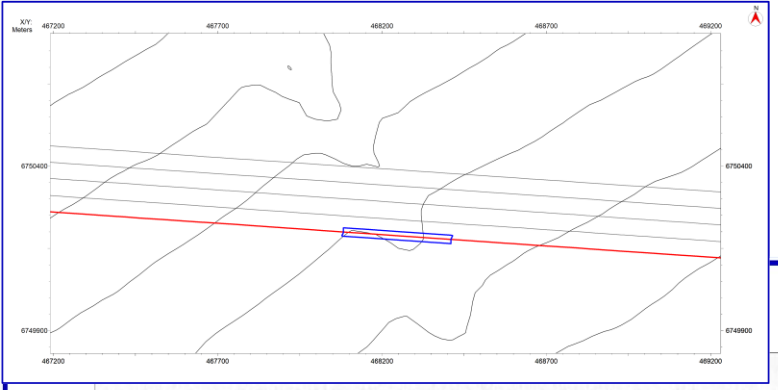
A

Debris flow deposits at gully base

5 ms

4m

15 m


X/Y:
Meters
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468700
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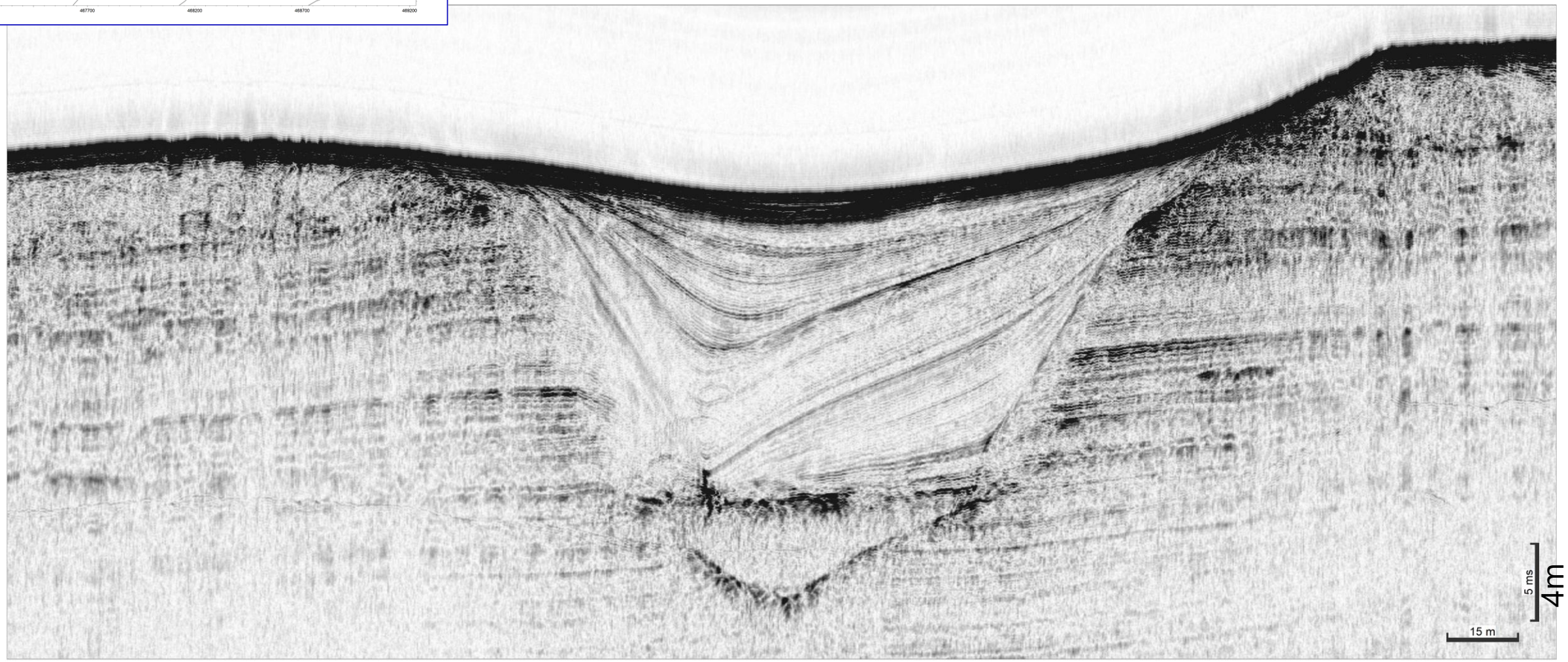
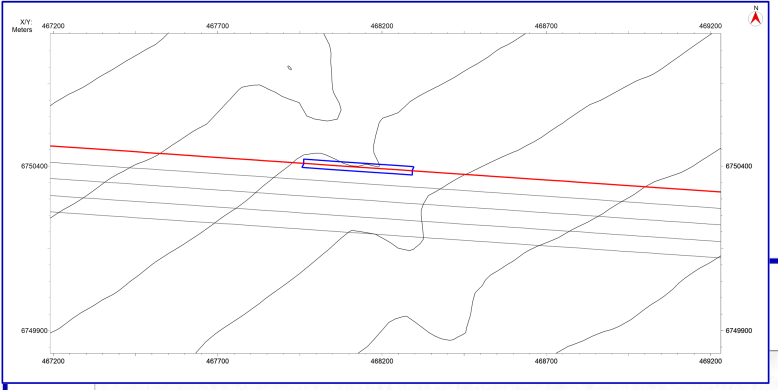
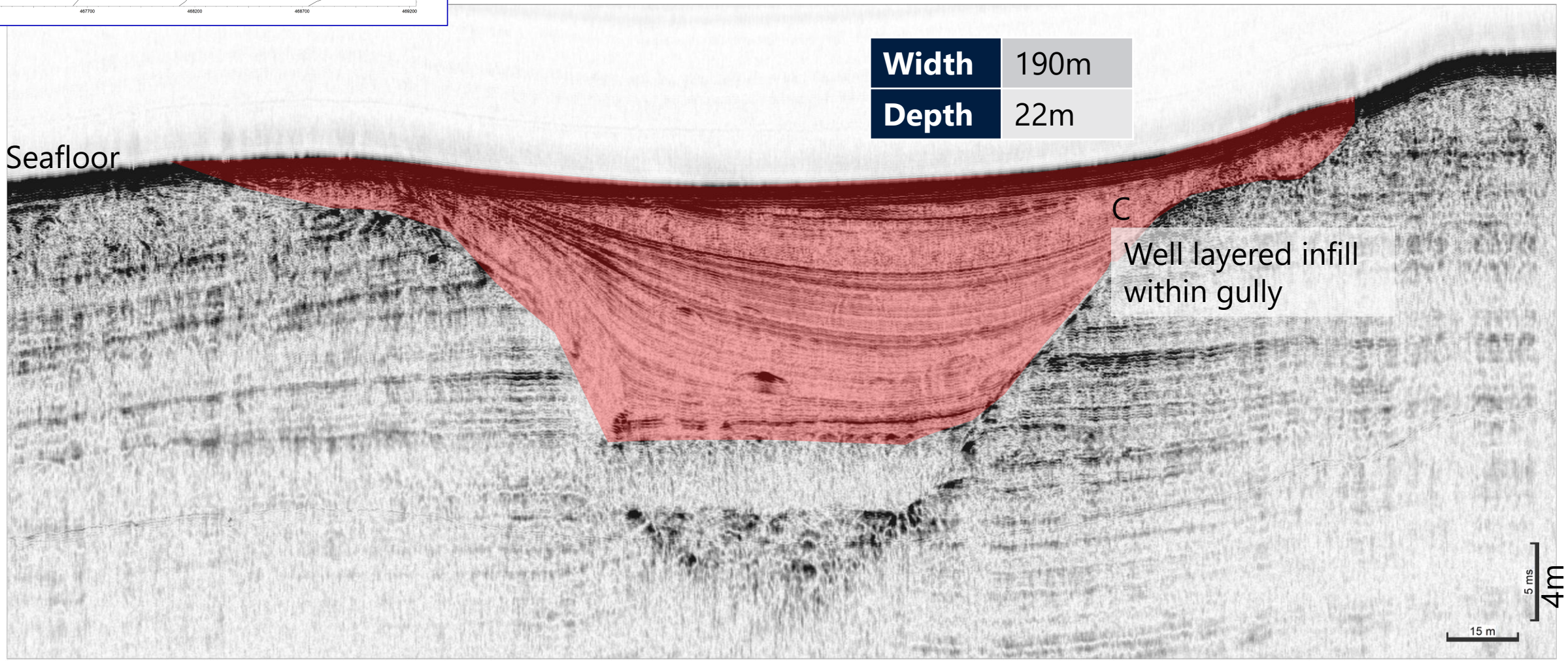
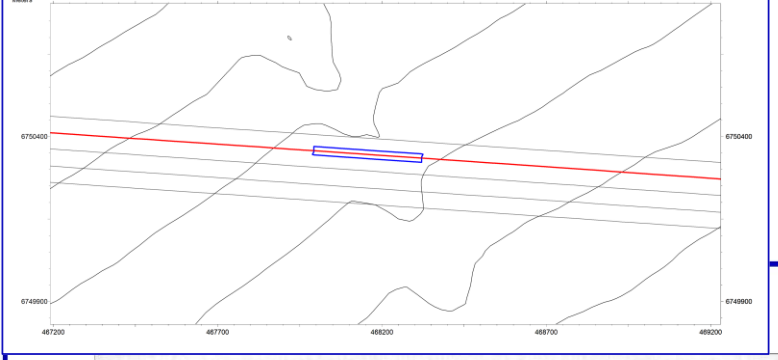
6749900


5 ms
4m
15 m

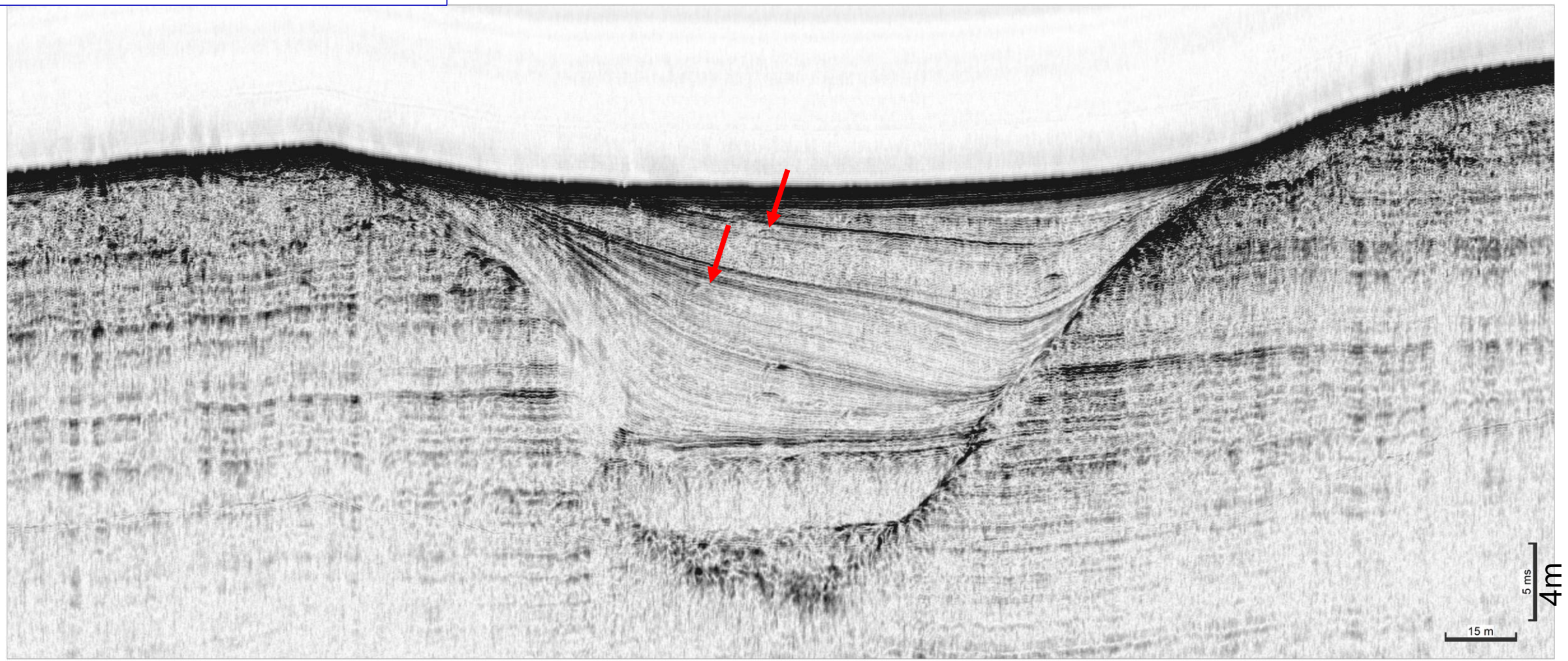

X/Y: Meters
467200
467700
468200
468700
469200
6750400
6749900

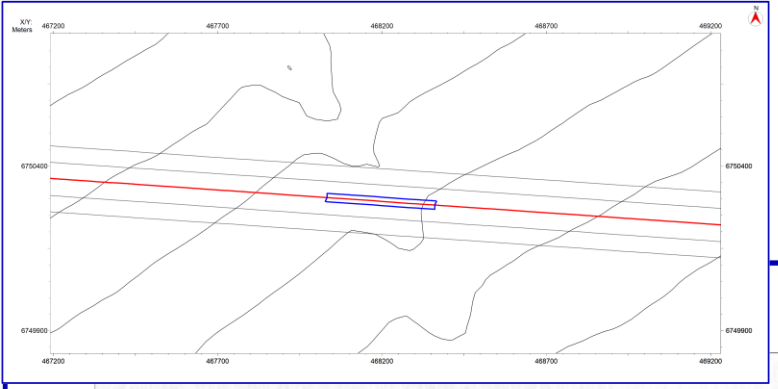
Section 1


Width 190m
Depth 22m
Seafloor
C
Well layered infill within gully
5 ms
4m
15 m

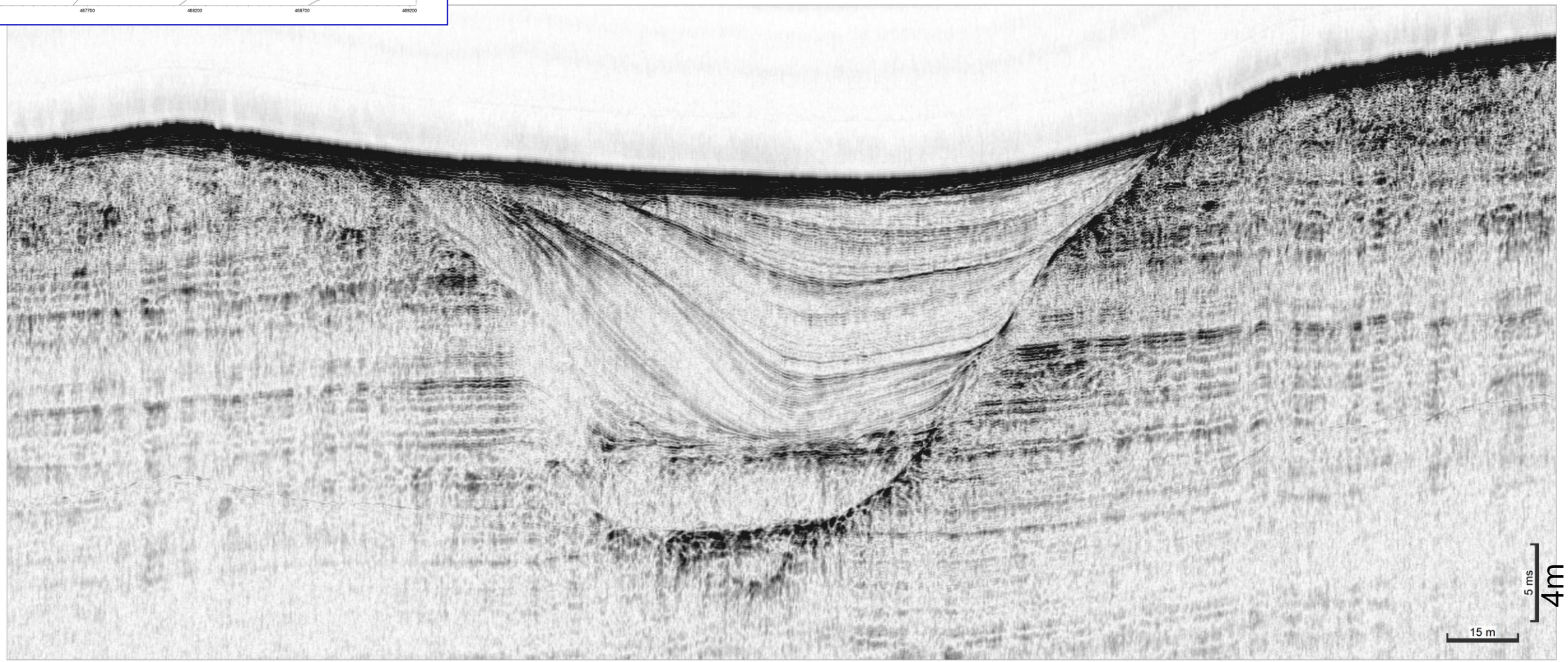

6750400
6749900
467200
467700
468200
468700
469200

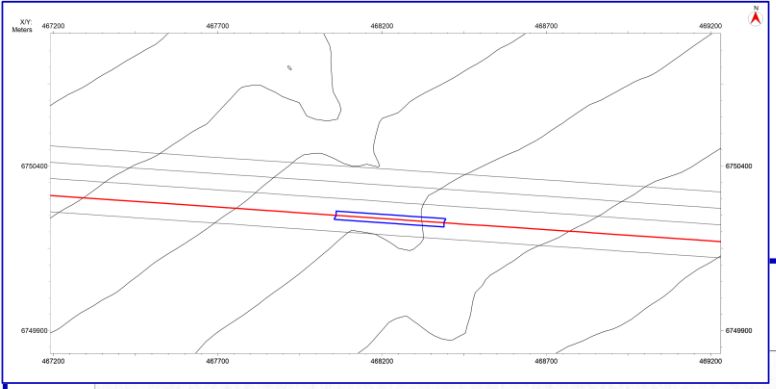
Section 2


5 ms
4m
15 m

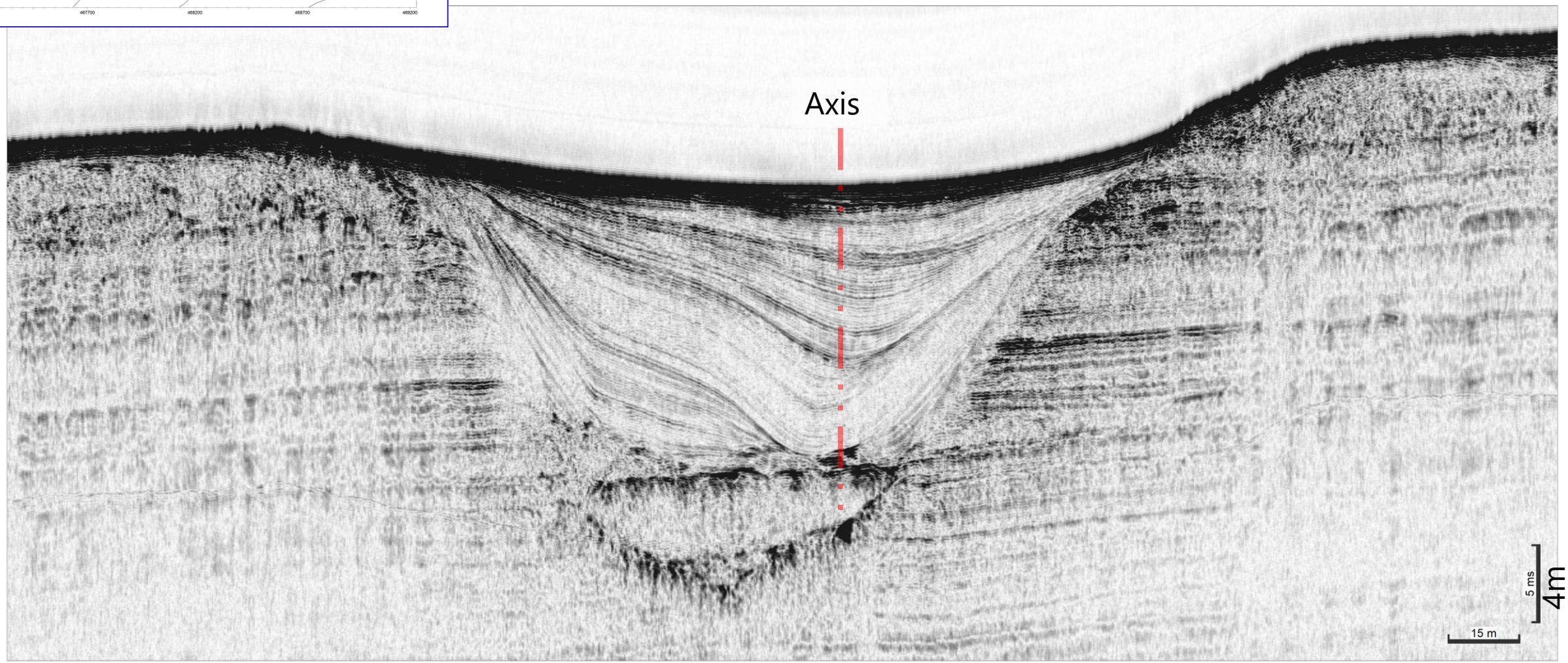

X/Y:
Meters
467200
467700
468200
468700
469200
6750400
6749900

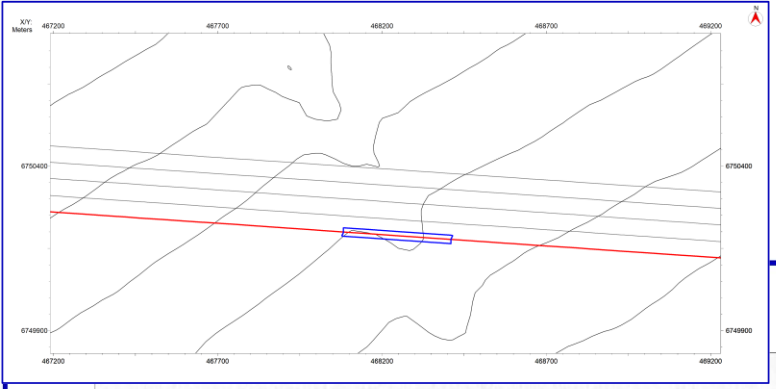
Section 3


5 ms
4m
15 m

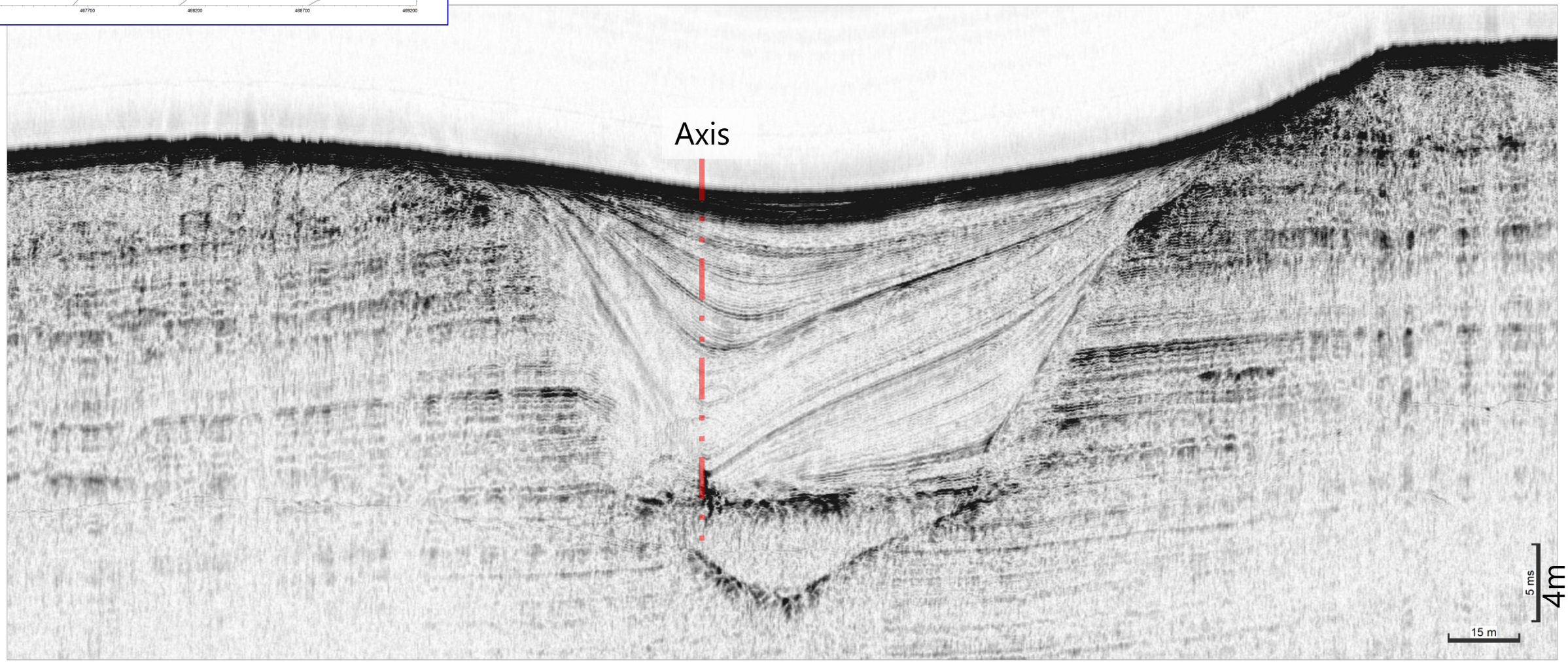

X/Y:
Meters
467200
467700
468200
468700
469200
6750400
6749900

Section 4

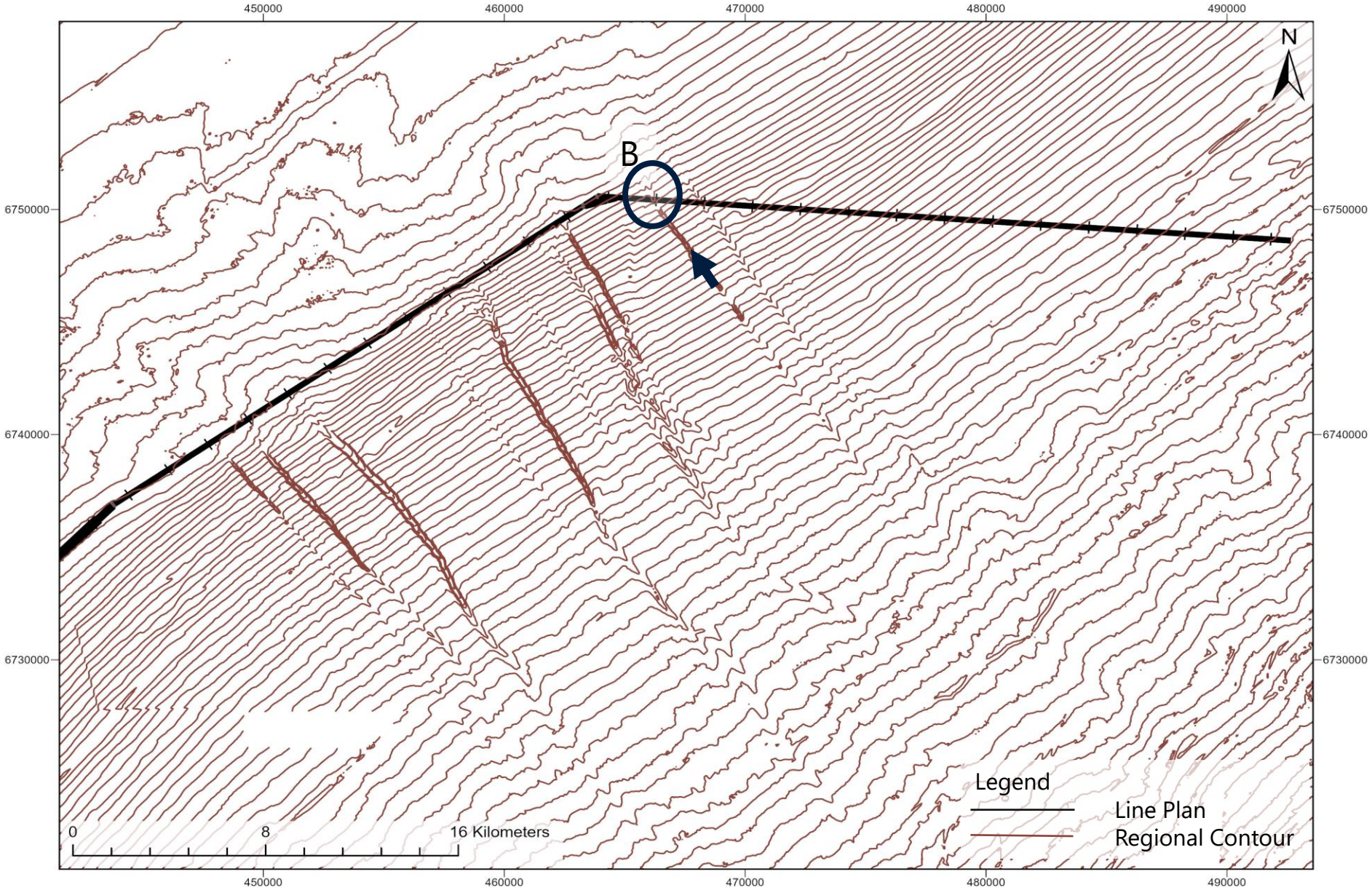

Axis
5 ms
4m
15 m

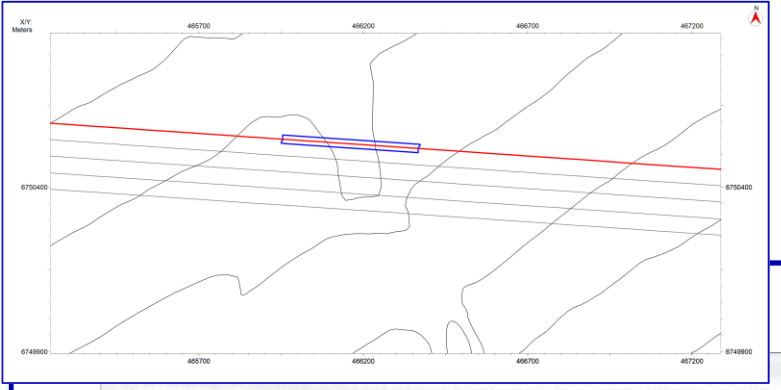

X/Y;
Meters
467200
467700
468200
468700
469200
6750400
6749900

Section 5

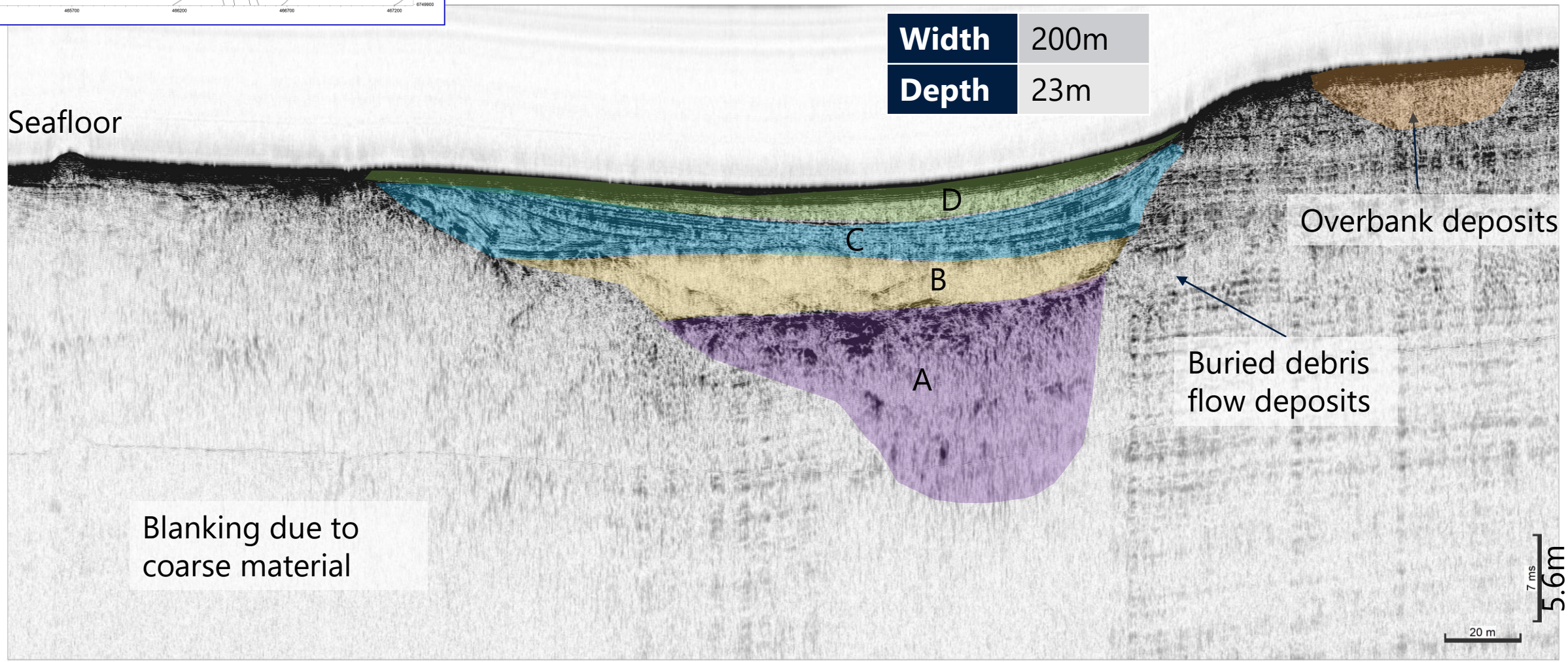

Axis
5 ms
4m
15 m

Gully B

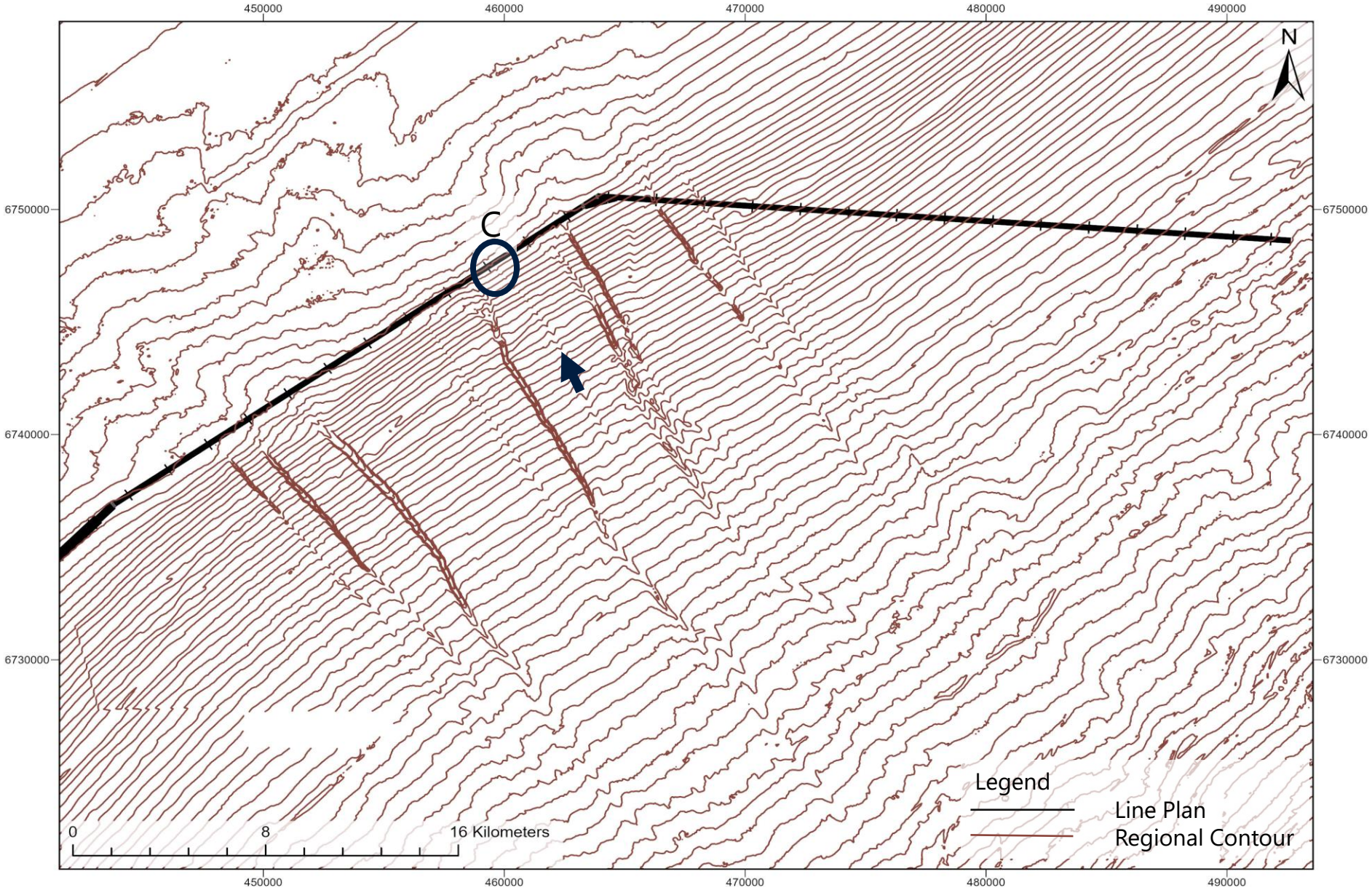

450000
460000
470000
480000
490000
6750000
6740000
6730000
N
B
Legend
Line Plan
Regional Contour
0
8
16 Kilometers


X/Y:
Meters
465700
466200
466700
467200
6750400
6749900

Section 1


Width 200m
Depth 23m
Seafloor
D
C
B
A
Overbank deposits
Buried debris flow deposits
Blanking due to coarse material
7 ms
5.6m
20 m

Gully C


450000
460000
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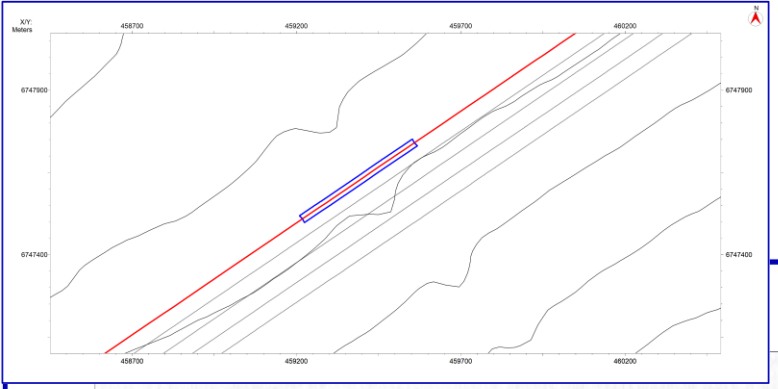
480000
490000
6750000
6740000
6730000
N
C
Legend
Line Plan
Regional Contour
0
8
16 Kilometers



Section 1

Width	80m
Depth	14m

Overbank deposits

B

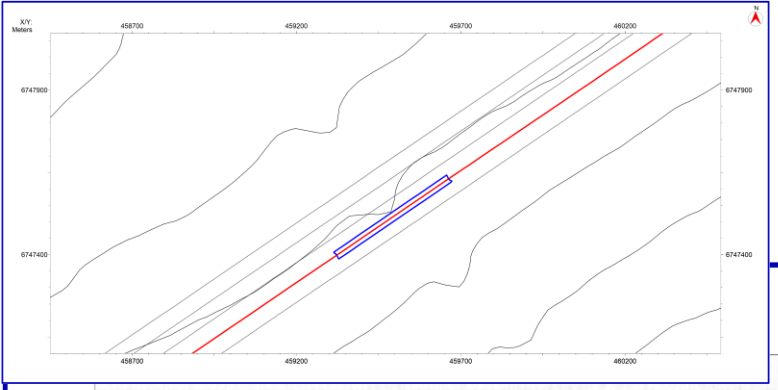
A

Debris flow deposits at gully base

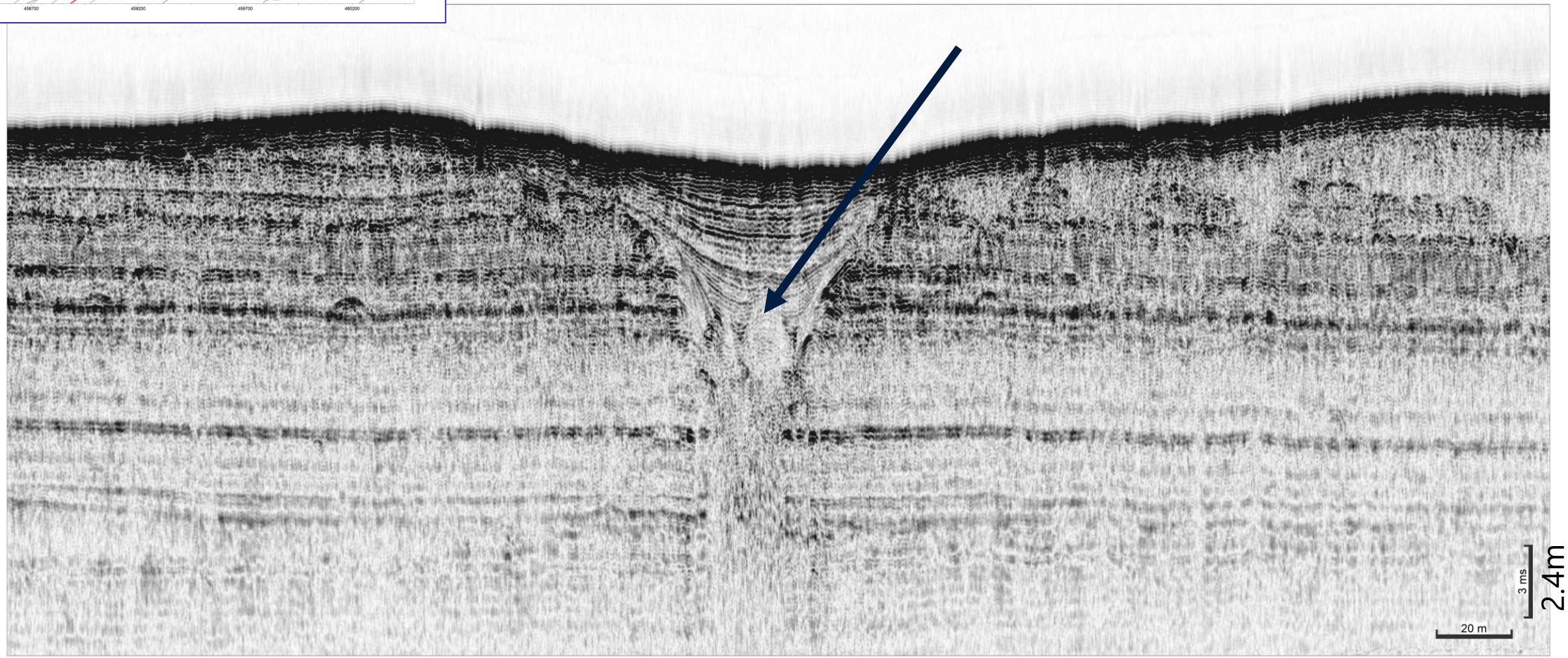
3 ms

2.4m

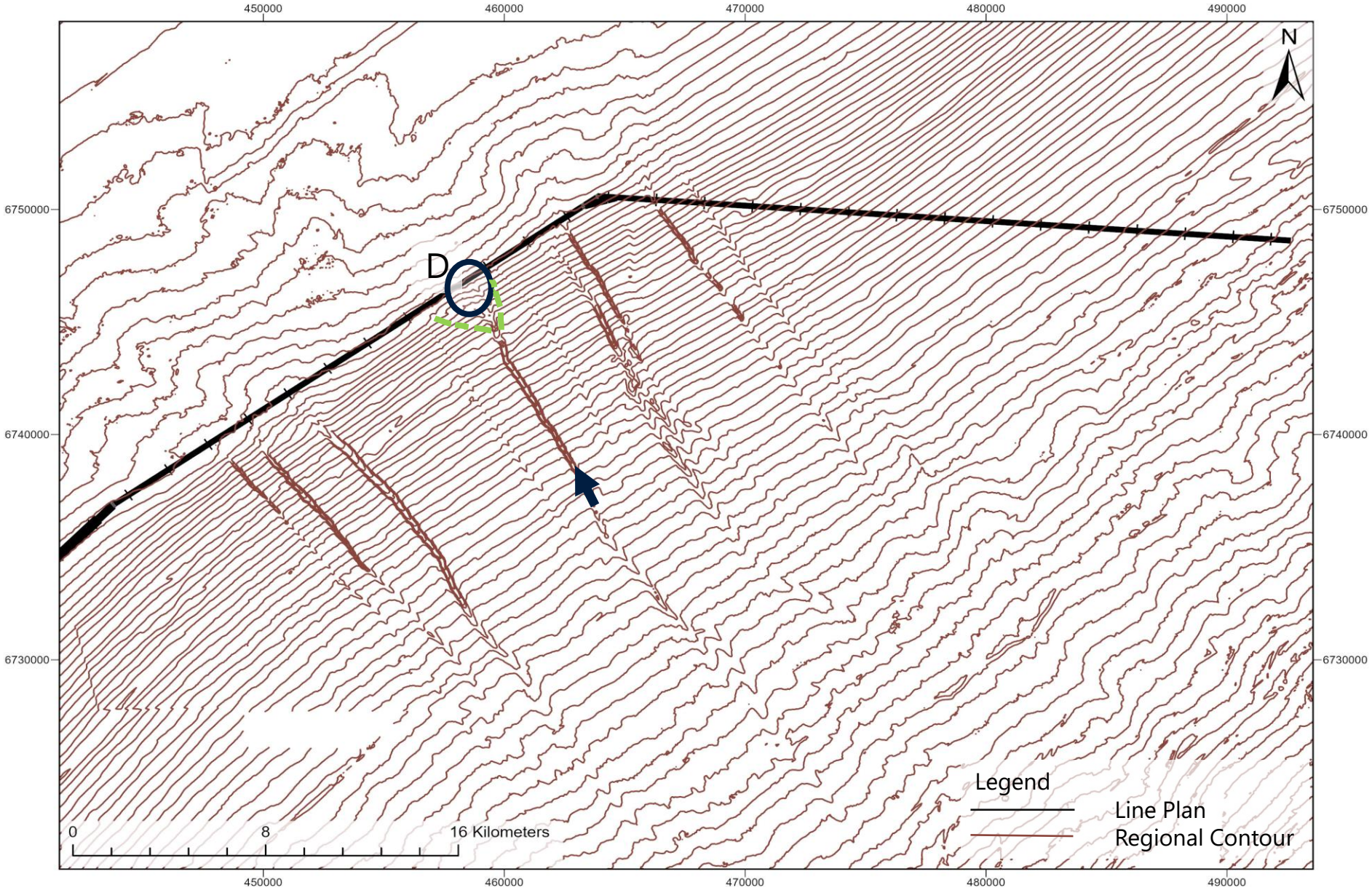
20 m


X/Y:
Meters
458700
459200
459700
460200
6747900
6747400

Section 4


3 ms
2.4m
20 m

Gully D


450000
460000
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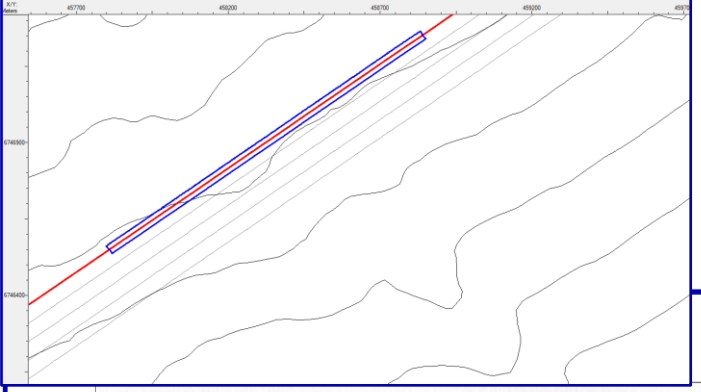
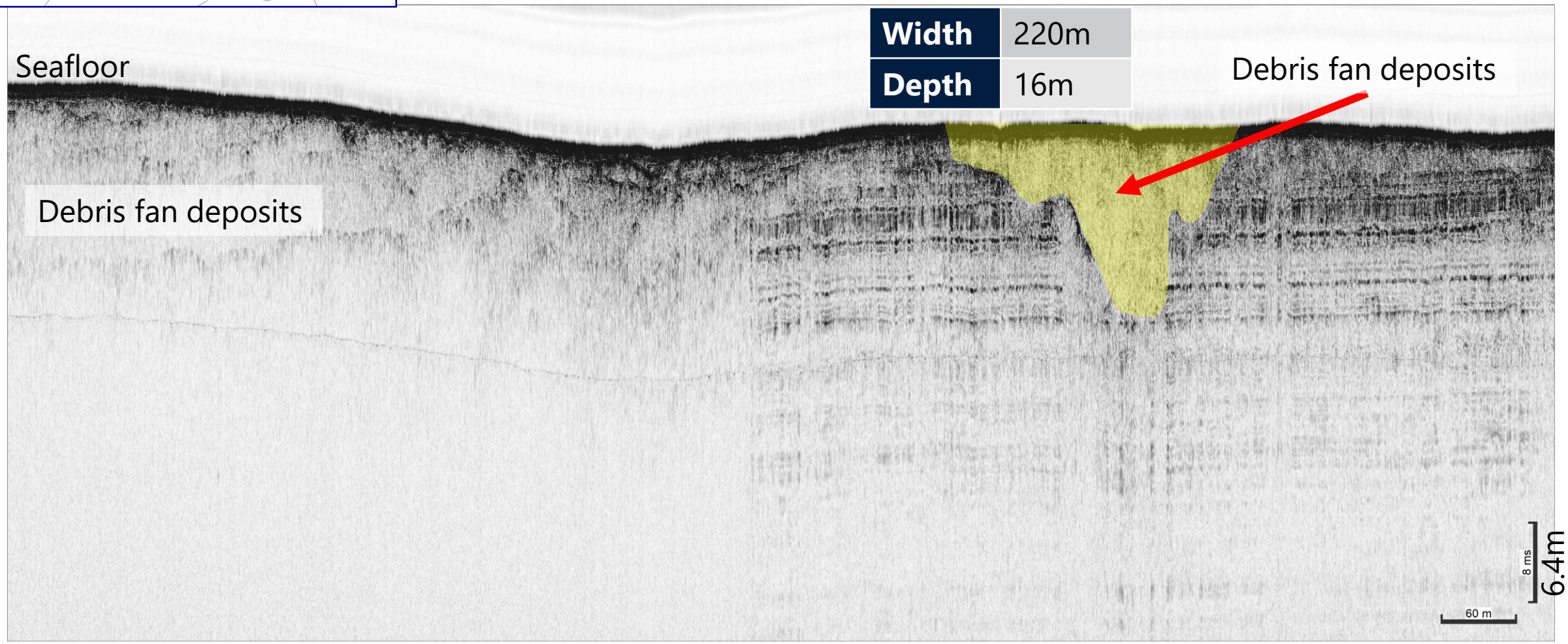
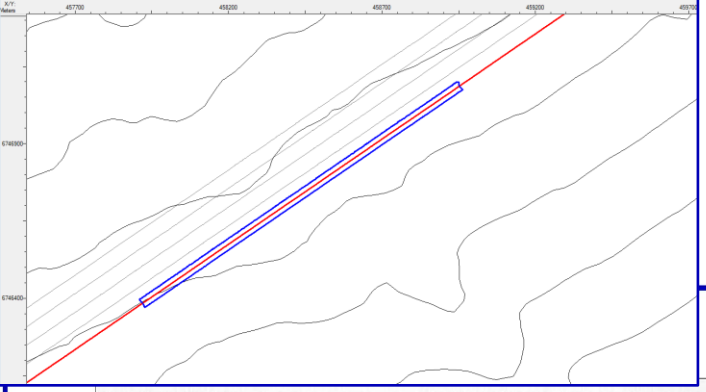
6740000
6730000
N
D
Legend
Line Plan
Regional Contour
0
8
16 Kilometers



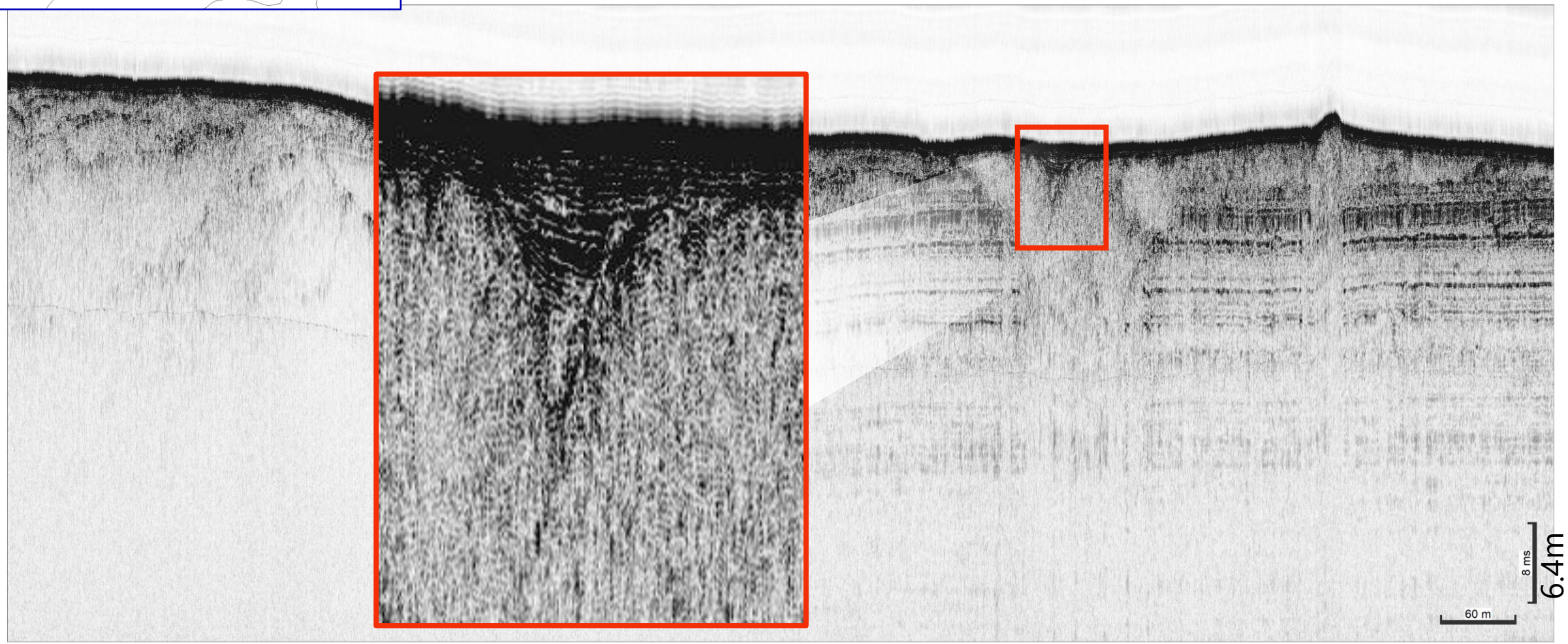
Section 1



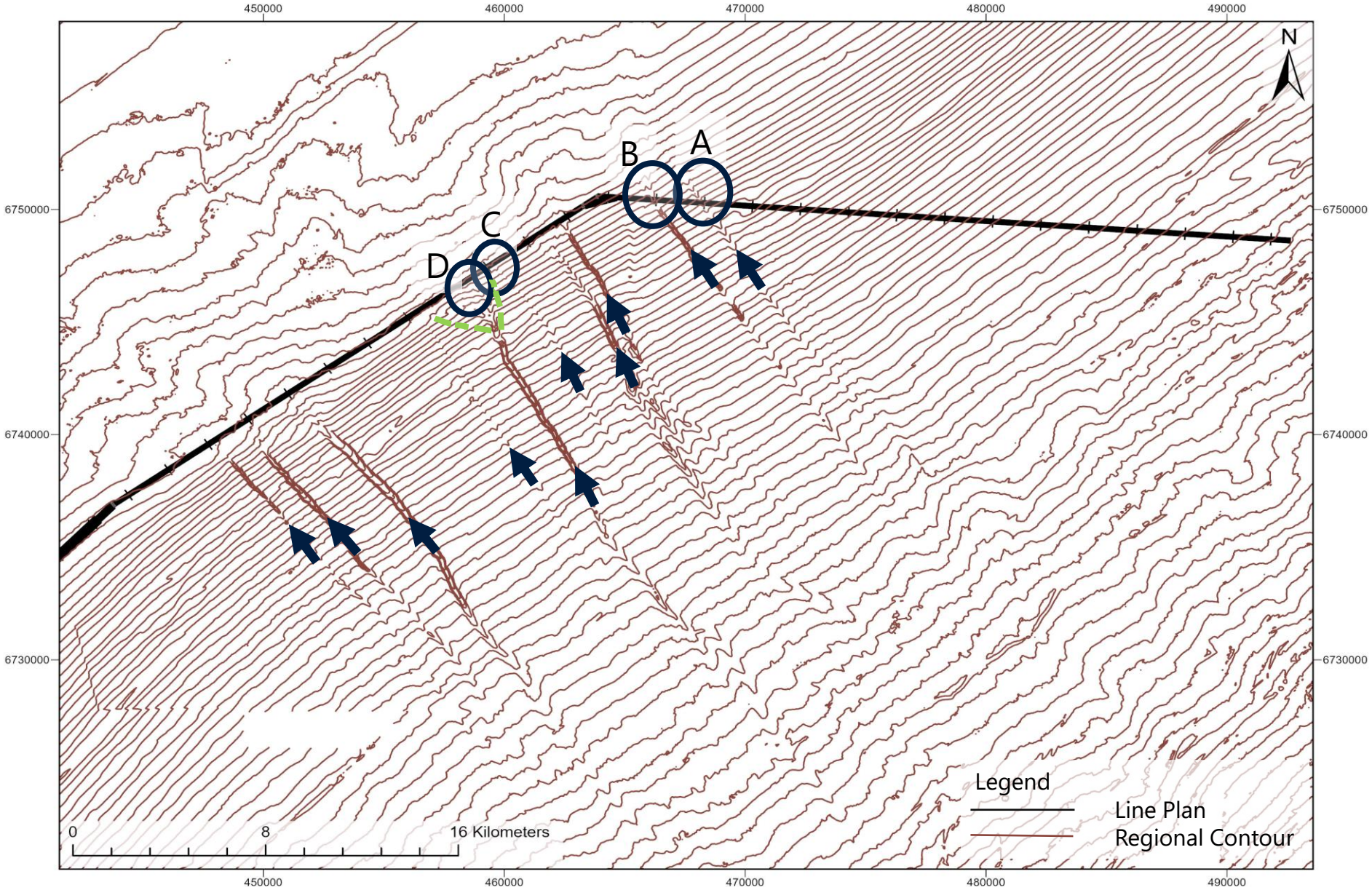
Width	220m
Depth	16m



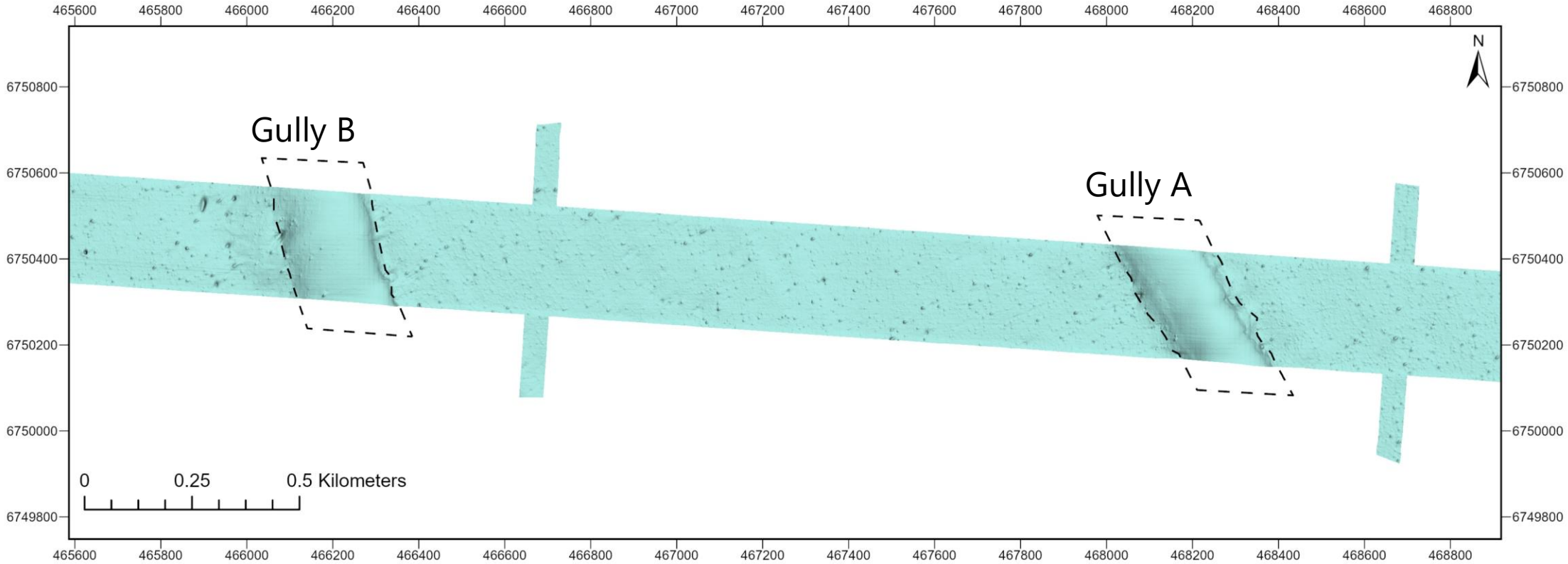
Section 5

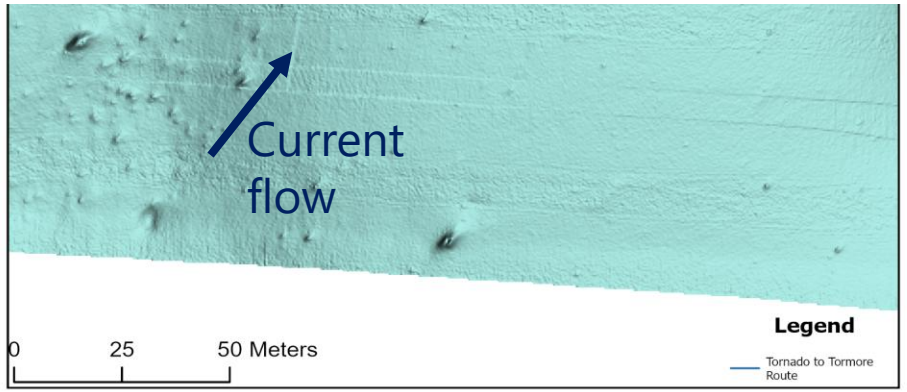


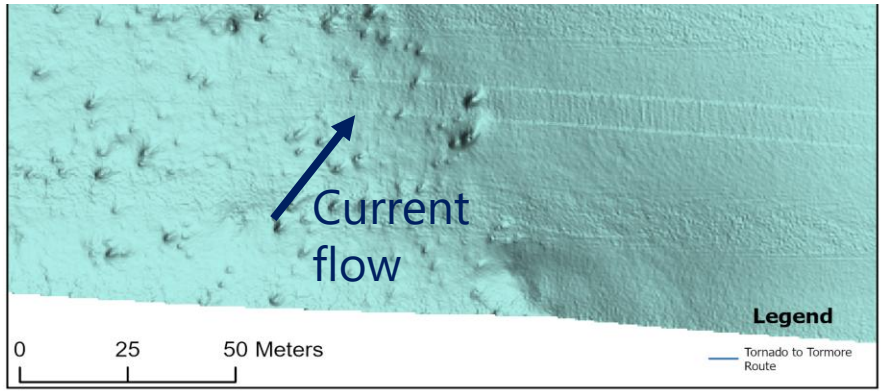
Regional Bathymetric Contours and Line Plan



MBES Shaded Relief Images - 0.5 m resolution







Summary

On the instruction of Ithaca Energy (UK) Ltd, Fugro performed a geophysical pipeline route survey at the north-west of Shetland.

An AUV was required for the geophysical survey, which was completed safely according to expectations.

The stability of the AUV together with the advantage of being able to place the chirp sub-bottom profiler close to the seafloor enables the acquisition of high-resolution seismic data.

The high-resolution data acquired clearly resolved the various sedimentary units in the gullies and along the route, crucial for the engineers to manage possible risks.

Gullies ABC identified as inactive due to well-layered sedimentary units indicating gradual deposition and comet marks from boulders on the seafloor.

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OMV (UK) Ltd (2010) End of well report Tornado 204/13-1 Stena Carron.

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