

A 3D seismic data visualization showing a complex geological structure. The image features a dark, textured background with several bright, irregularly shaped regions in red and yellow, indicating areas of high seismic intensity or specific geological features. The overall appearance is that of a deep-sea exploration target, possibly a gas hydrate or oil reservoir. The text is overlaid on the upper left portion of the image.

***Deep-water Exploration Targets from shelf
edge to basin floor; Seismic Stratigraphy,
Seismic Geomorphology and Sequence
Stratigraphy Based on 3D Seismic Data***

Henry W. Posamentier

• Shelf Edge (Staging Area)

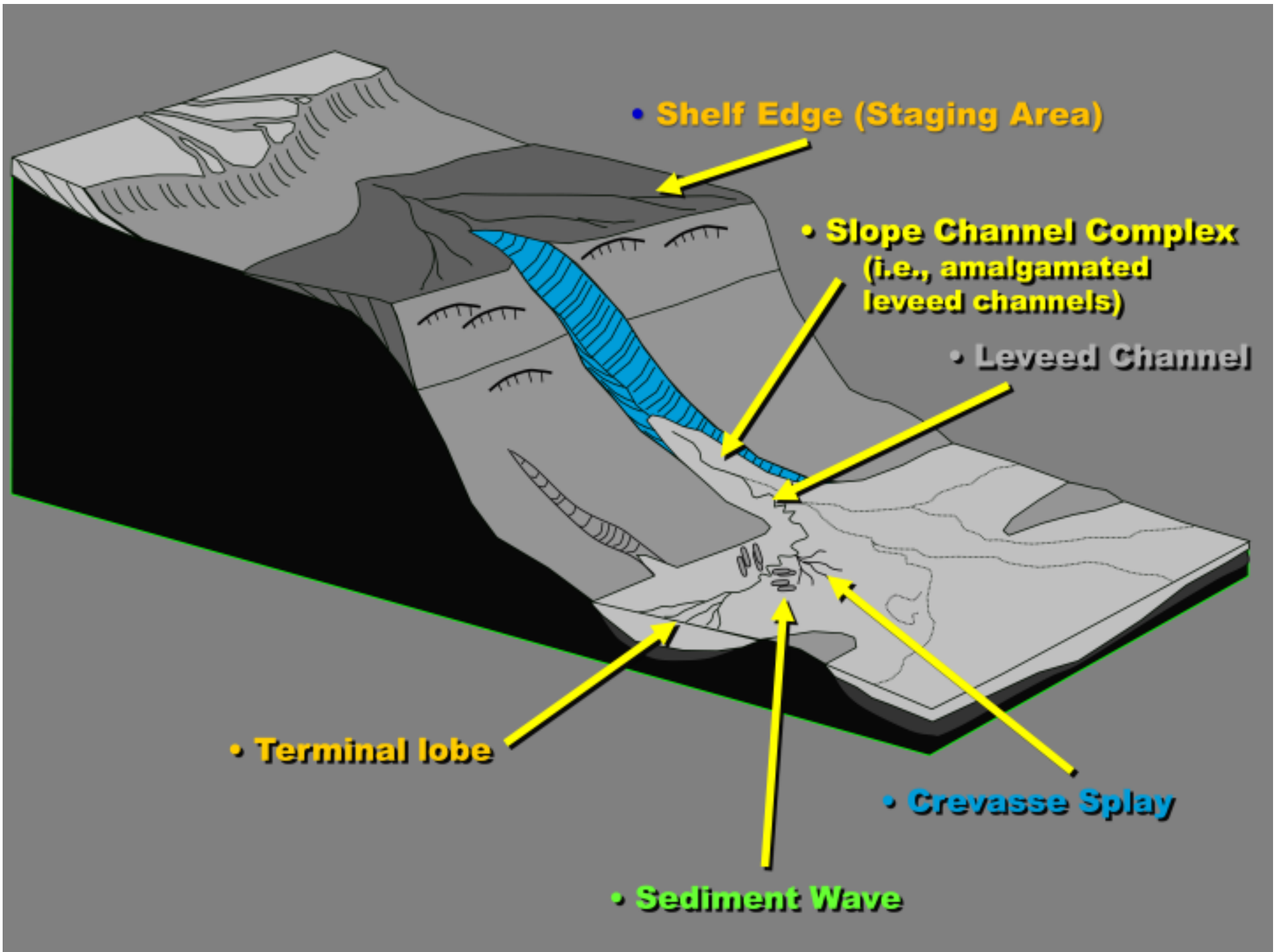
• Slope Channel Complex
(i.e., amalgamated
leveed channels)

• Leveed Channel

• Terminal lobe

• Crevasse Splay

• Sediment Wave



TYPES OF DEEP-WATER DEPOSITS

- Turbidites

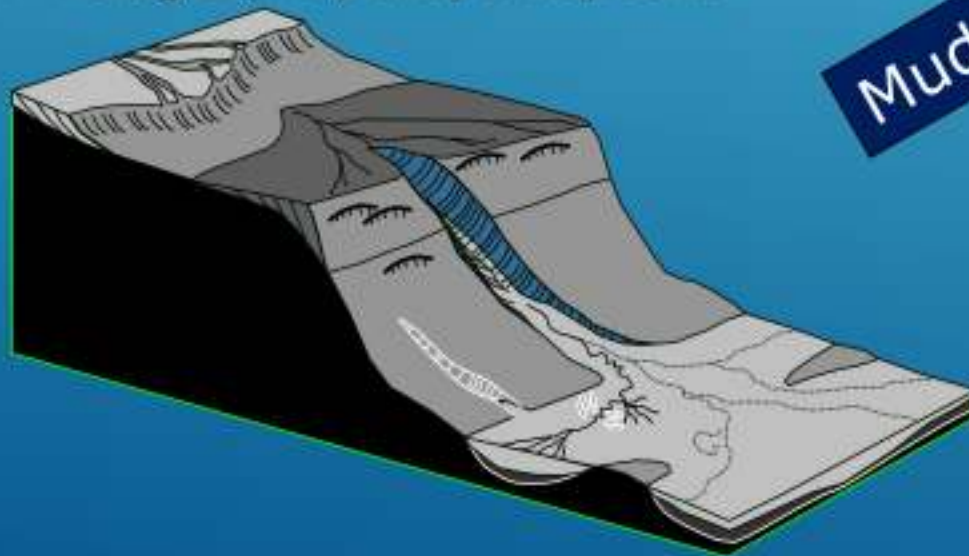
- in channels
- in lobes (i.e., terminal splays/fans)
- in overbank

Sand Prone

- Mass transport deposits

- Contour-current deposits (i.e., sediment waves/drifts)
- Hemipelagic (i.e., drape deposits)
- Pelagic (i.e., drape deposits)

Mud Prone



HOW TO KNOW YOU ARE IN A DEEP-WATER SETTING (FROM SEISMIC DATA)

– ESTABLISHING **CONTEXT**

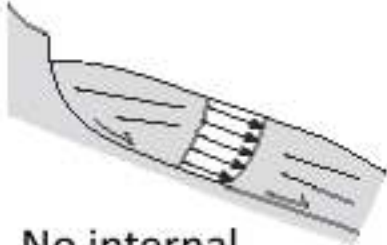
- ❖ Presence of widespread polygonal faulting (i.e., shrinkage cracks)
- ❖ Presence of sediment waves
- ❖ Presence of seismically resolvable mass transport deposits
- ❖ Presence of seismically resolvable channel levees
- ❖ Presence of clinoforms defining deep-water setting (geomorphology)

Gravity Flow Deposits

Mass Transport Deposits

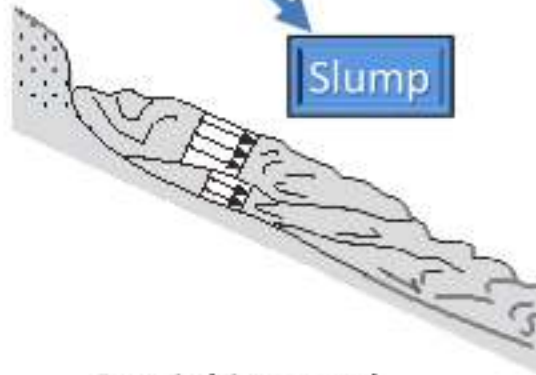
Turbidite Deposits

Slide



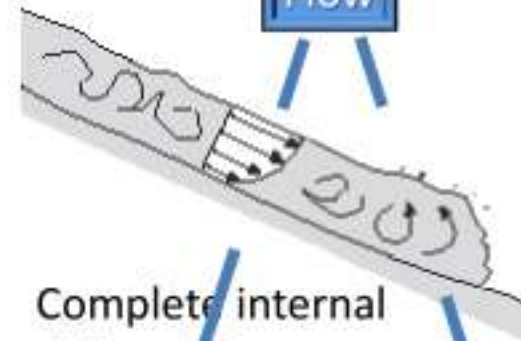
No internal deformation

Slump



Partial internal deformation

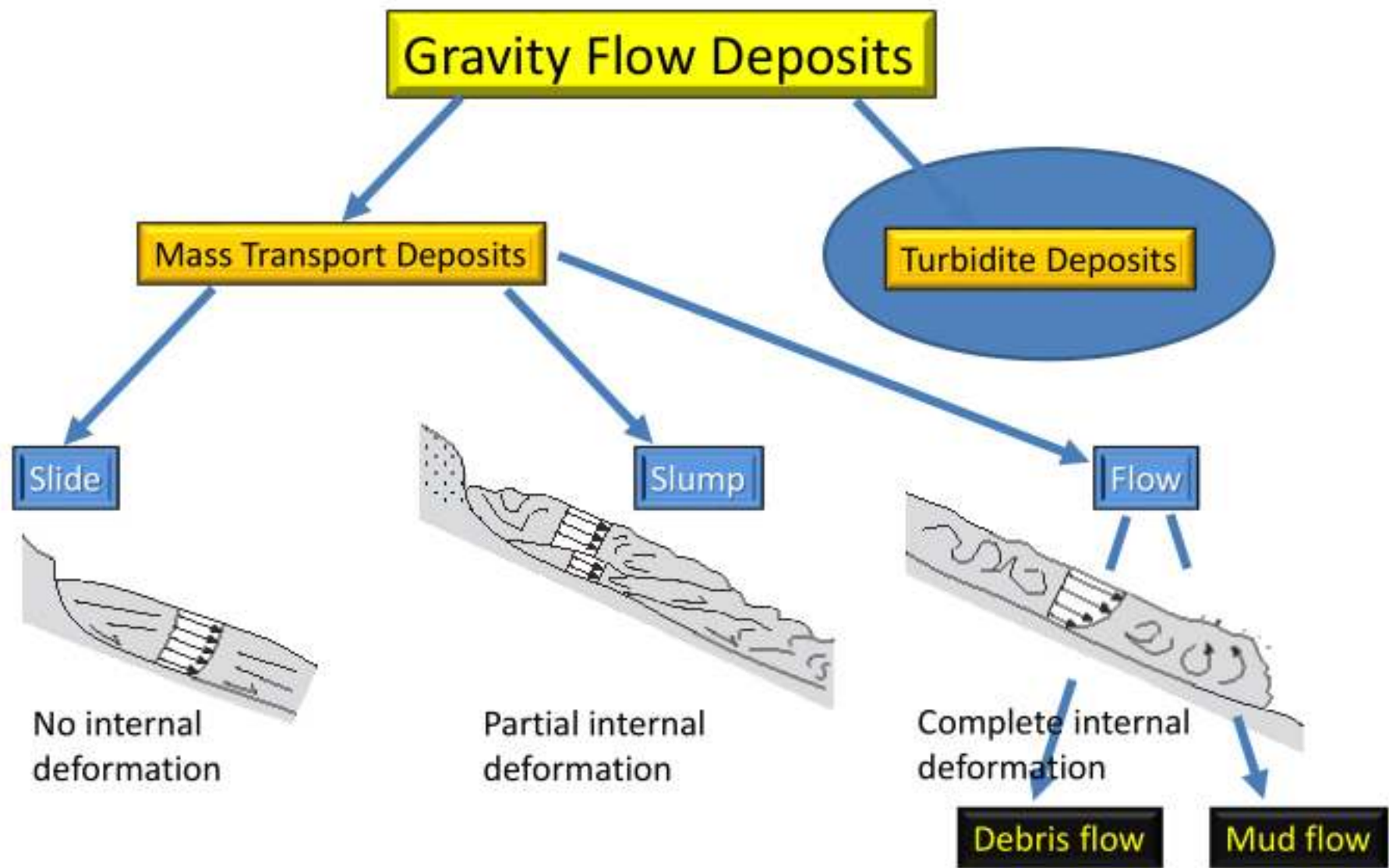
Flow



Complete internal deformation

Debris flow

Mud flow



What does a turbidite look like?



<http://i.imgur.com/W2r0y.jpg>

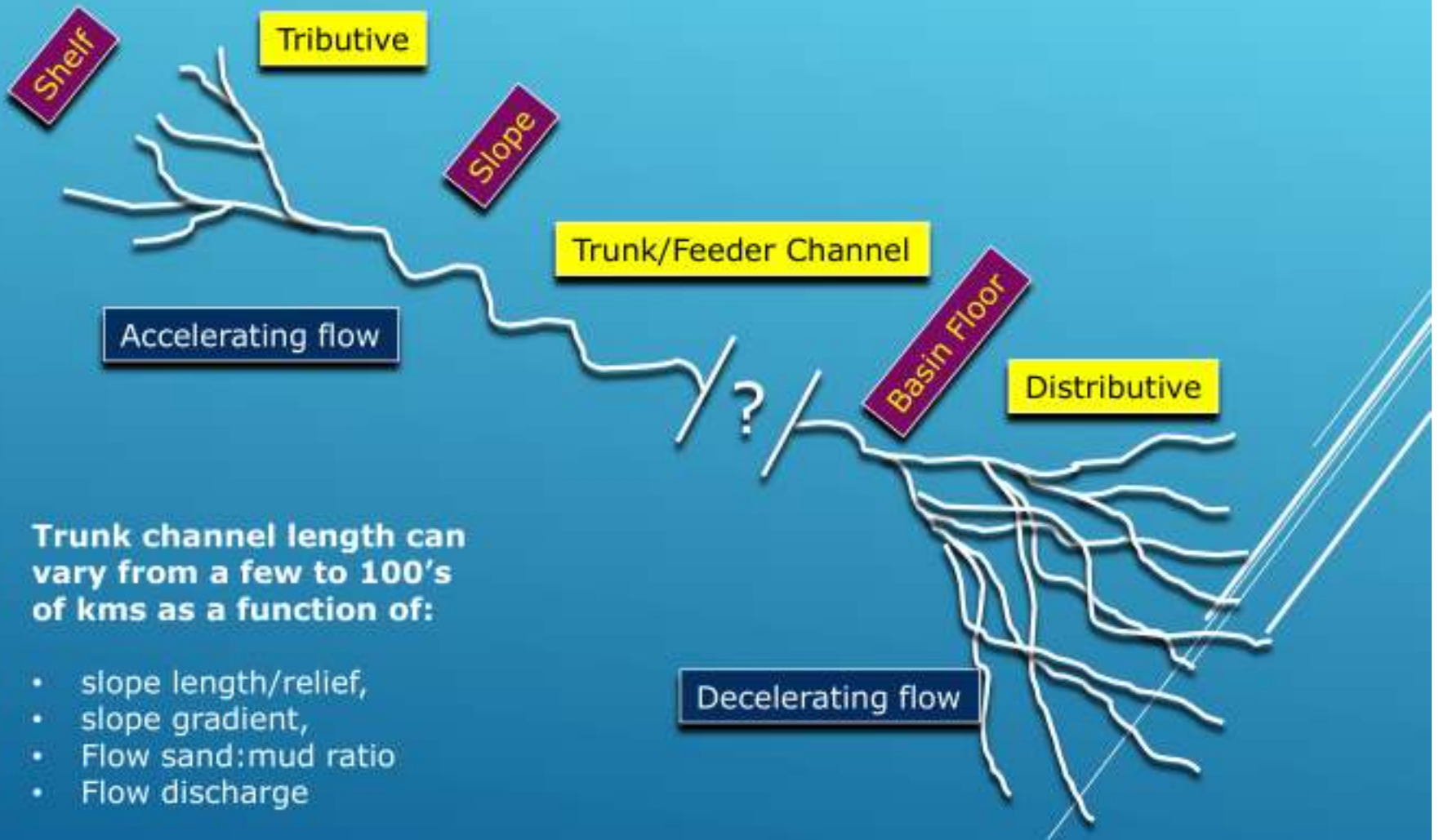
What does a turbidite look like?

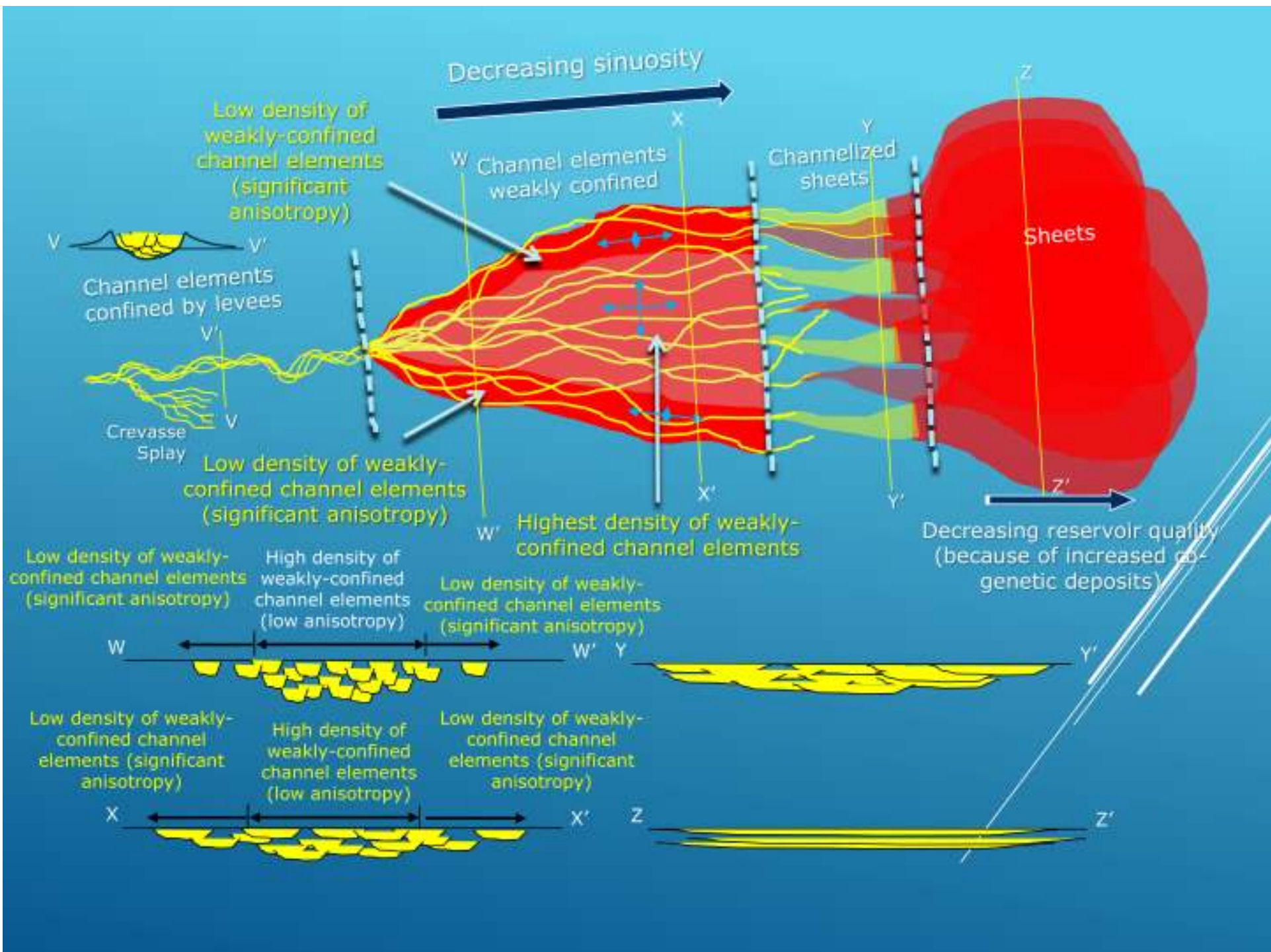


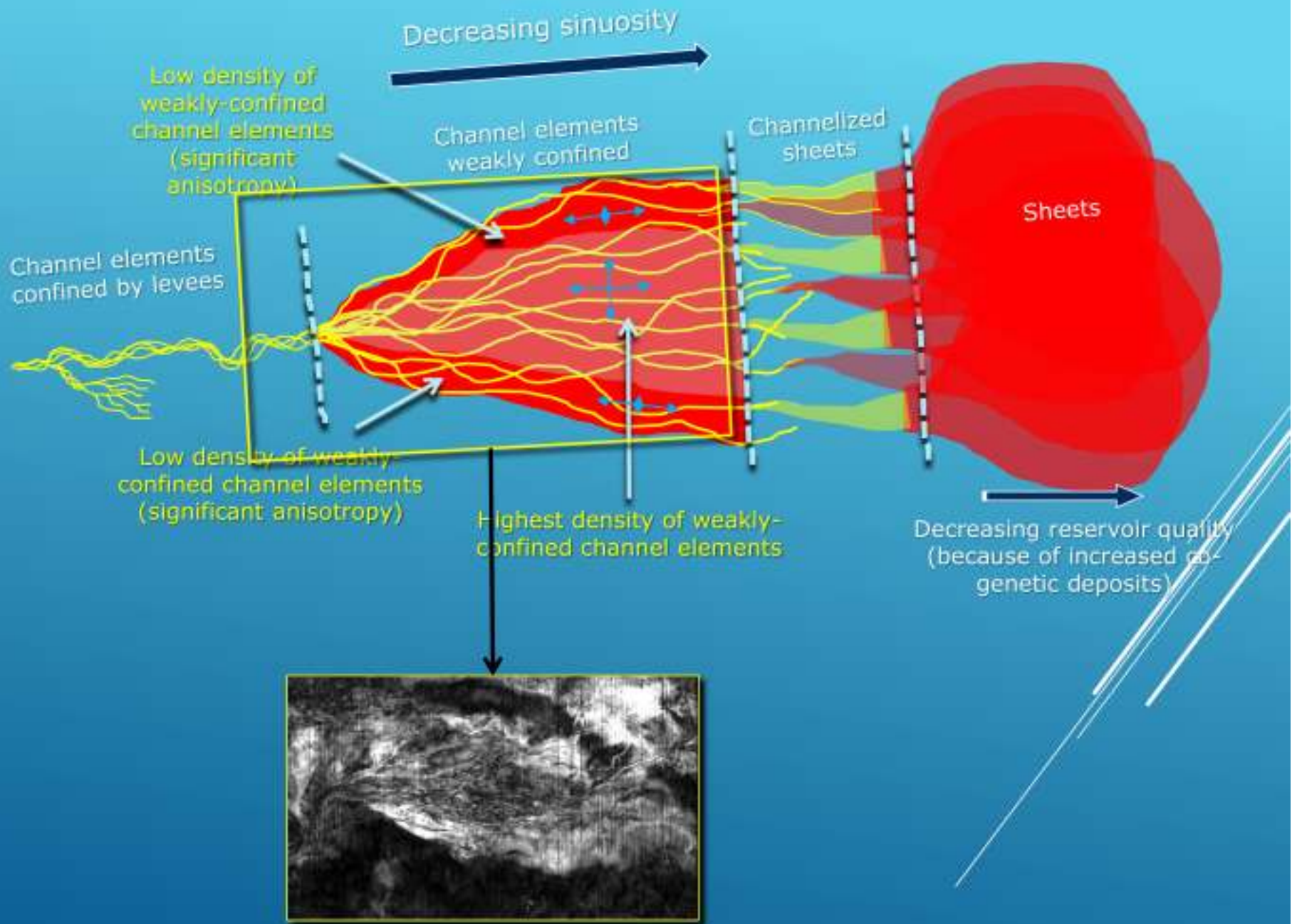
Dust storm over Denver

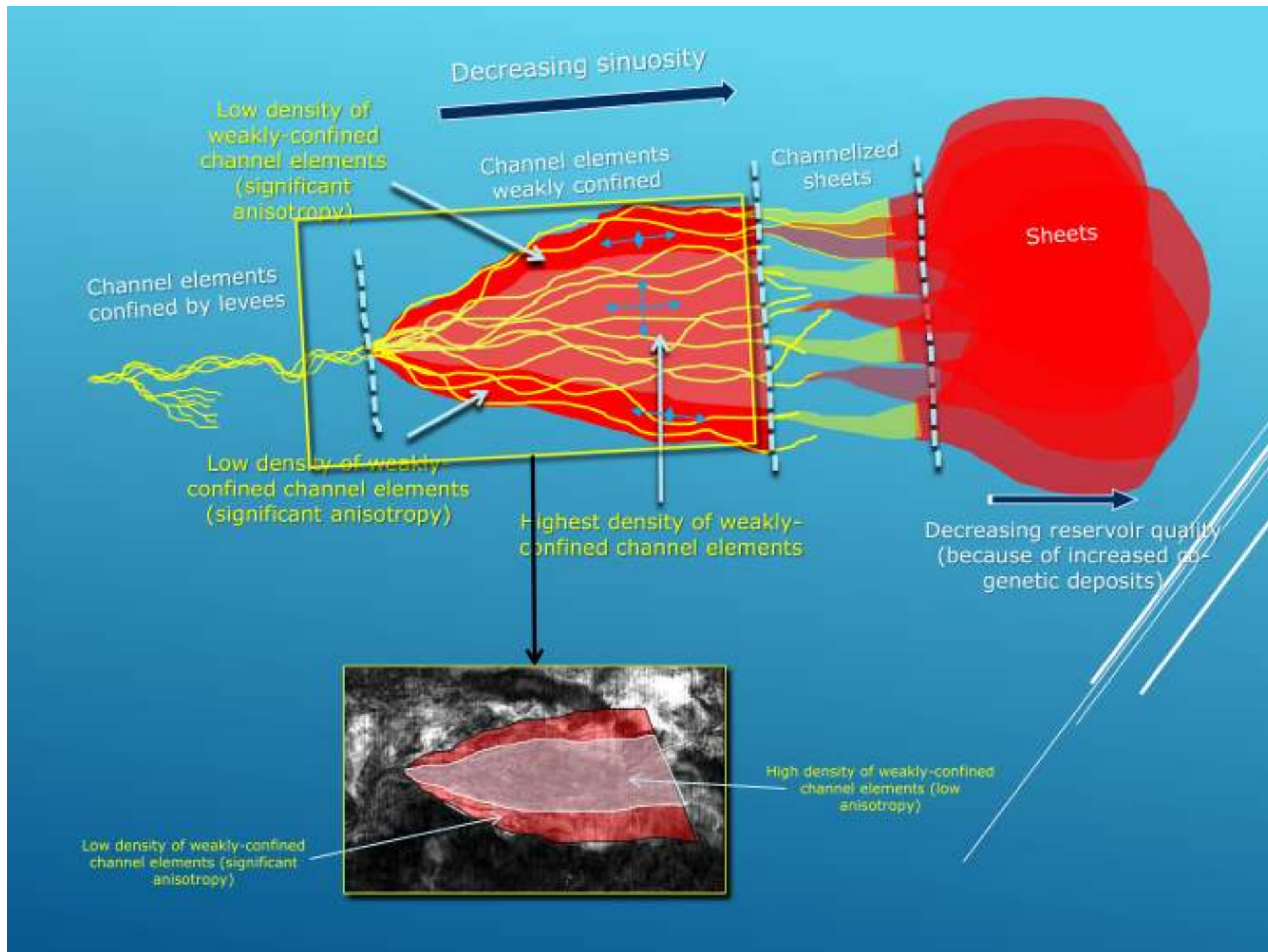
http://rookery.s3.amazonaws.com/1041500/1041812_444e_625x1000.jpg

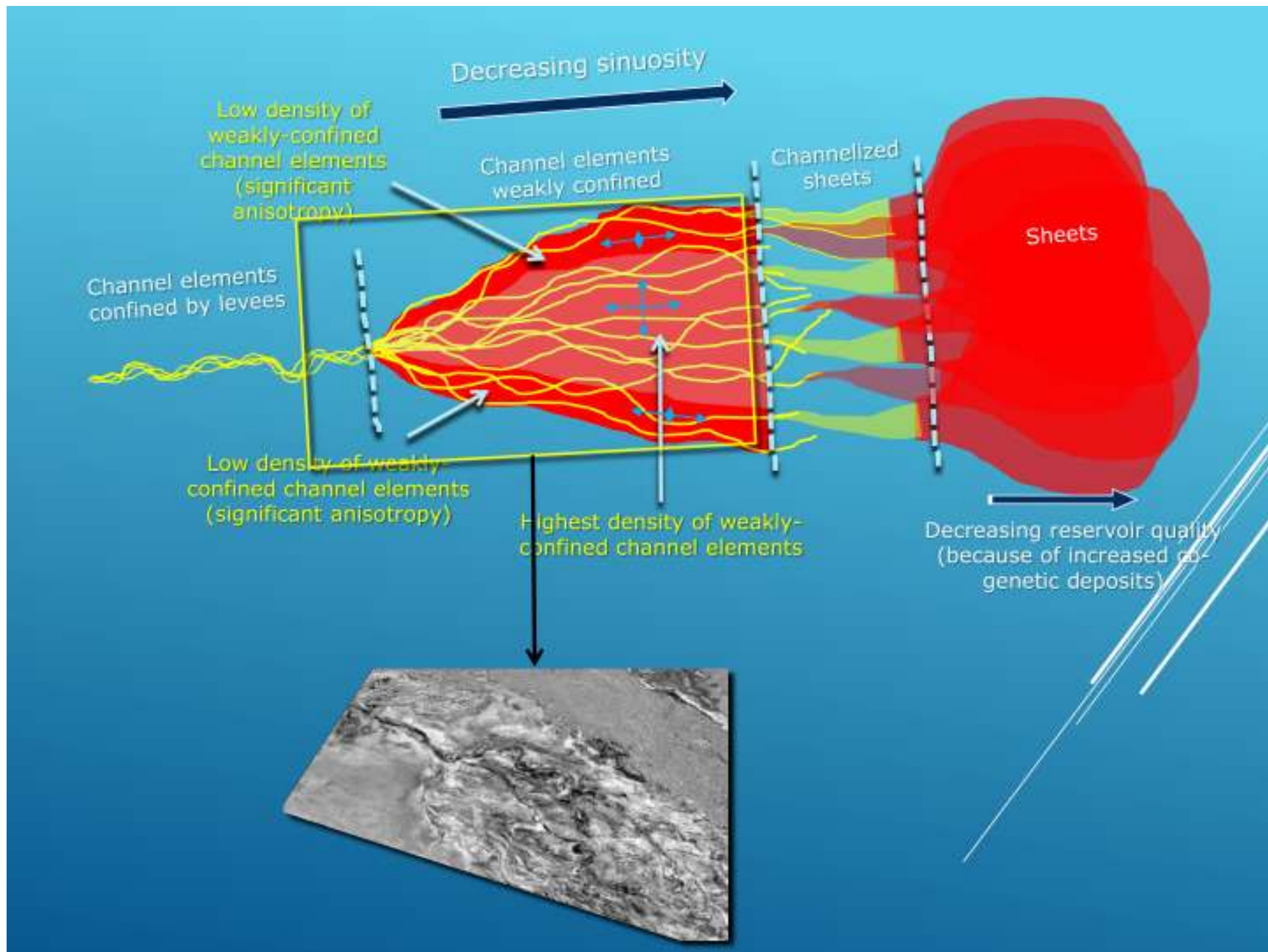
Turbidite Geomorphology Fundamentals

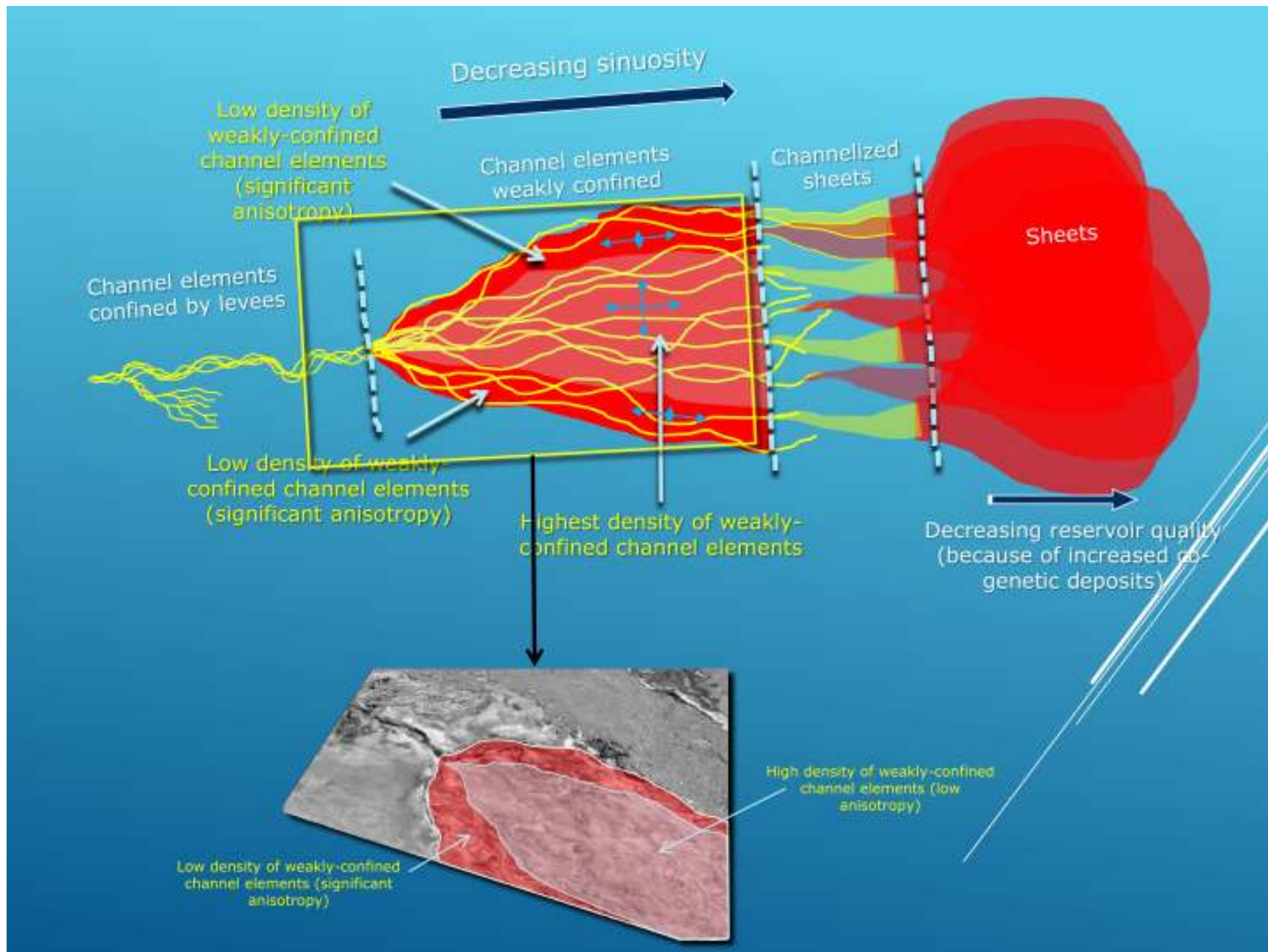




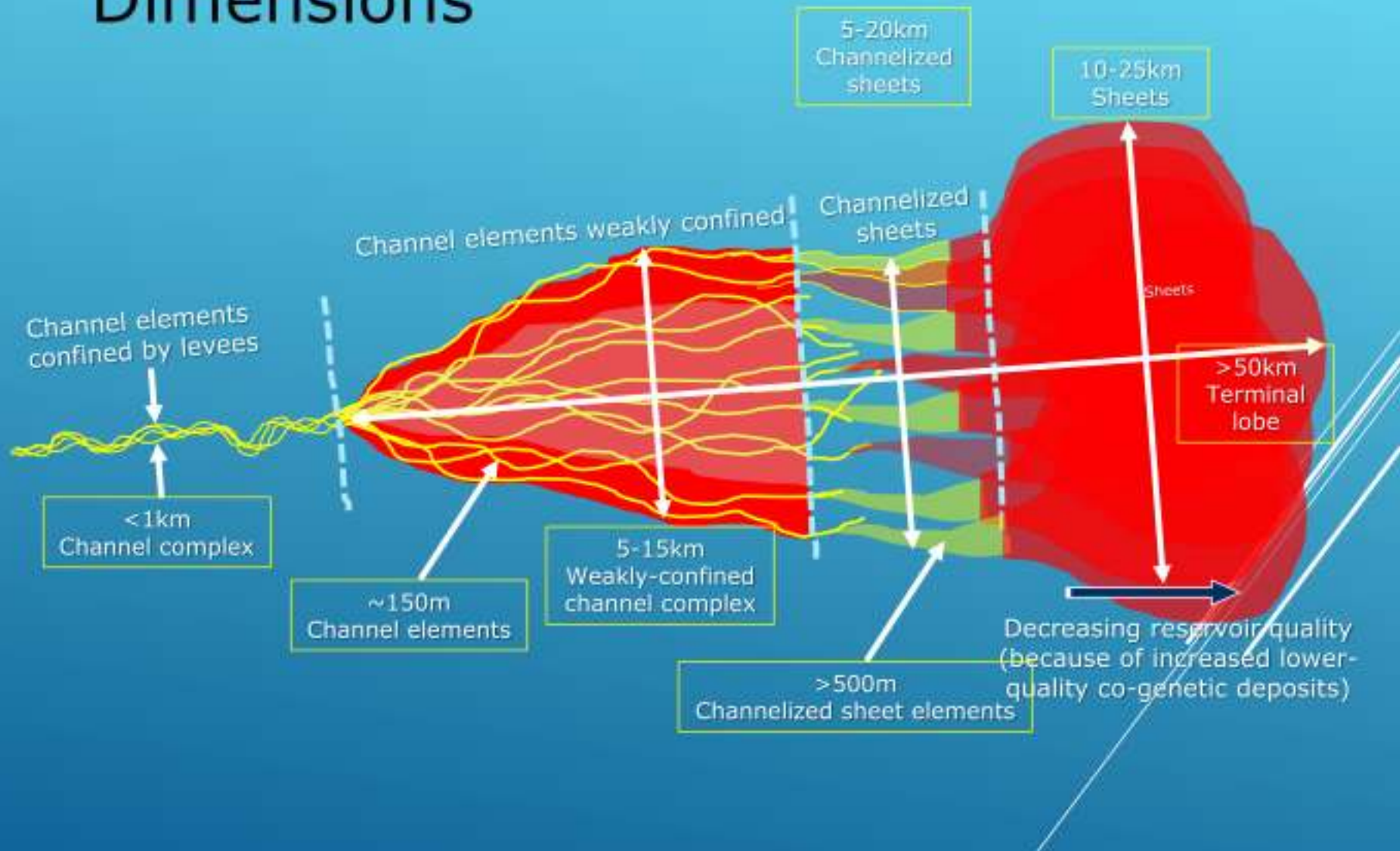








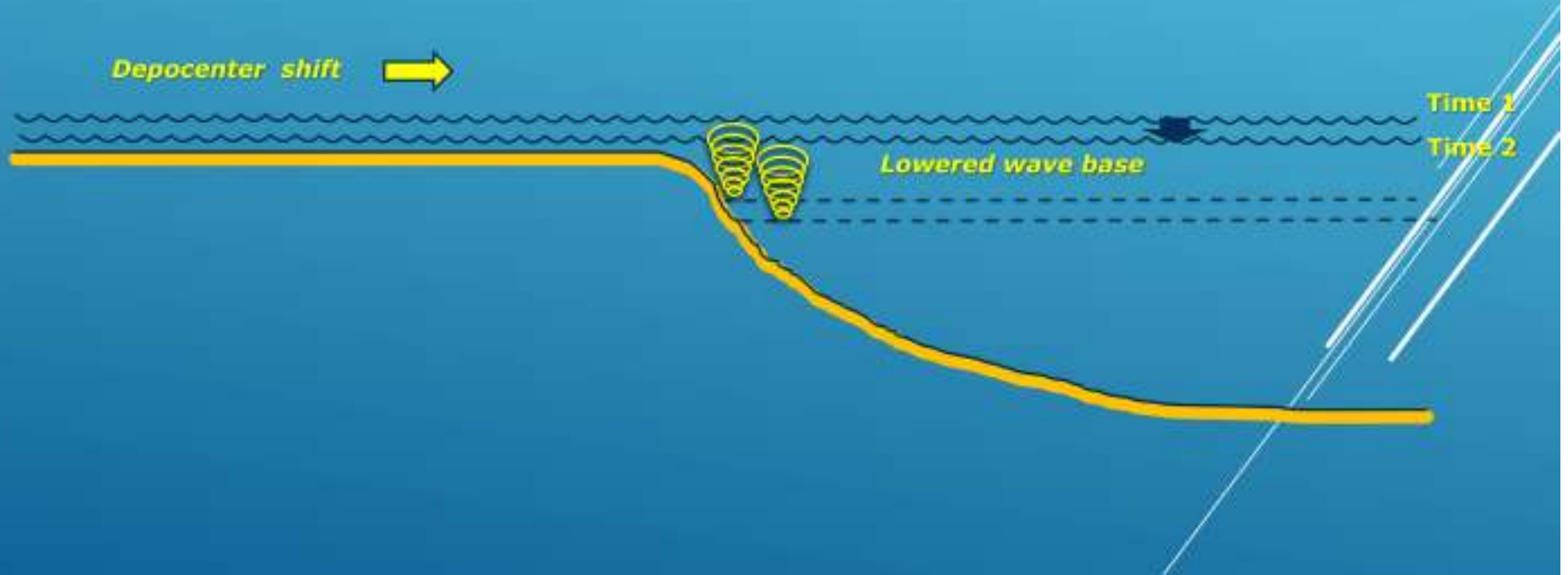
Dimensions



10 RULES FOR TURBIDITES TO LIVE BY

1. Turbidites are a turbulent mixture of sand, mud, and water, and **flow downhill** propelled by gravity
2. Flow **velocity is driven by density contrast** between the flowing and ambient mediums, as well as by **gradient**
3. The **higher the flow velocity** the greater the flow's carrying **capacity and competence**
4. Turbulence is an excellent **sorting** process
5. The **farther a flow goes** the **better sorted it becomes** (provided the "clock" does not get reset)
6. **Muddier flows are more effective at building bigger levees**
7. There is a direct correspondence between **sand-rich shelf edge** systems and **sand-rich basin slope/floor deposits**
8. **Confined flow** can maintain **higher flow velocity** than unconfined flow
9. Turbidity currents follow **bathymetric lows**
10. When **sea-level is falling** shelf sediment bypass occurs and flows down the slope and into the deep water are more **sand rich** ...and vice versa

WORKING HYPOTHESIS: RELATIVE SEA-LEVEL CHANGES INFLUENCE SEDIMENTOLOGICAL PROCESS AT THE SHELF EDGE, WHICH HAVE FAR REACHING EFFECTS FARTHER BASINWARD



Example: Shelf edge to deep water

Depocenter

Event: Lowered storm wave base

Effect: change of equilibrium conditions on upper slope

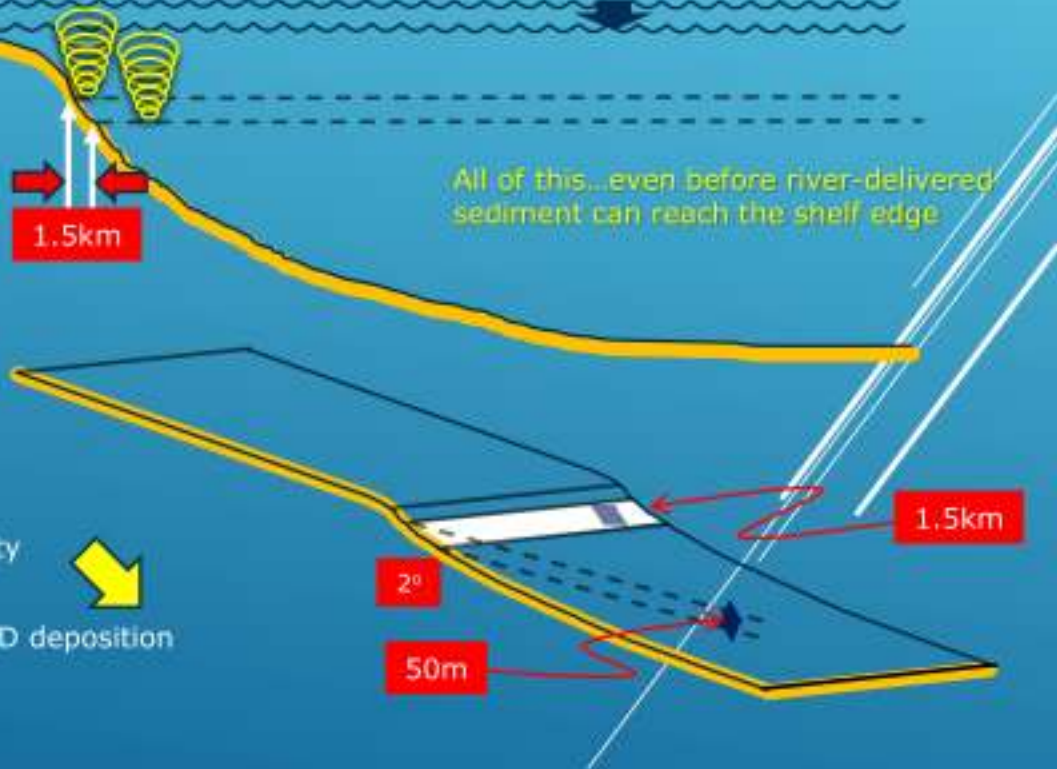
Pressure/temperature conditions

Potential dissociation of hydrates

Slope instability

Slope failure → failure – MTD deposition

All of this...even before river-delivered sediment can reach the shelf edge



Example: Shelf edge to deep water

Depocenter

Event: potential shift of oceanic currents

Effect: change of equilibrium conditions on upper slope

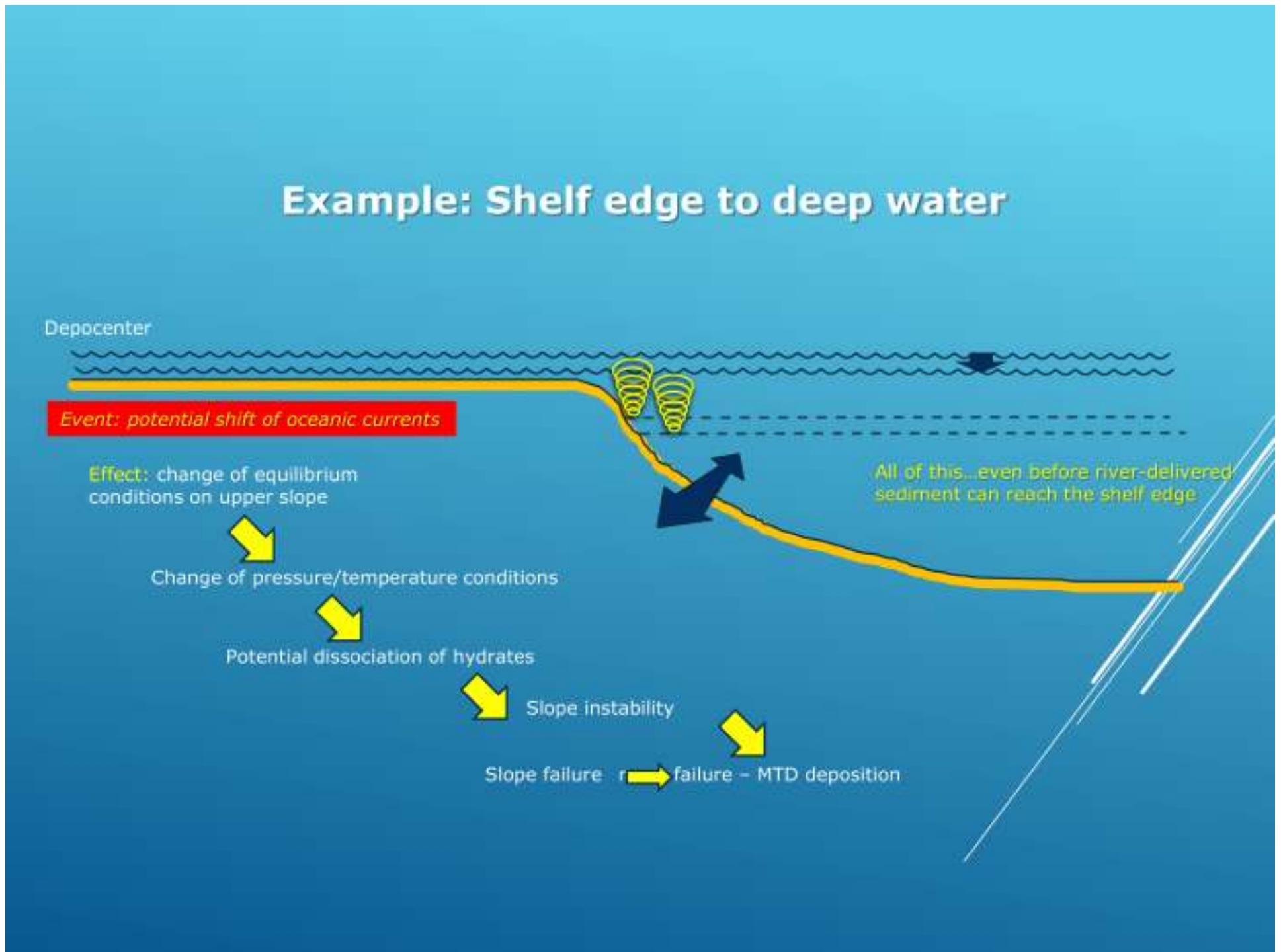
Change of pressure/temperature conditions

Potential dissociation of hydrates

Slope instability

Slope failure → failure - MTD deposition

All of this...even before river-delivered sediment can reach the shelf edge



Example: Shelf edge to deep water

Depocenter



Event: forced regression and progressive seaward shift of depocenters

Effect: increasing sediment loading of outer shelf and upper slope



Effect: change of equilibrium conditions on upper slope



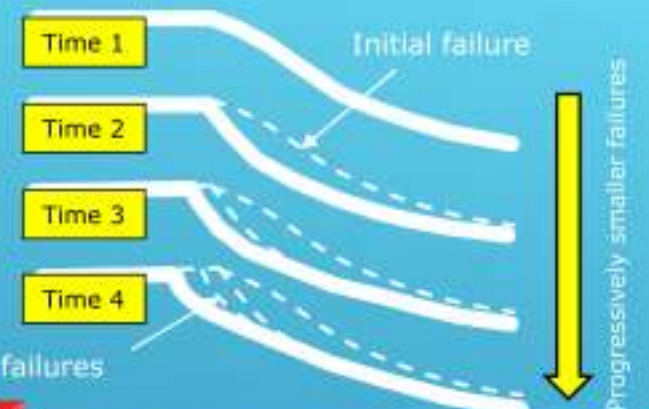
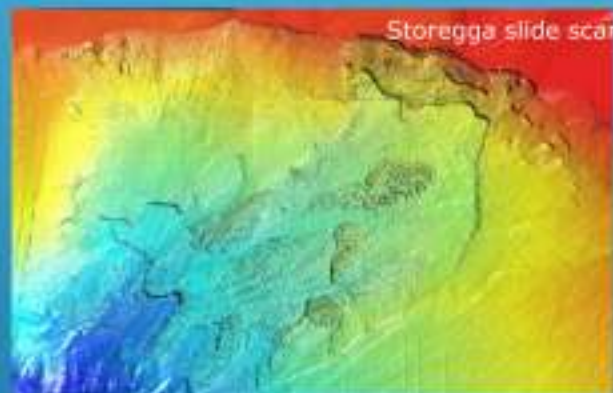
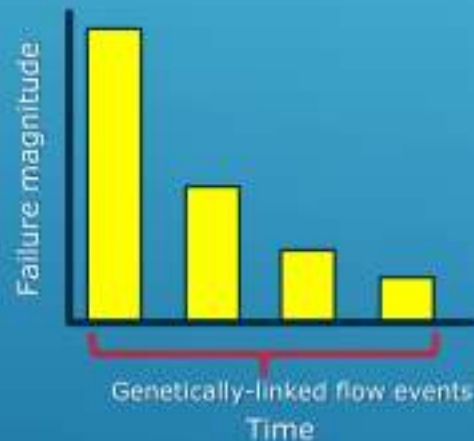
Slope instability



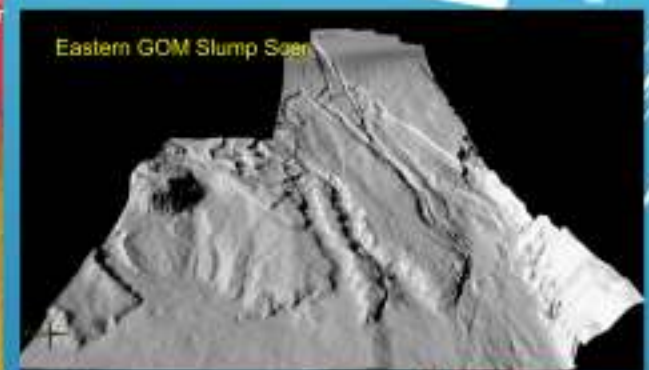
Slope failure → failure - MTD/turbidite deposition



PROCESS EVENTS AT THE SHELF EDGE INFLUENCE THE PRODUCTS OBSERVED DOWN SLOPE AND ON BASIN FLOOR



Smaller re-equilibration failures



Multiple scars superimposed on master scar

- Failures at the shelf edge can transform from mass flow to Turbidity currents
- Shelf edge re-equilibrates after failure by a process of successively smaller events
- Progressively smaller flows



cut and fill process/product

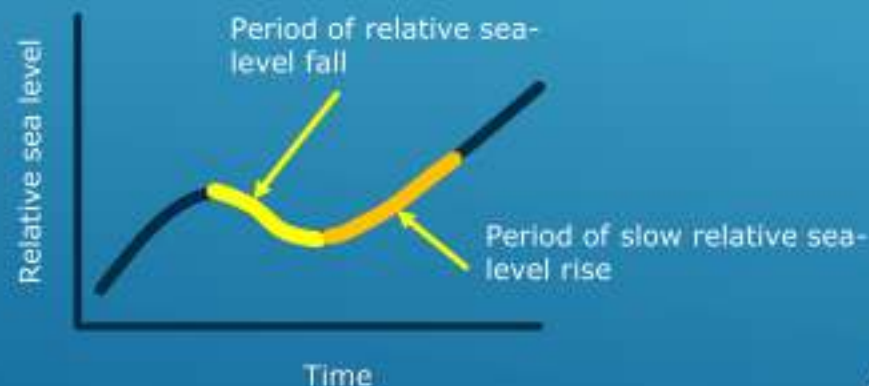
SLOPE FAILURE DUE TO SEDIMENT LOADING

Basic premise: Relative sea level **fall**, progressively greater shelf-edge instability (increased sediment delivery – because of forced regression)

- Continued progressively seaward shift of depocenter
- Shelf bypass through incising valleys and canyons
- Progressively greater slope failures

Basic premise: Relative sea level **rises**, diminished flow discharge and decreased sand:mud

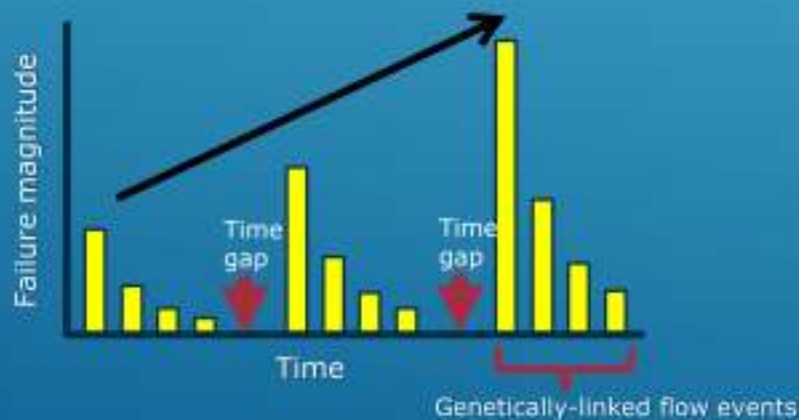
- Stationary to slow progressive landward shift of depocenter
- Gradual infill of incised valleys
- Progressively smaller slope failures



SLOPE FAILURE DUE TO SEDIMENT LOADING

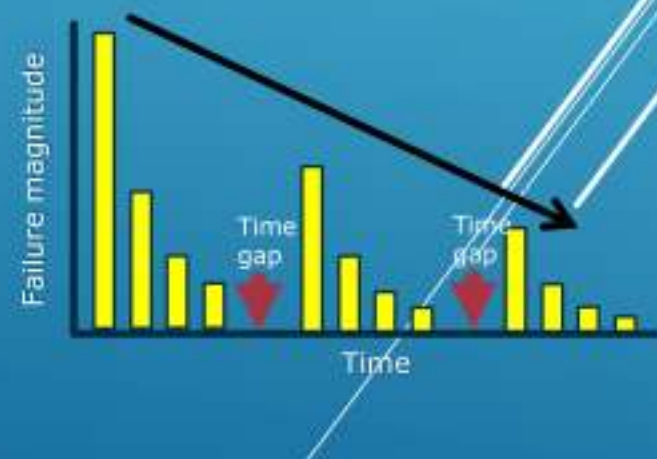
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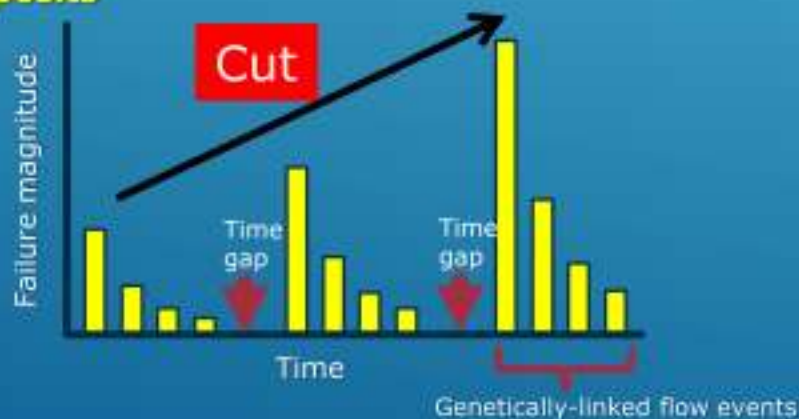
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- Gradual infill of incised valleys
- Progressively smaller slope failures



SLOPE FAILURE DUE TO SEDIMENT LOADING

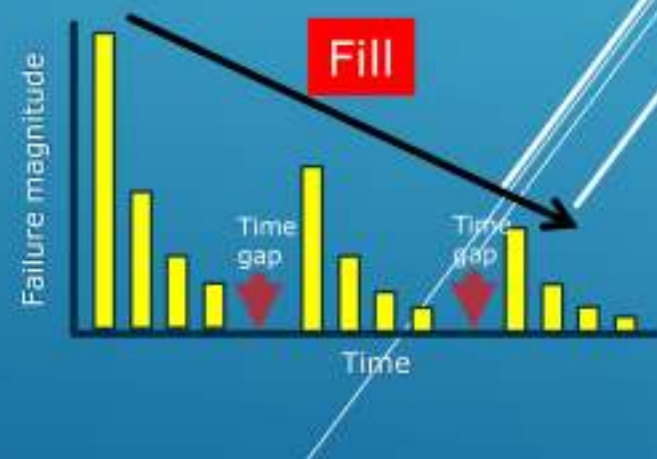
Basic premise: Relative sea level **fall**, progressively greater shelf-edge instability (increased sediment delivery – because of forced regression)

- Each successive major flow is characterized by higher energy than the preceding major flow
- Progressive deepening of erosive slope valley/canyon
- **Events of successive increased erosive power suggests poor preservation of earliest deposits**



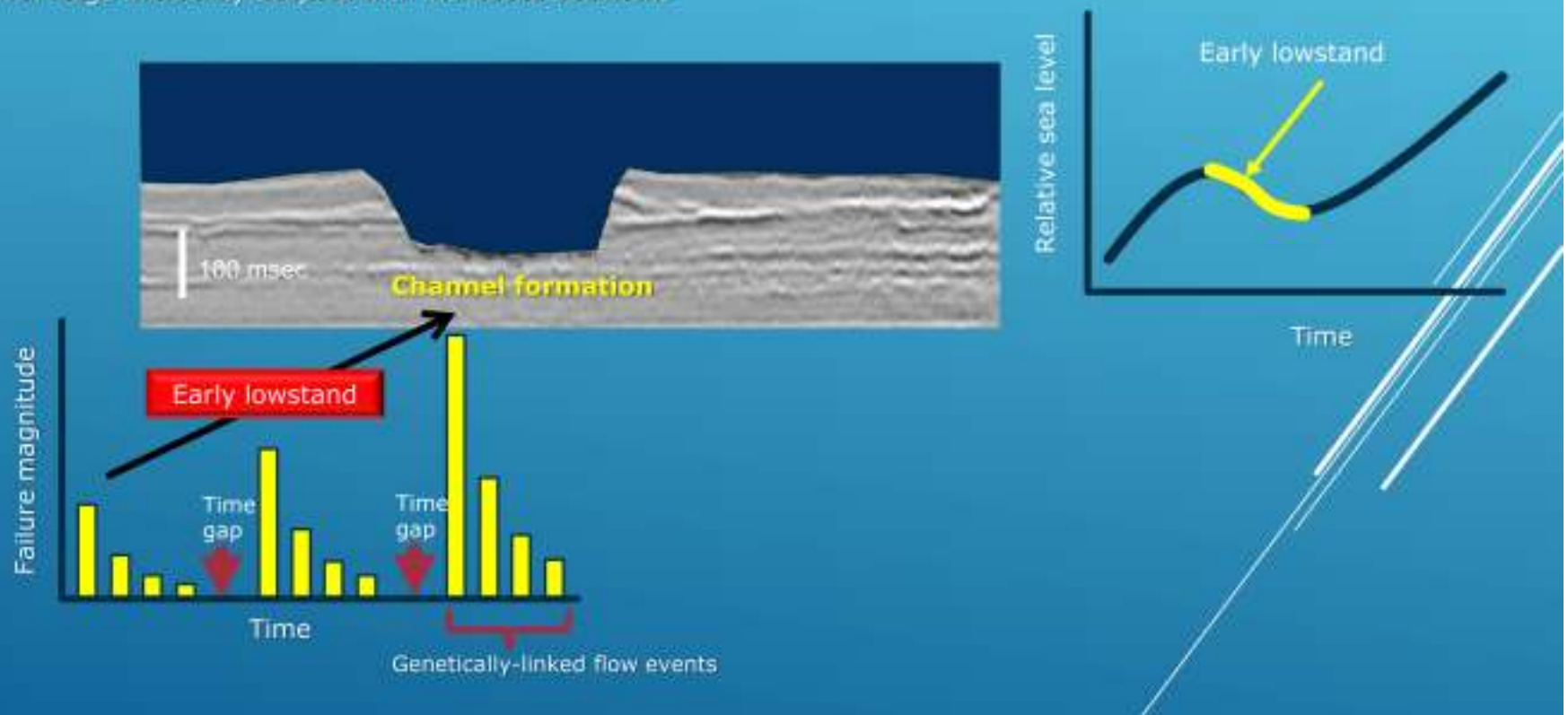
Basic premise: Relative sea level **rises**, diminished flow discharge and decreased sand:mud

- Each successive major flow is less energetic than the preceding major flow
- **Partial preservation of each flow complex**



SLOPE FAILURE DUE TO SEDIMENT LOADING

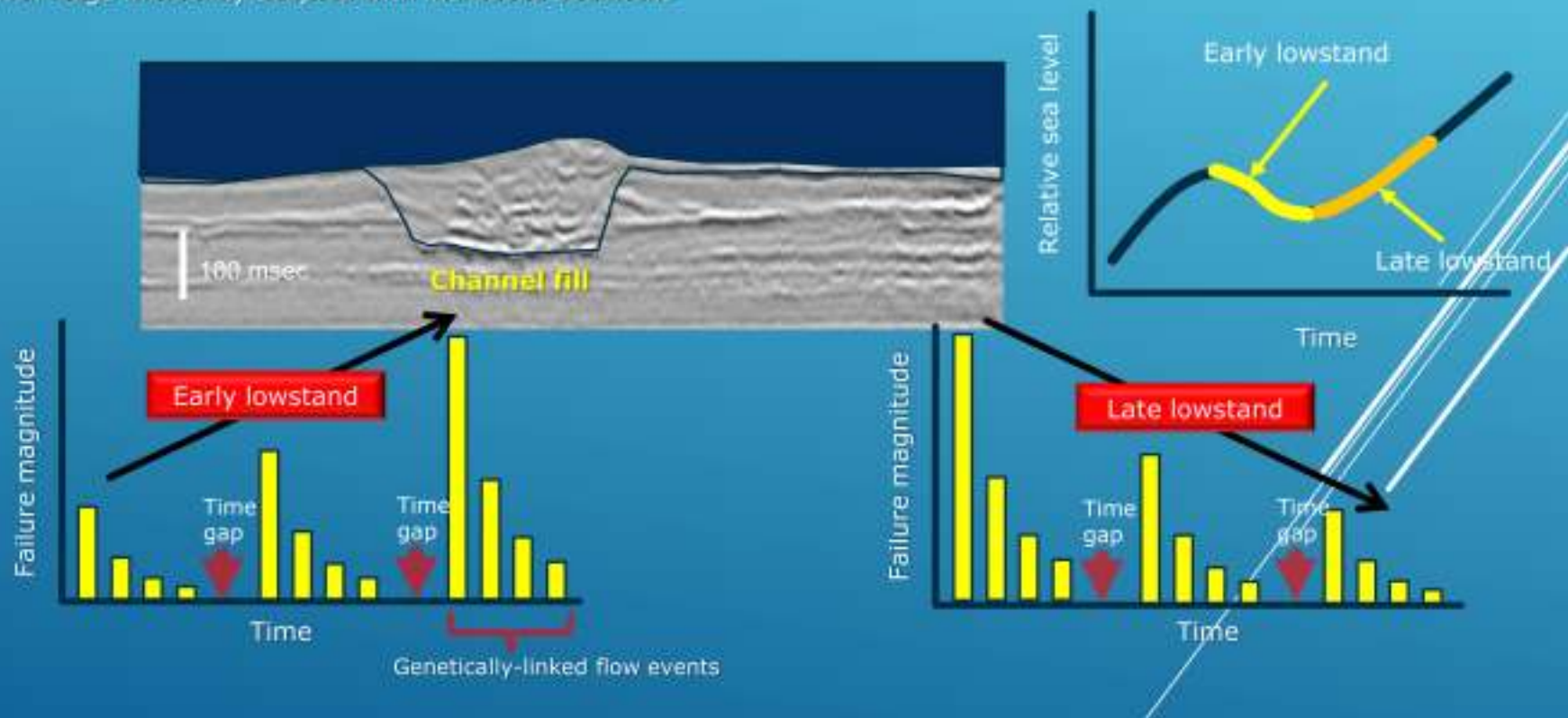
Basic premise: Relative sea level continues to fall, progressively greater shelf-edge instability coupled with increased sediment delivery



SLOPE FAILURE DUE TO SEDIMENT LOADING

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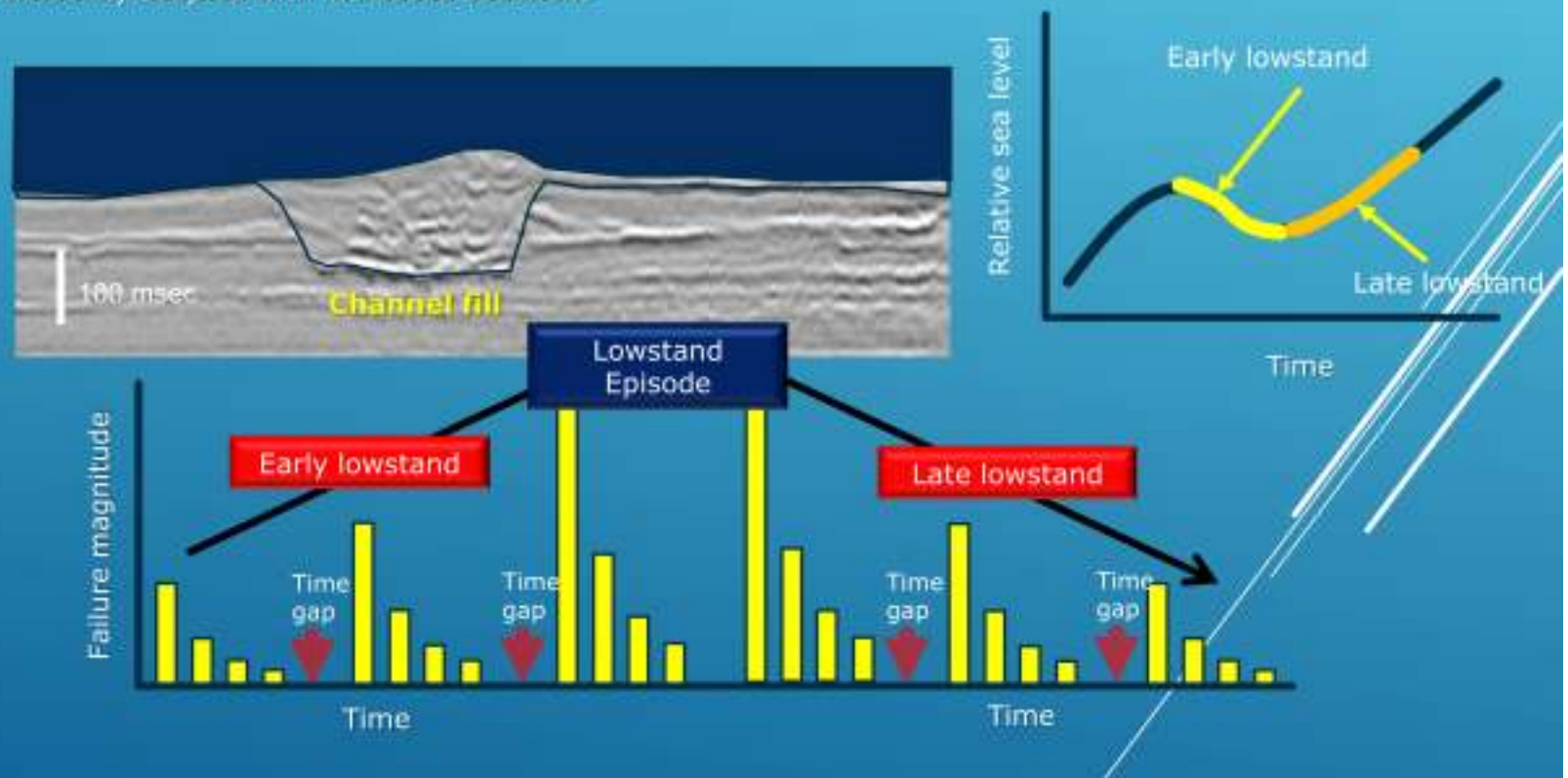
Basic premise: Relative sea level slowly rises
diminished flow, discharge and decreased sand:mud ratio



SLOPE FAILURE DUE TO SEDIMENT LOADING

Basic premise: Relative sea level continues to fall, progressively greater shelf-edge instability coupled with increased sediment delivery

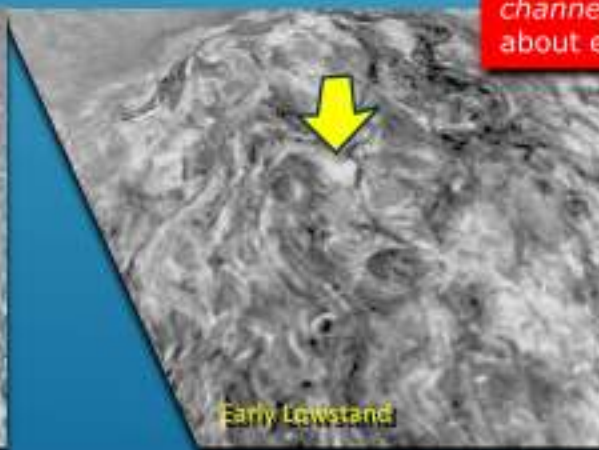
Basic premise: Relative sea level slowly rises, diminished flow discharge and decreased sand:mud ratio



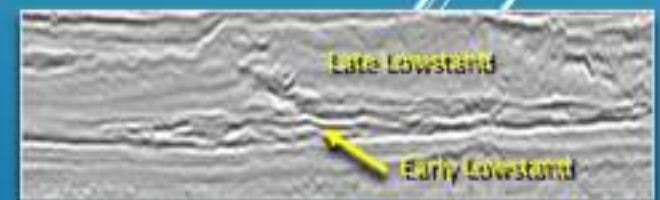
SEQUENCE STRATIGRAPHY PROVIDES FRAMEWORK THAT
LEADS YOU TO ASK MORE QUESTIONS

SEISMIC OBSERVATIONS (GEOMORPHOLOGY AND
STRATIGRAPHY) ALSO LEAD TO FURTHER QUESTIONS
REGARDING SEDIMENTOLOGICAL PROCESS AND
SEQUENCE STRATIGRAPHIC FRAMEWORK

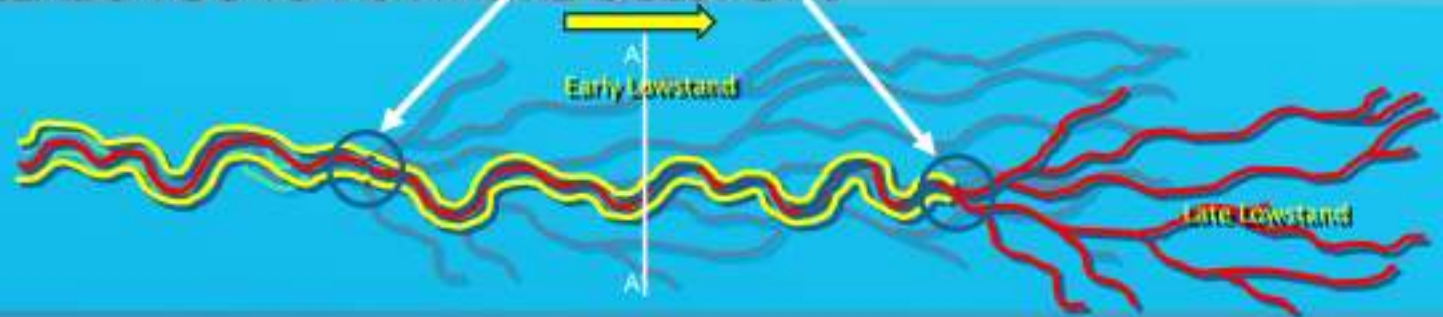
5 km



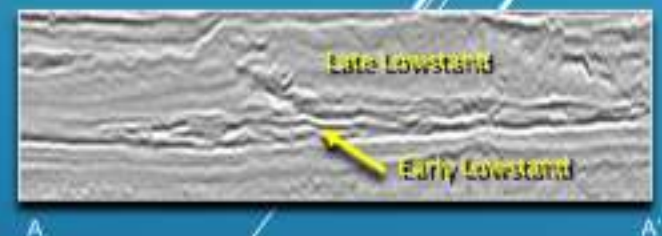
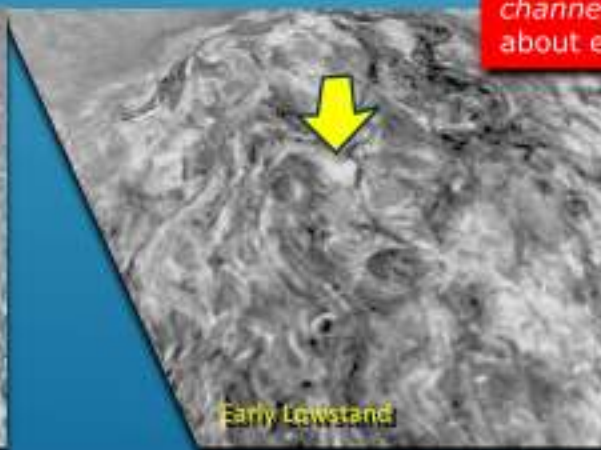
Example: What does the stratigraphic couplet of
channel-lobe complex to *simple channel complex* tell us
about events at the shelf edge?



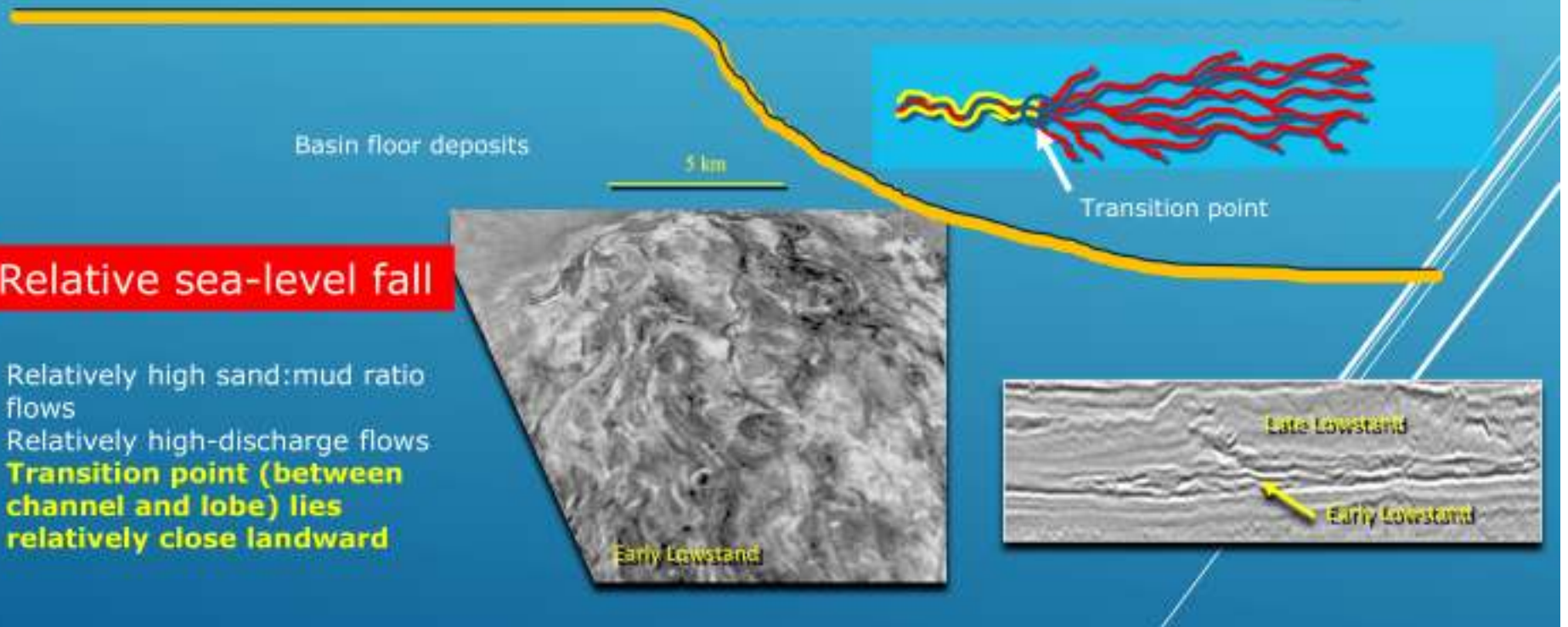
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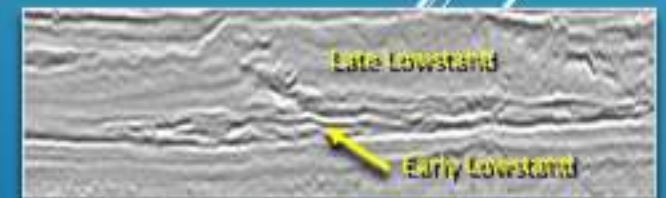
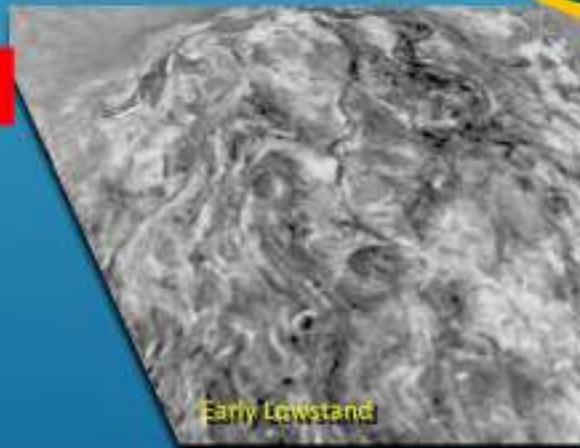


Basin floor deposits associated with an episode of lowstand relative sea-level

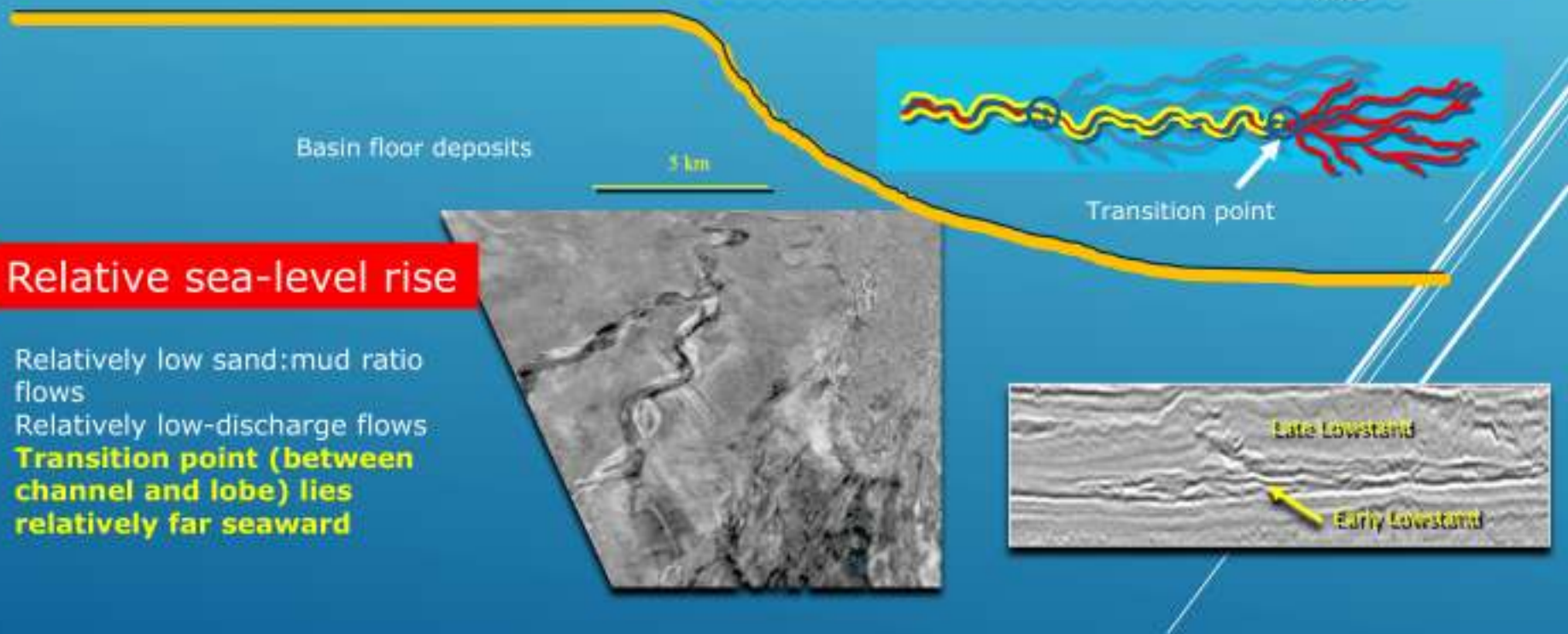


Relative sea-level fall

- Relatively high sand:mud ratio flows
- Relatively high-discharge flows
- **Transition point (between channel and lobe) lies relatively close landward**



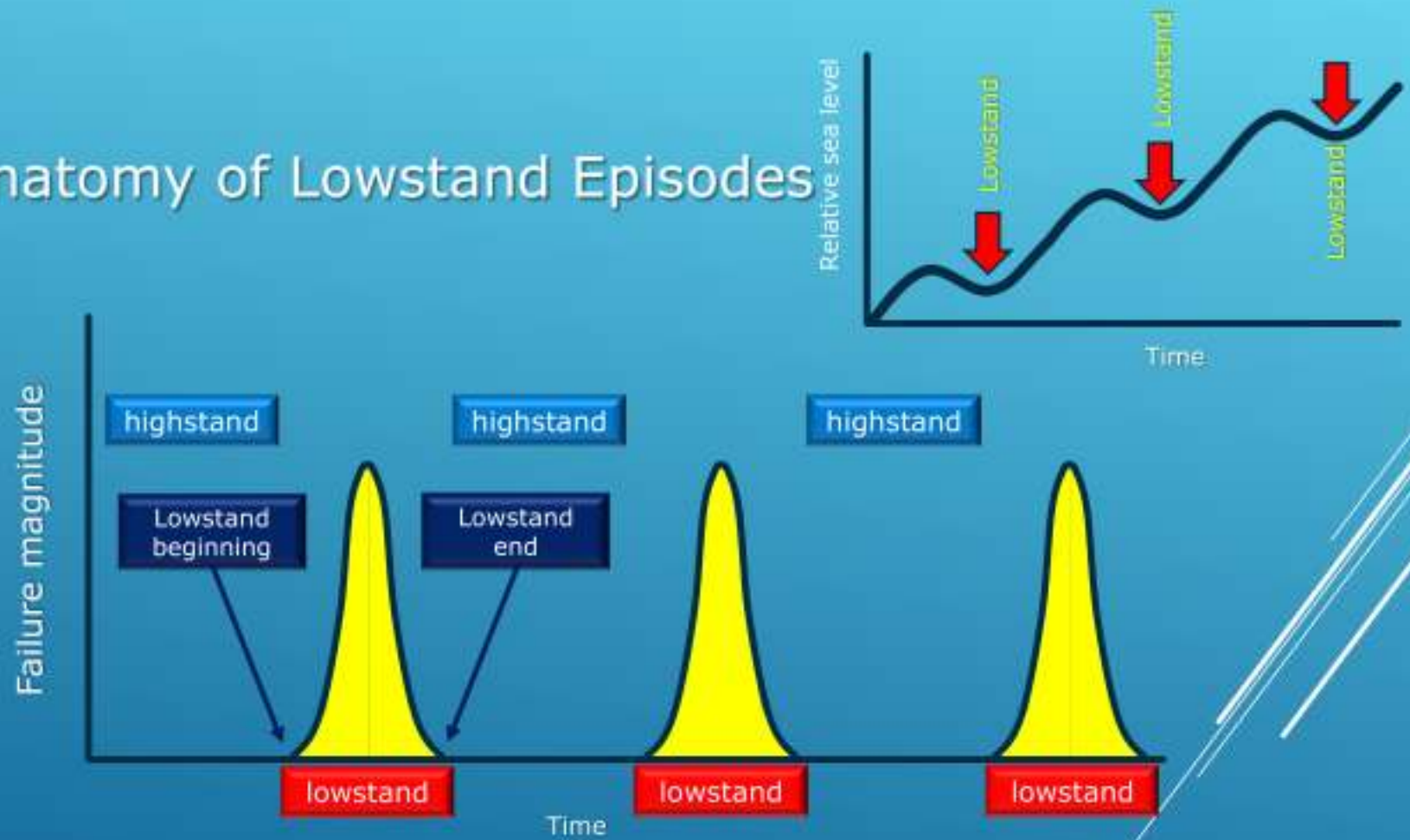
Basin floor deposits associated with an episode of lowstand relative sea-level



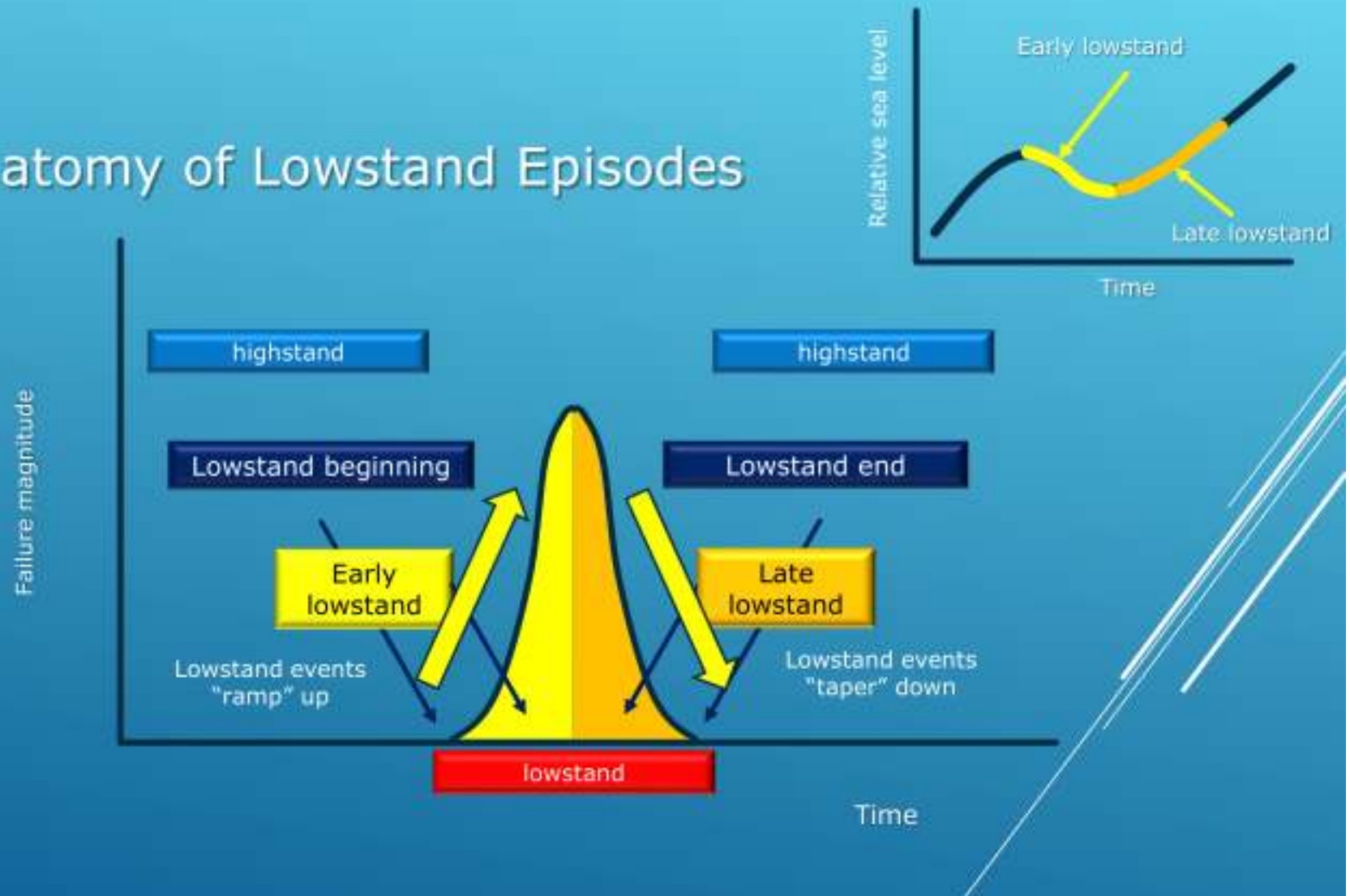
Relative sea-level rise

- Relatively low sand:mud ratio flows
- Relatively low-discharge flows
- **Transition point (between channel and lobe) lies relatively far seaward**

Anatomy of Lowstand Episodes



Anatomy of Lowstand Episodes



Anatomy of Lowstand Episodes

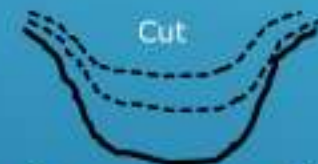
Early lowstand
Progressive channel
deepening with little or no
preservation of fill



Time 1



Time 2



Time 3



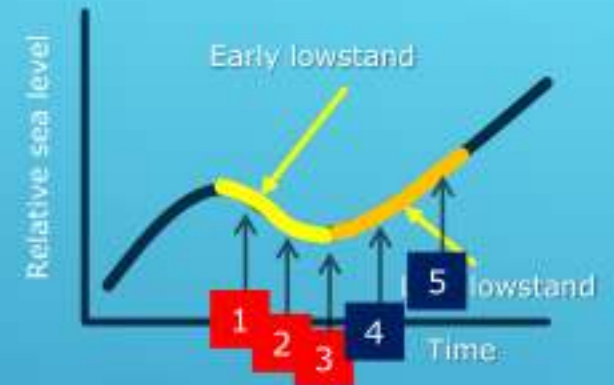
Time 4



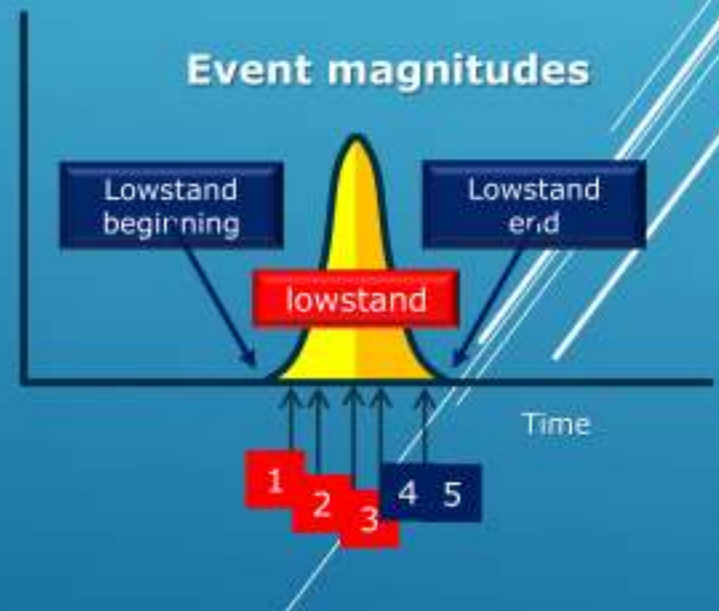
Time 5

Late lowstand
Progressive channel infill
by "underfit" flows

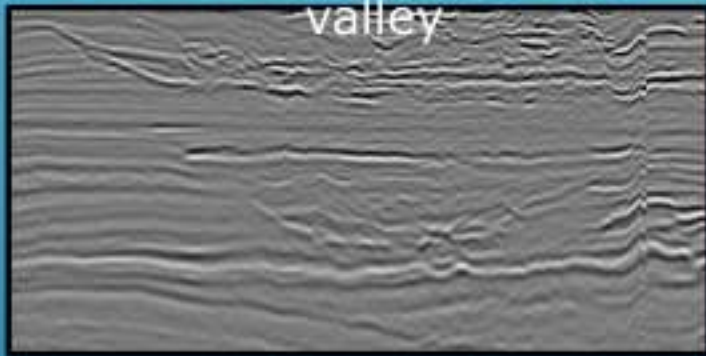
Failure magnitude



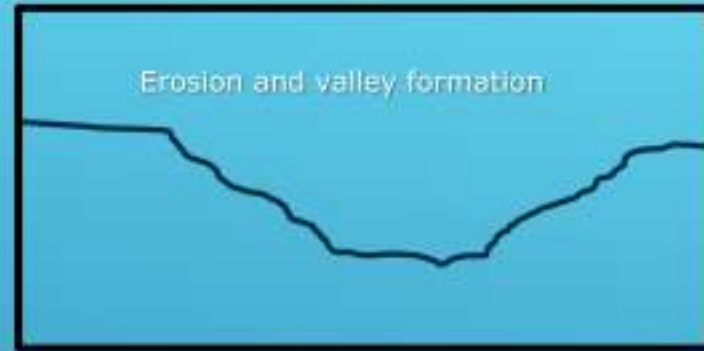
Event magnitudes



Early and Late Lowstand deposition within a slope valley



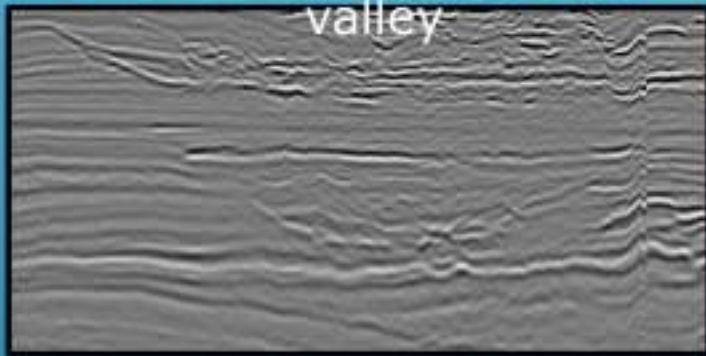
Erosion and valley formation



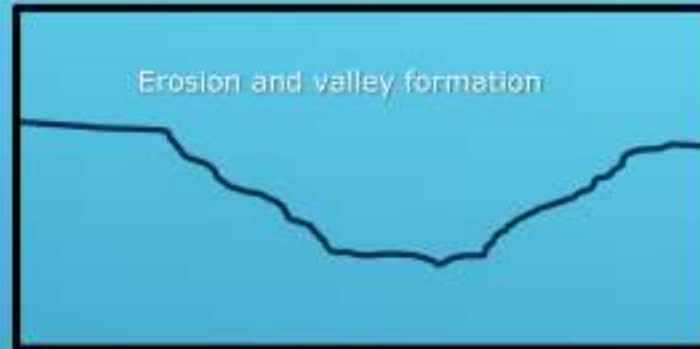
Each flow is successively **more**
energetic and erodes earlier-
deposited sediments



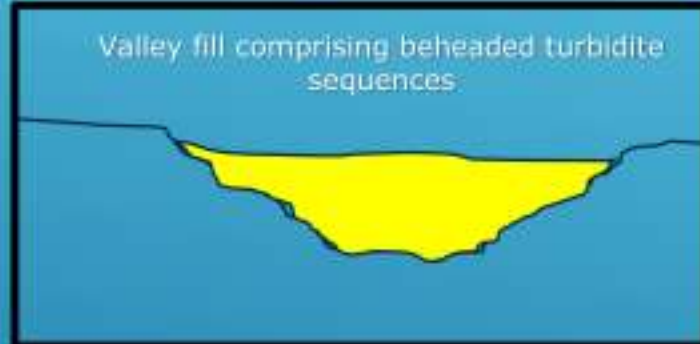
Early and Late Lowstand deposition within a slope valley



Erosion and valley formation

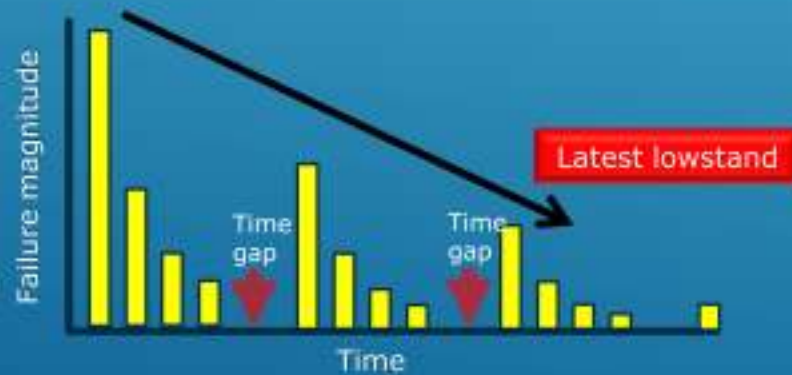
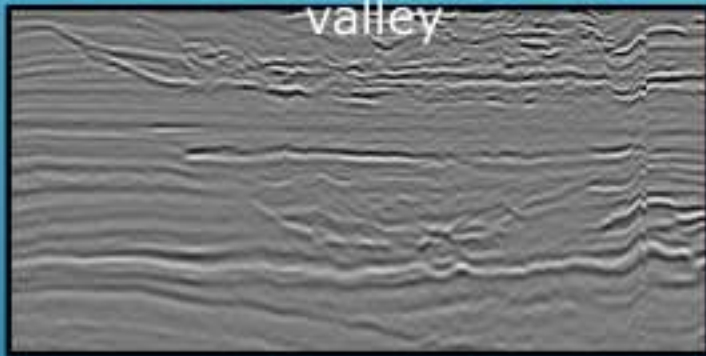


Valley fill comprising beheaded turbidite
sequences

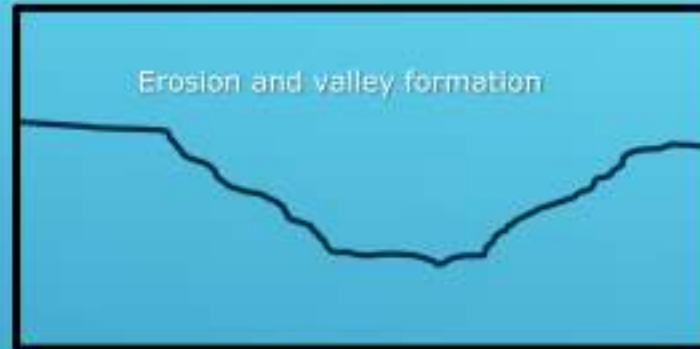


Each flow is successively **less**
energetic and only partially erodes
earlier-deposited sediments

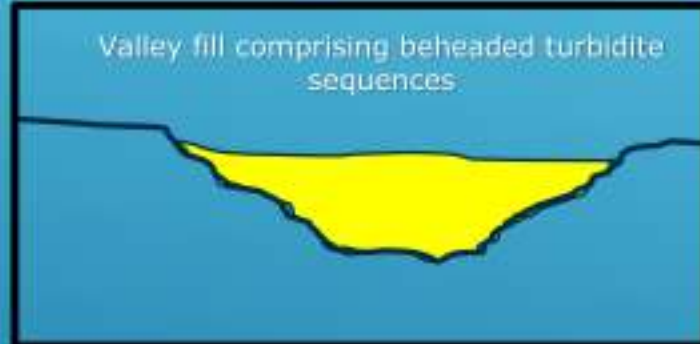
Early and Late Lowstand deposition within a slope valley



Erosion and valley formation



Valley fill comprising beheaded turbidite sequences

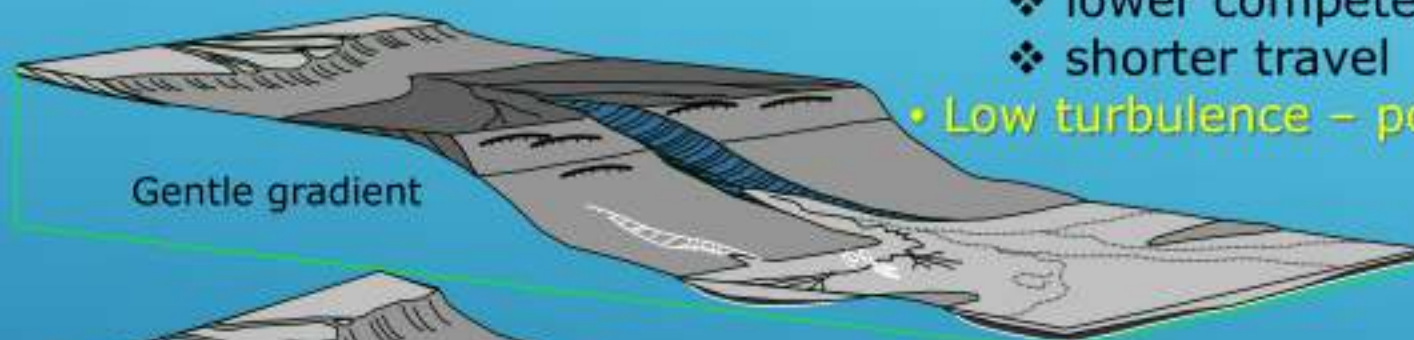


Latest lowstand deposits comprising small flows that terminate as small fans confined within valleys

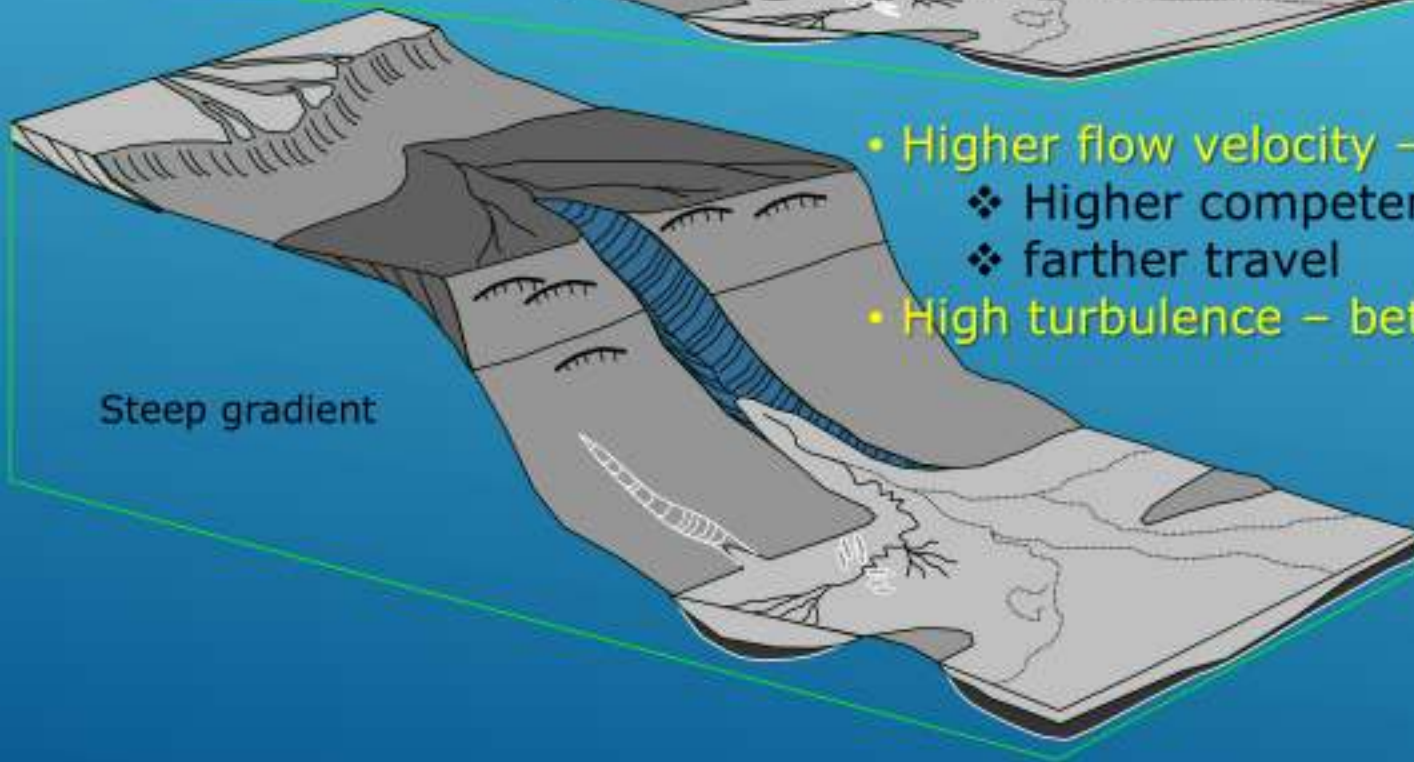


GRADIENT EFFECT – BASAL FRICTION IS THE KEY...

- Low flow velocity – higher basal friction
 - ❖ lower competence
 - ❖ shorter travel
- Low turbulence – poorer sorting

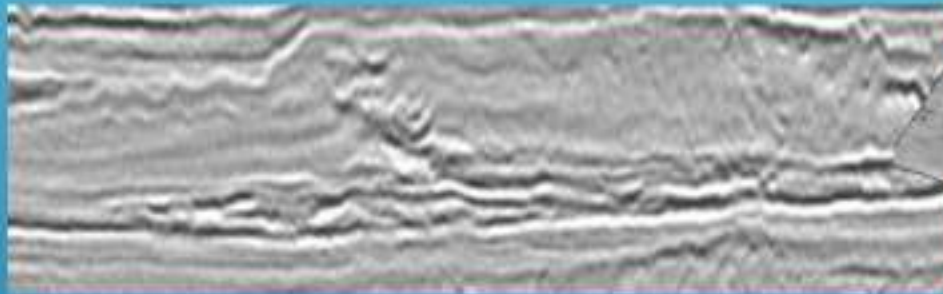


- Higher flow velocity – lower basal friction
 - ❖ Higher competence
 - ❖ farther travel
- High turbulence – better sorting

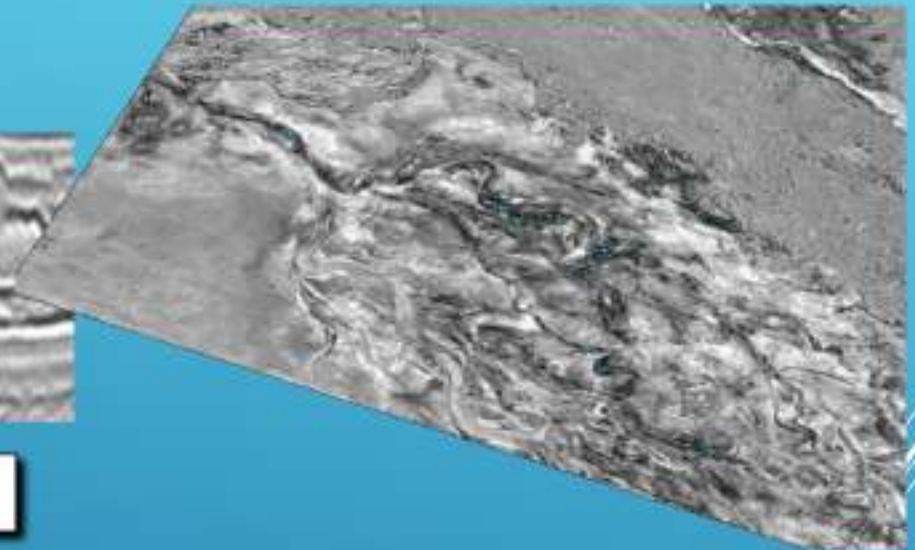


TURBULENCE IS AN EXCELLENT SORTING PROCESS

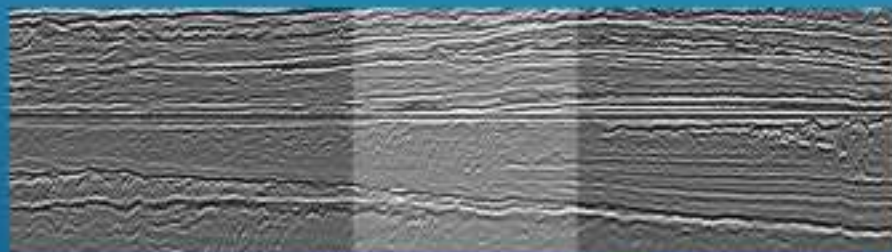
Good reservoir



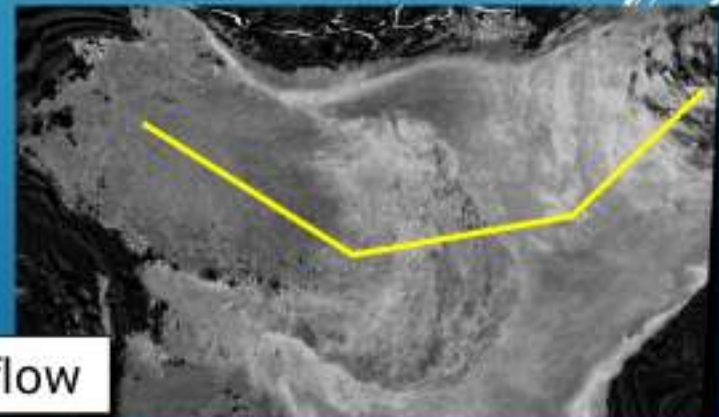
Turbidite → turbulent flow



Bad reservoir



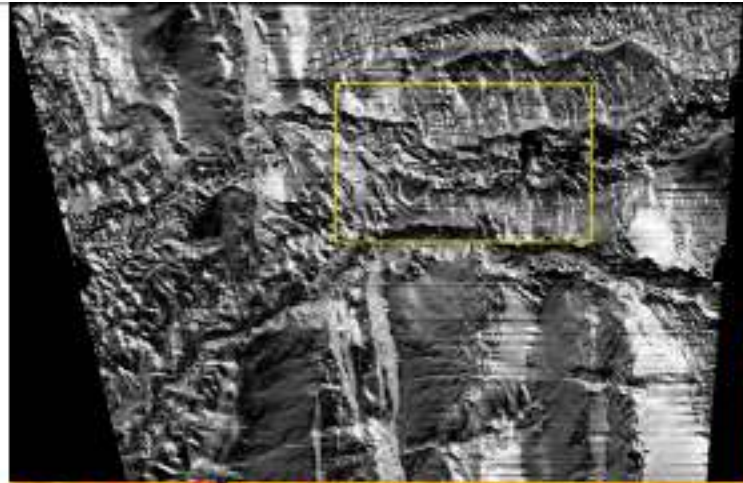
Mass Transport Deposit → Laminar flow



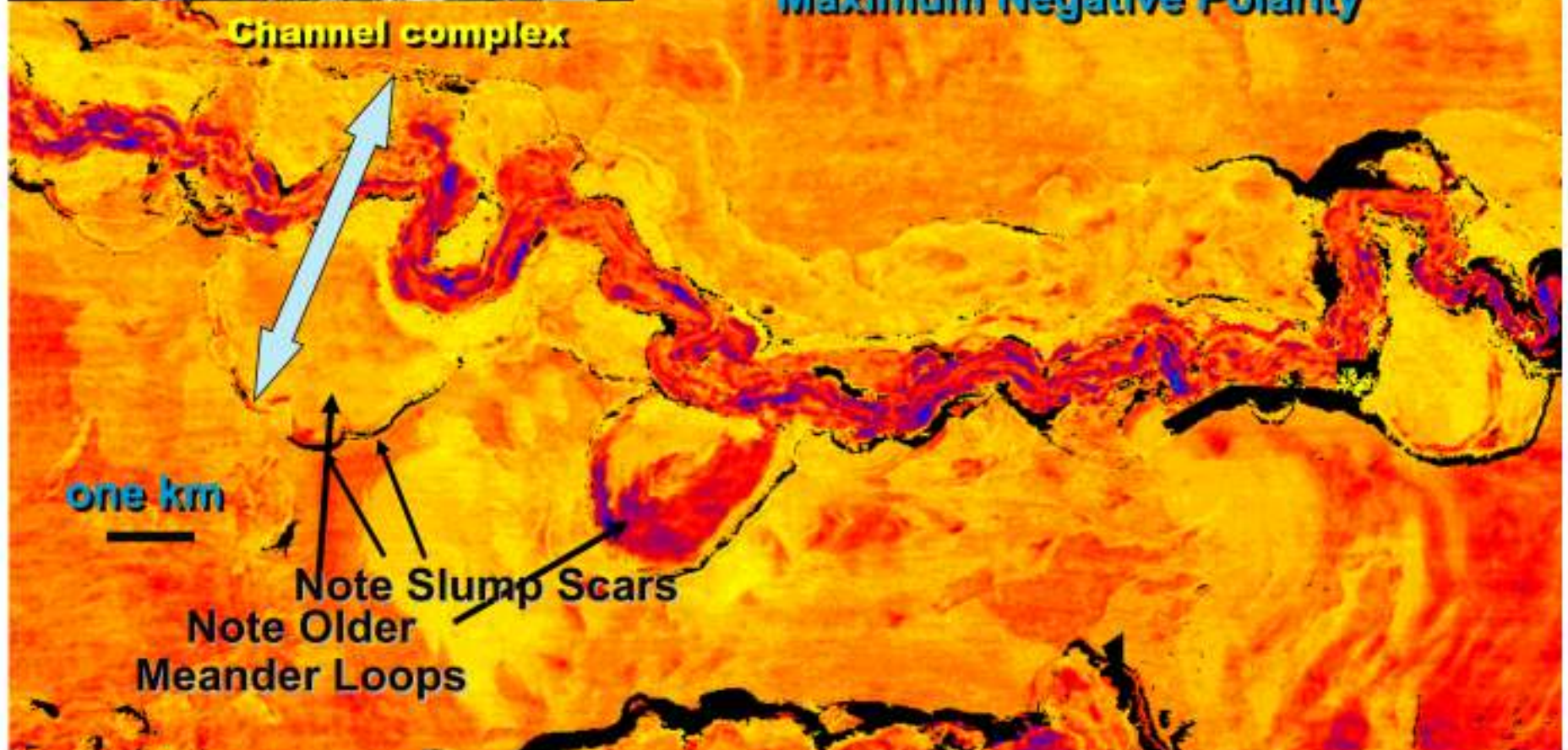
Confined Flow in Channels

- **On the slope (within slope valleys and canyons)**
- **On the basin floor**

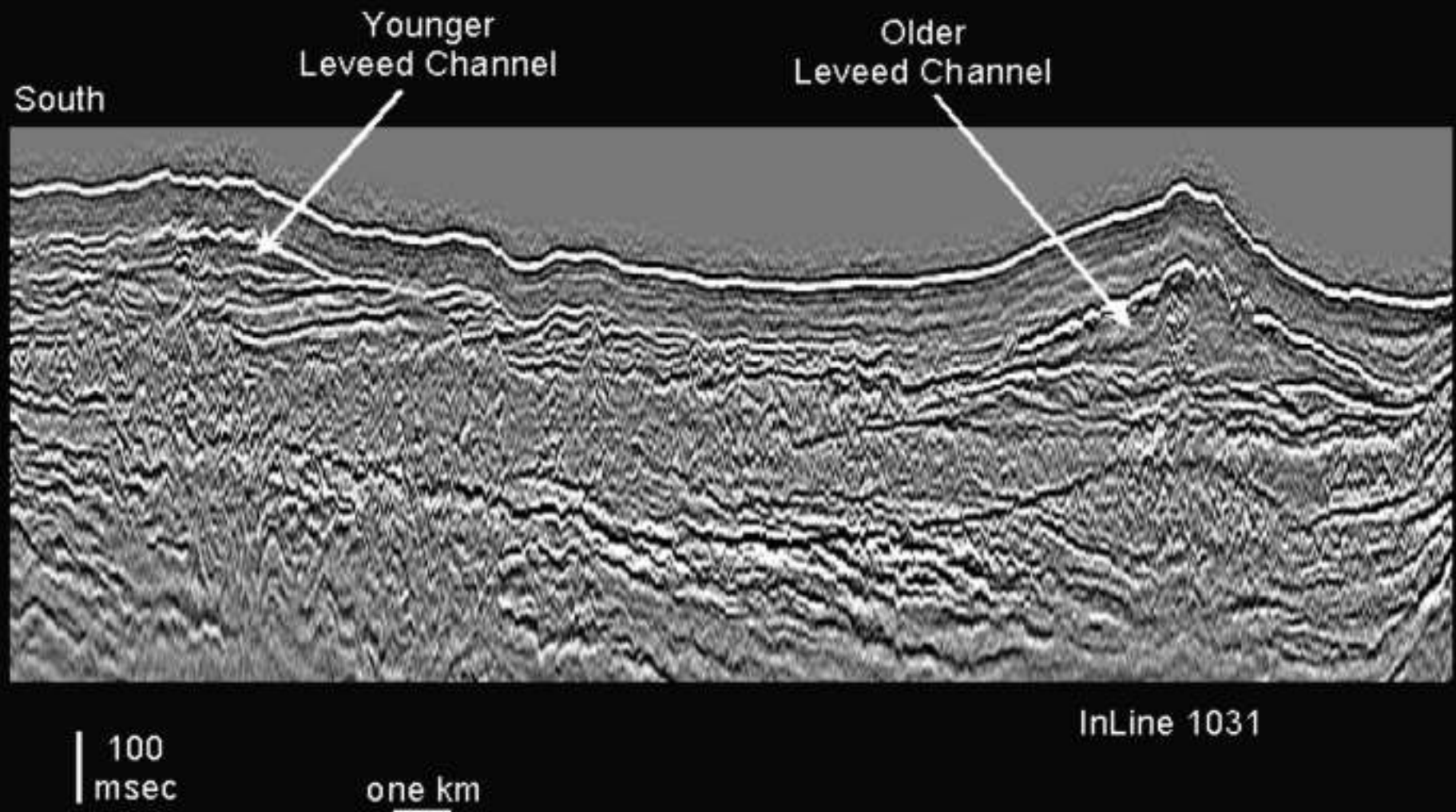
Leveed Channel on Slope

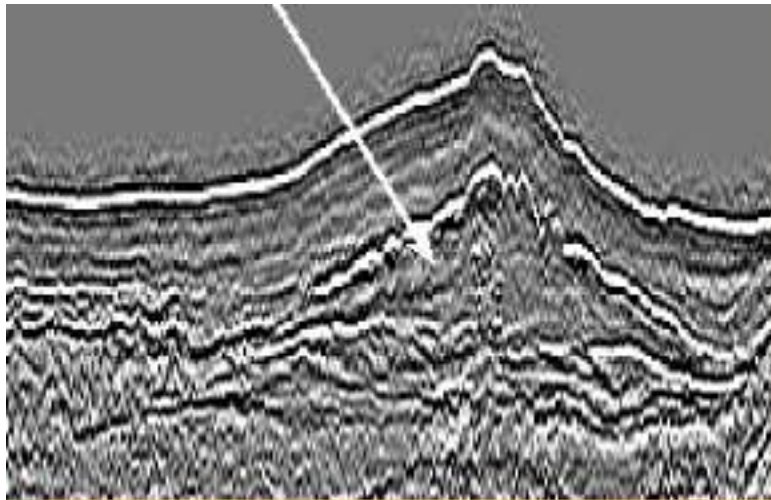


Interval Attribute (Sea Floor + 80 msec)
Maximum Negative Polarity

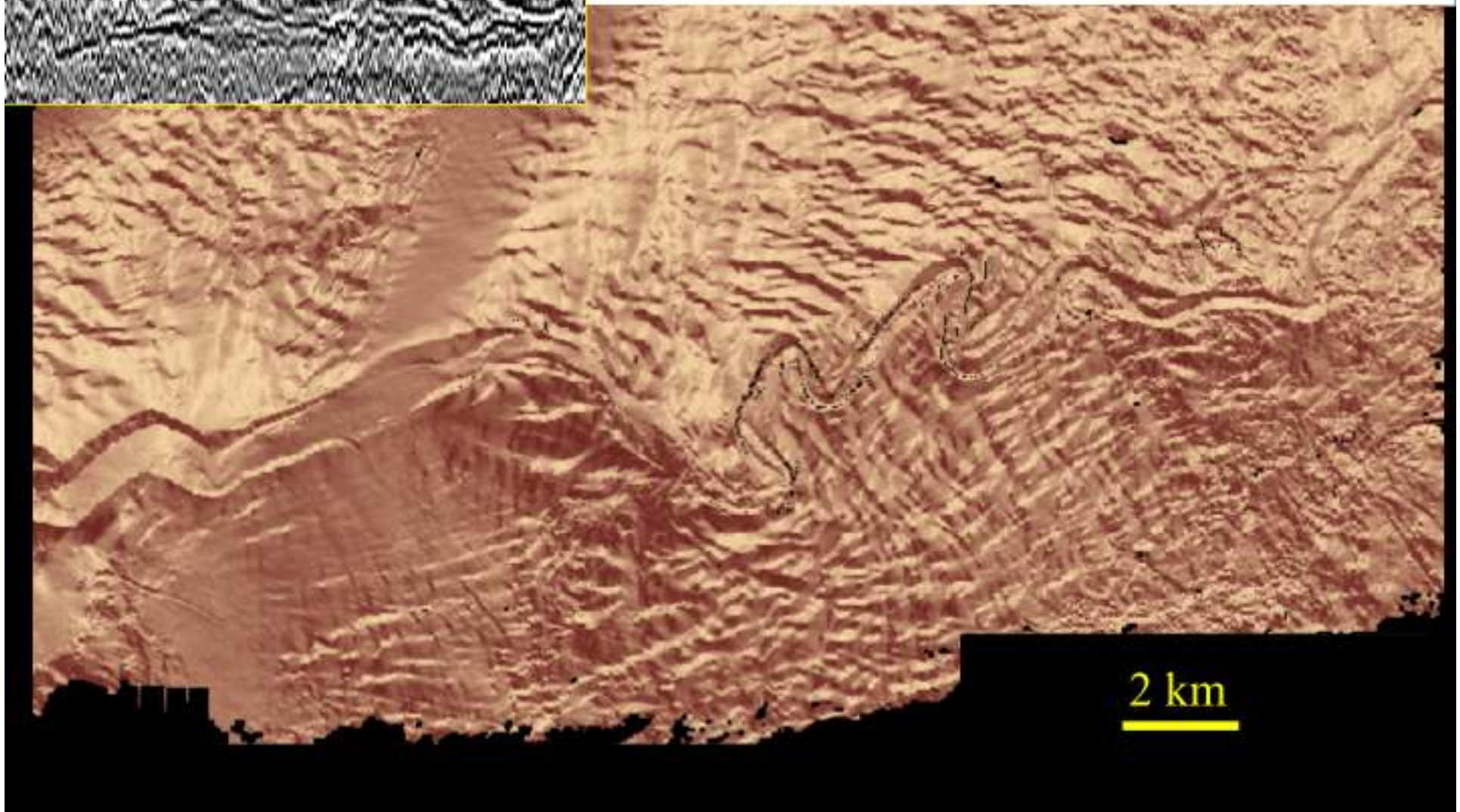


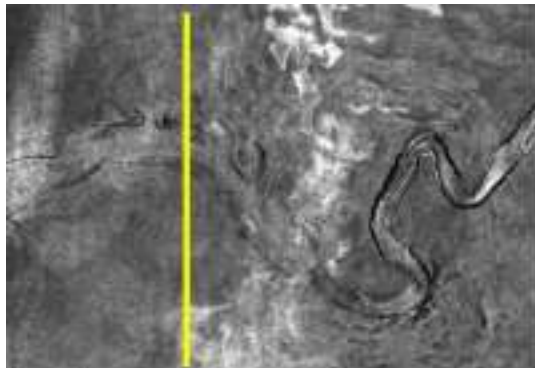
Transverse Profile across Two Leveed Channels



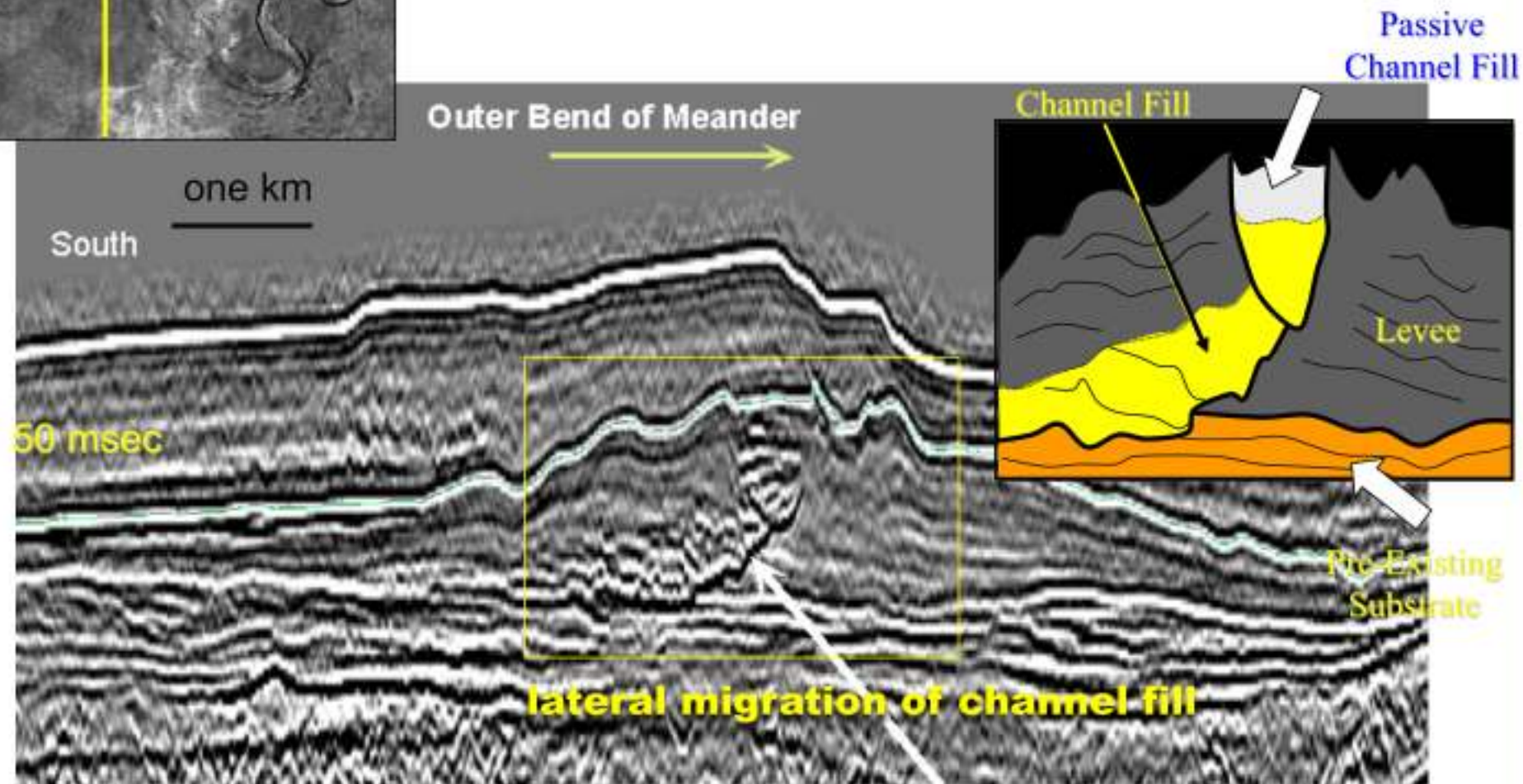


Leveed Channel on basin floor

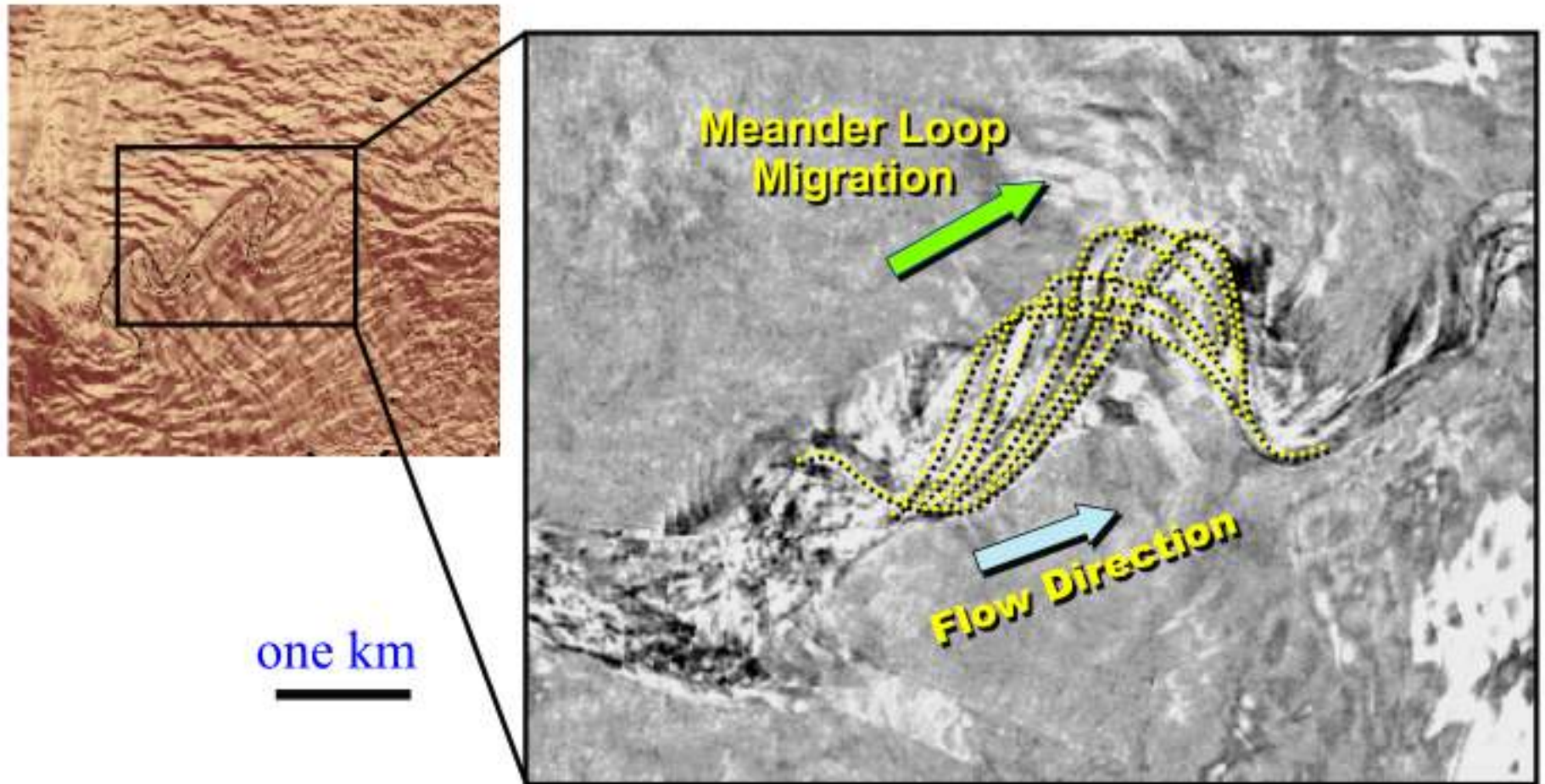




Leveed Channel on Basin Floor

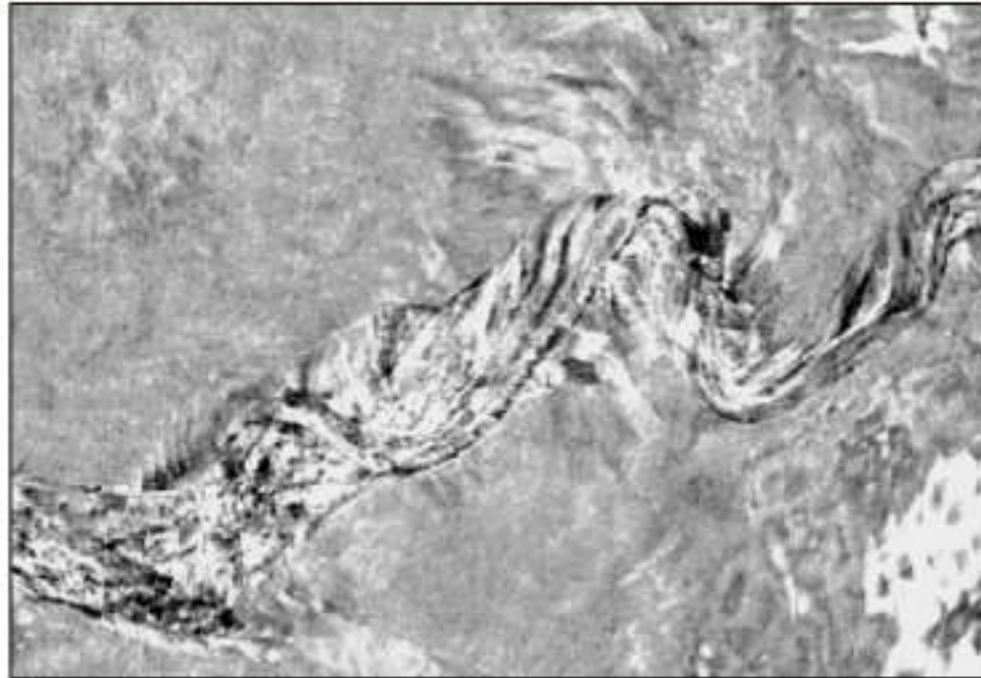


Leveed Channel Characterized by Meander Migration

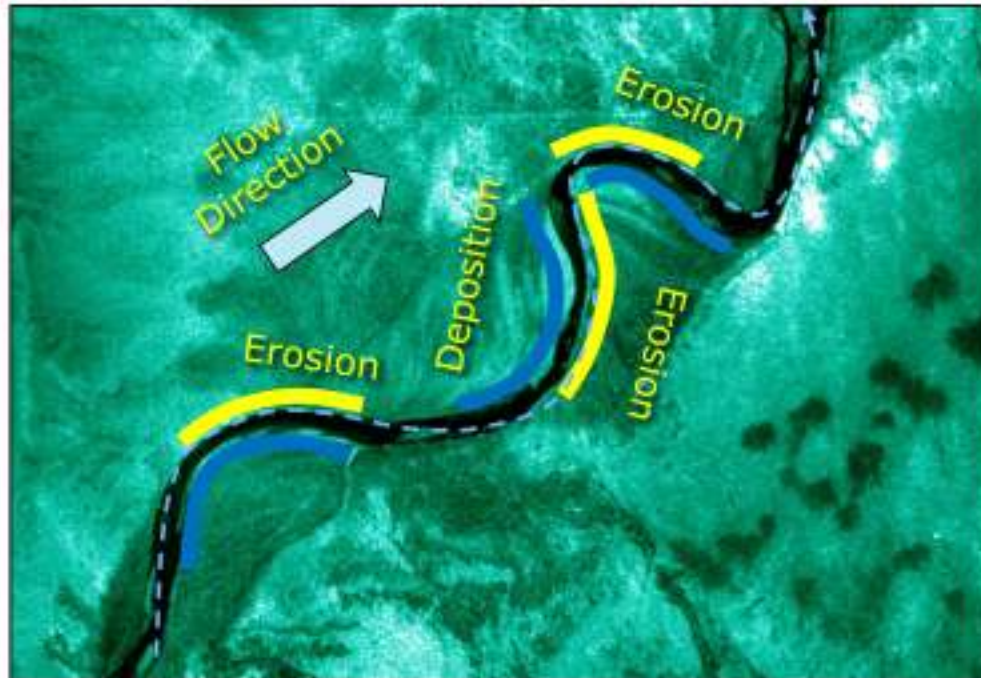


Amplitude Extraction - Horizon Slice (-36 msec)

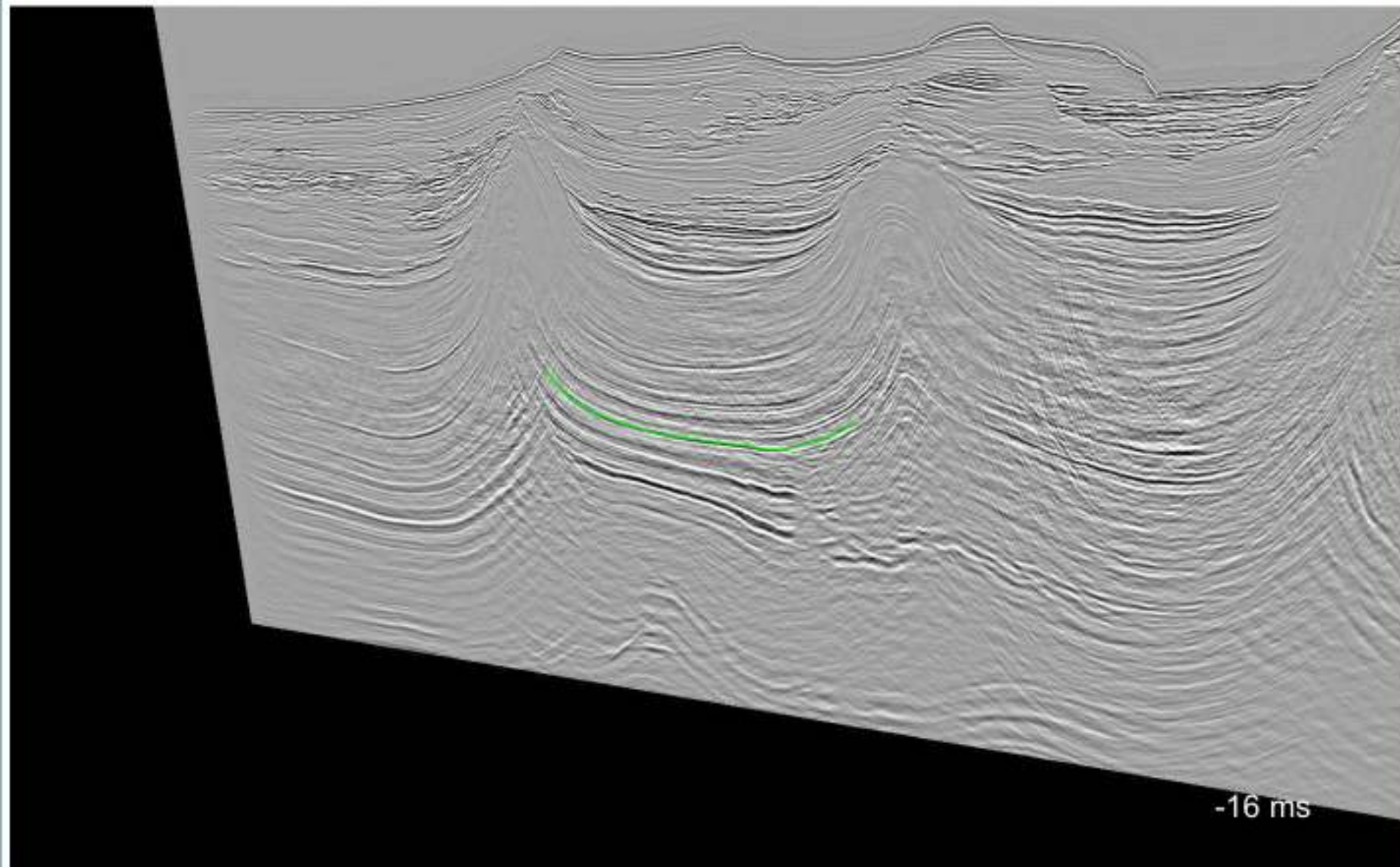
Deep-water



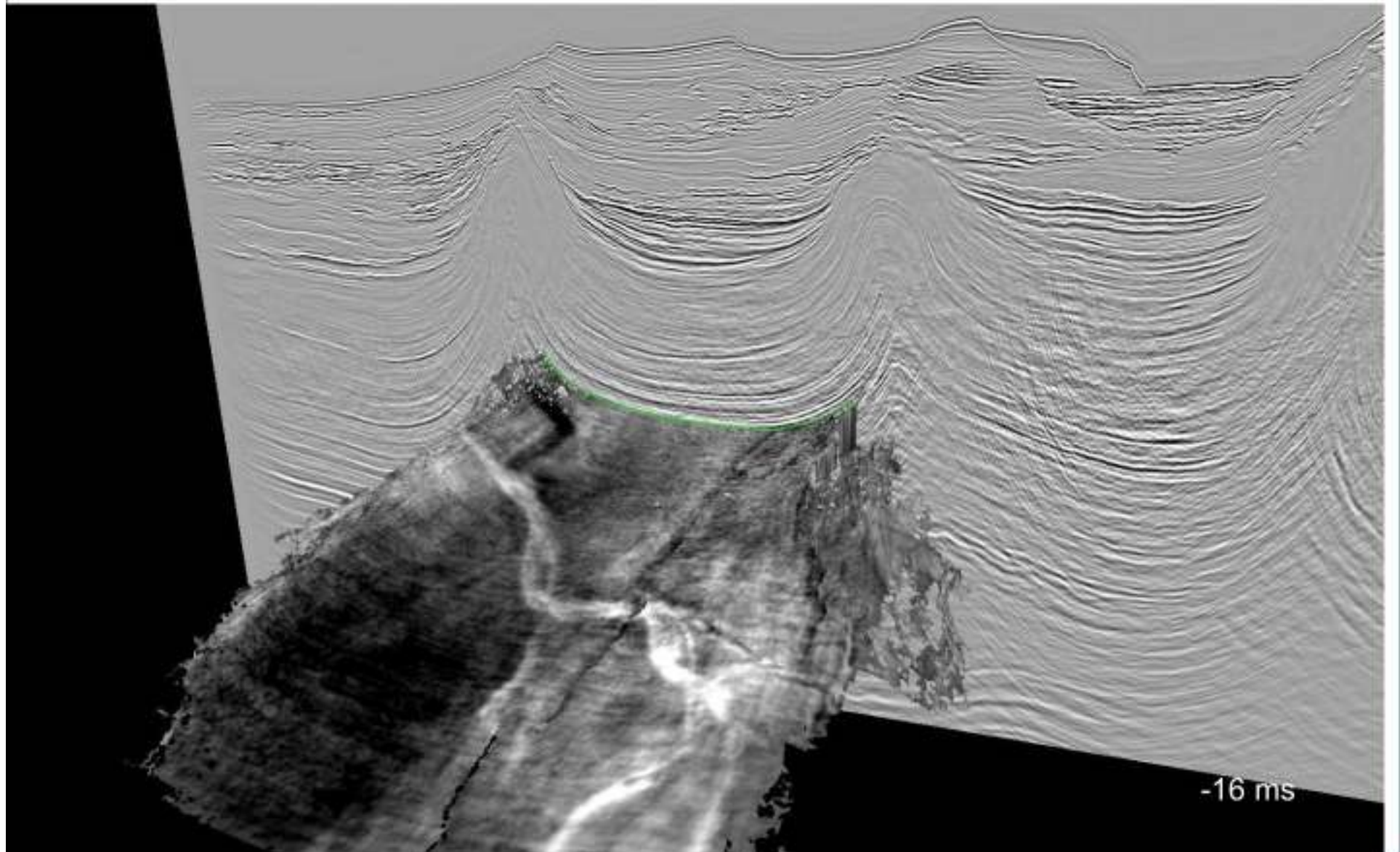
Fluvial

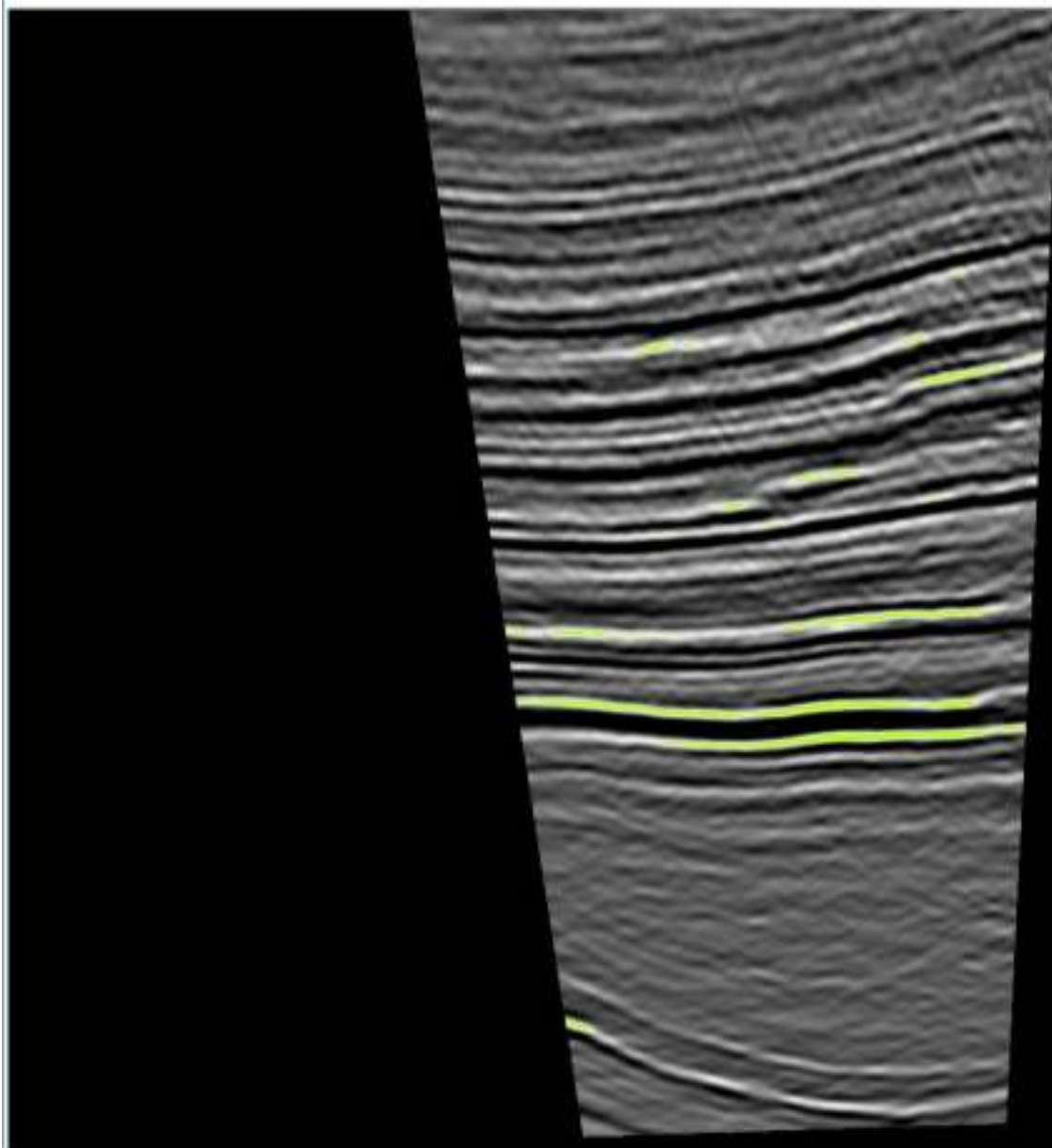


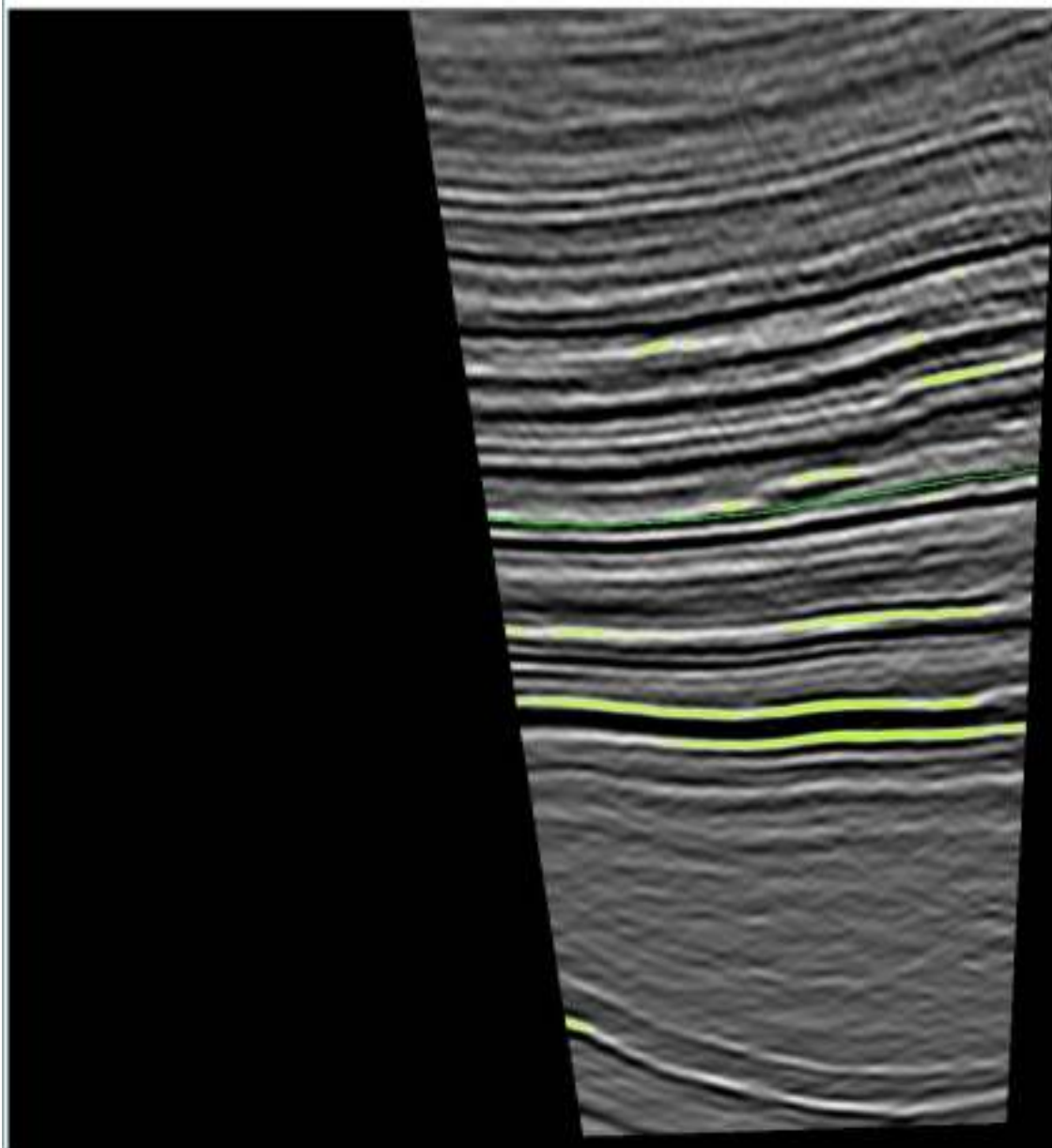
Leveed Channel

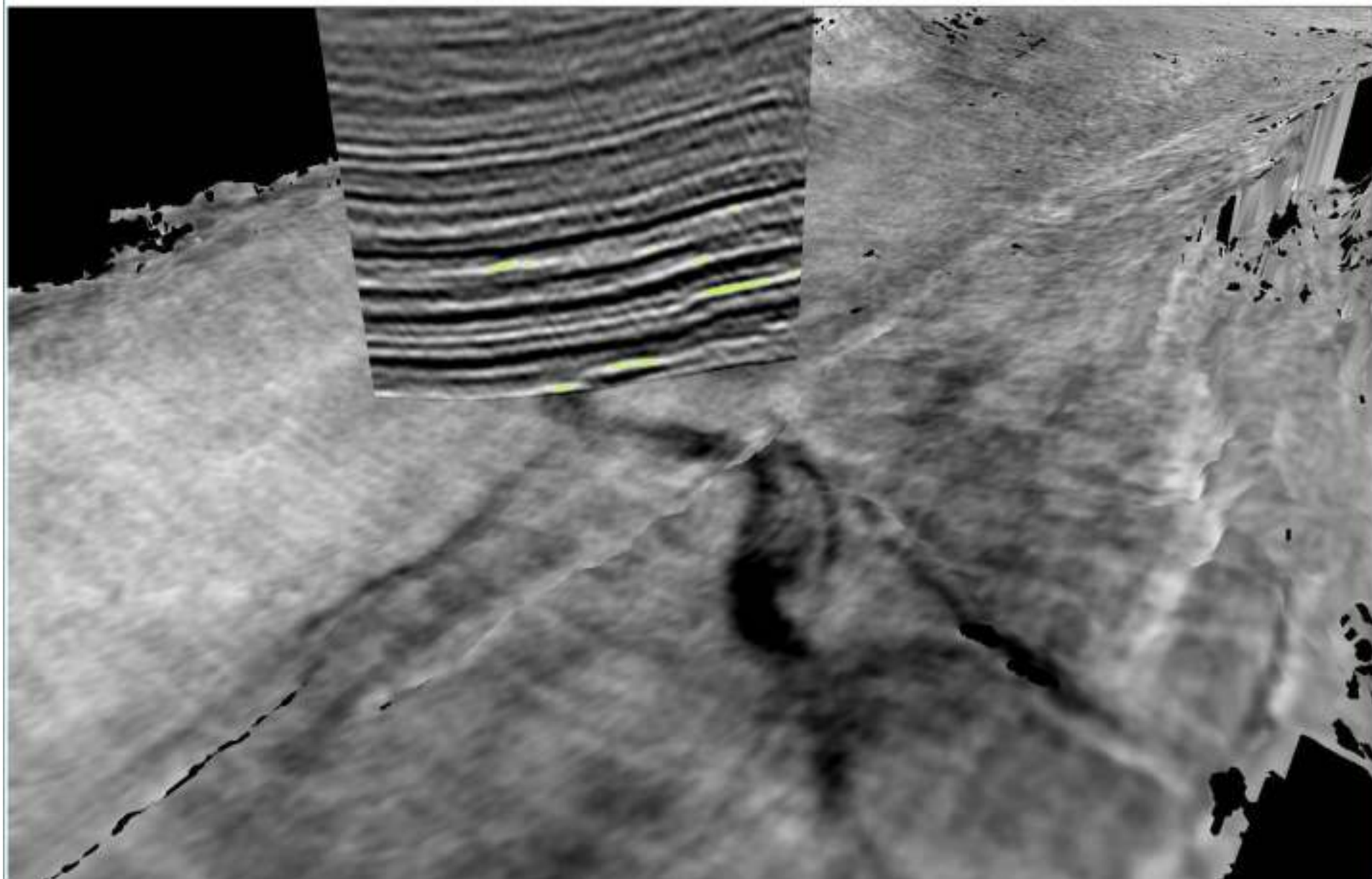


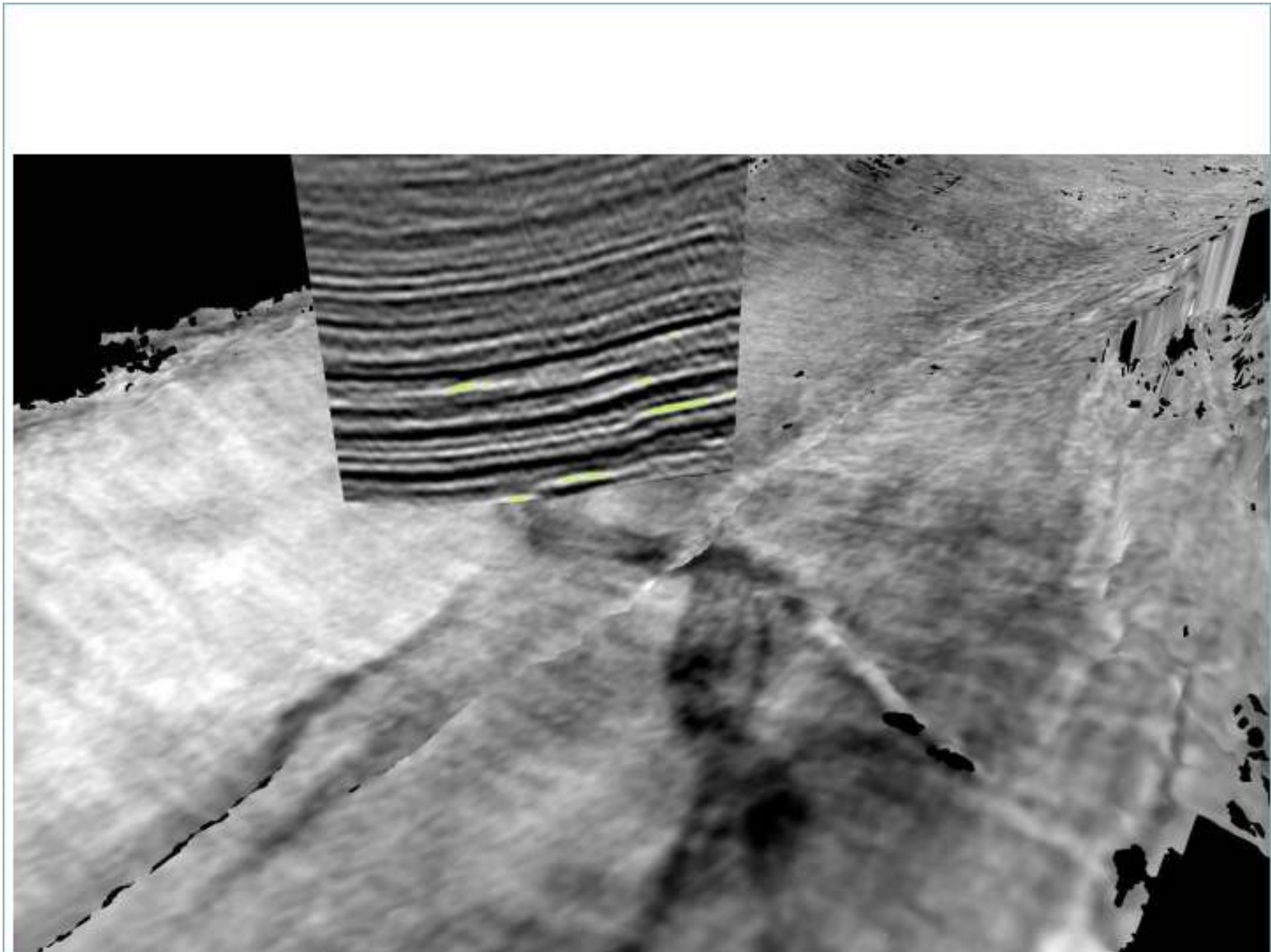
Leveed Channel

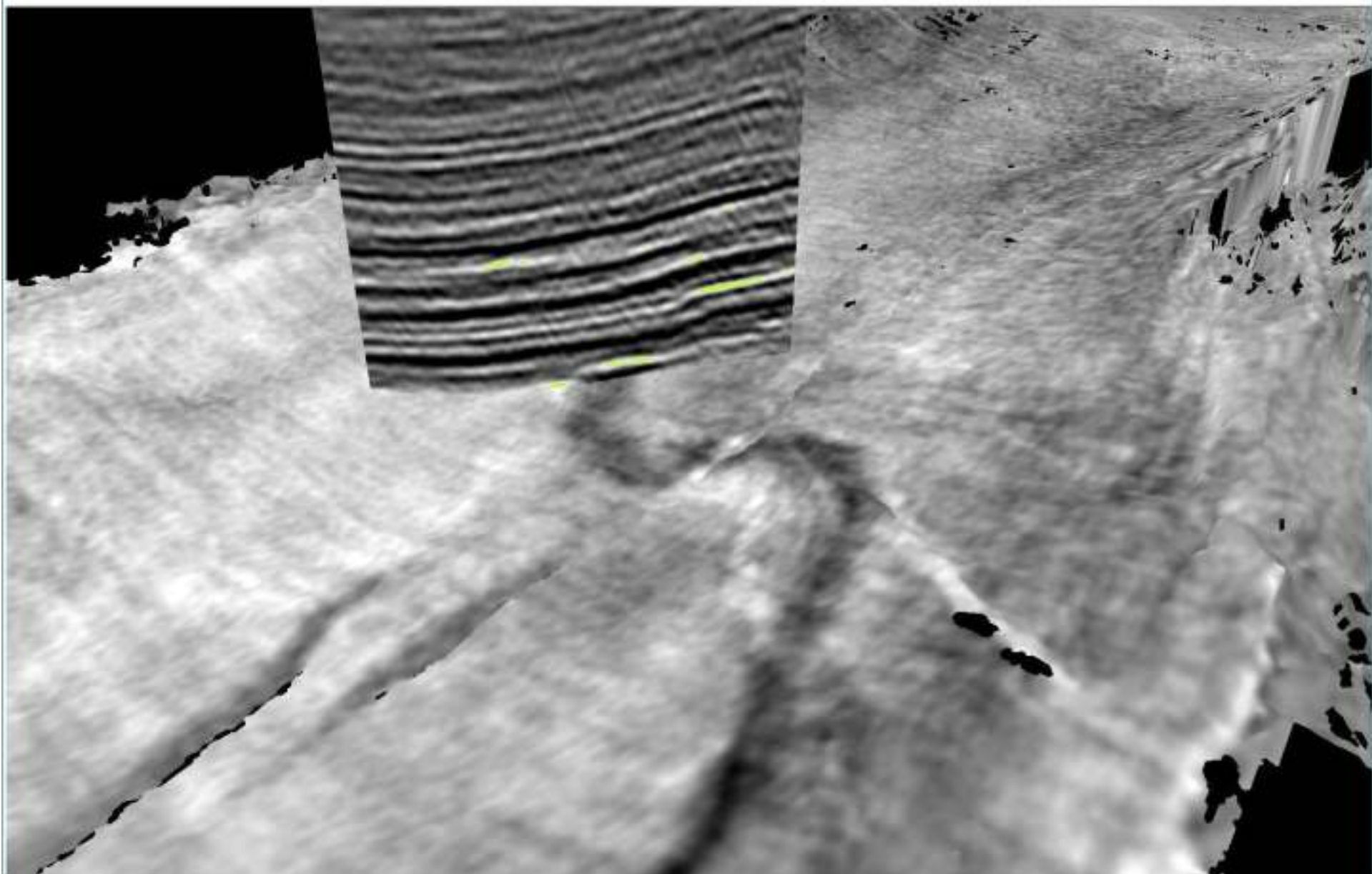


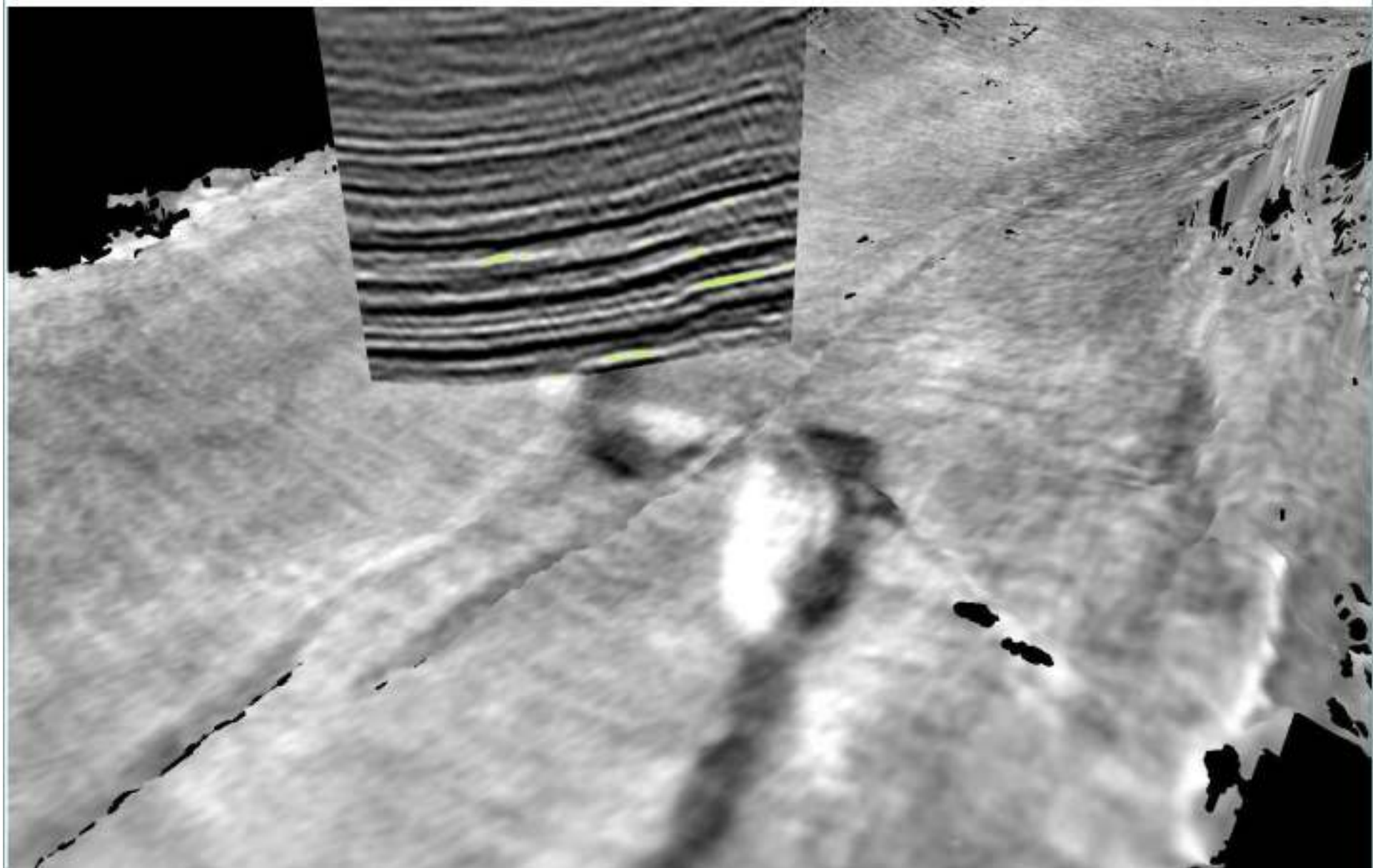


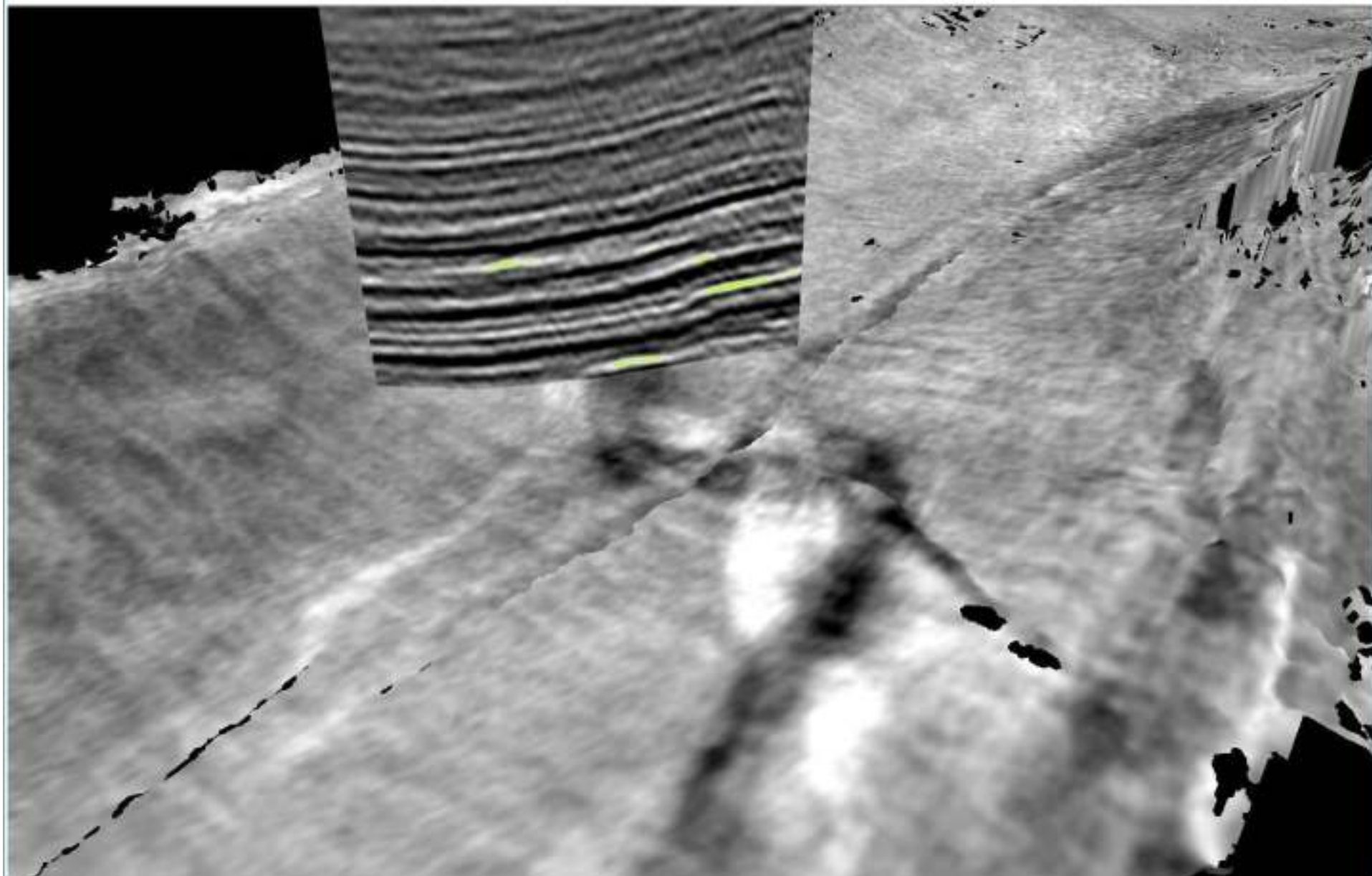


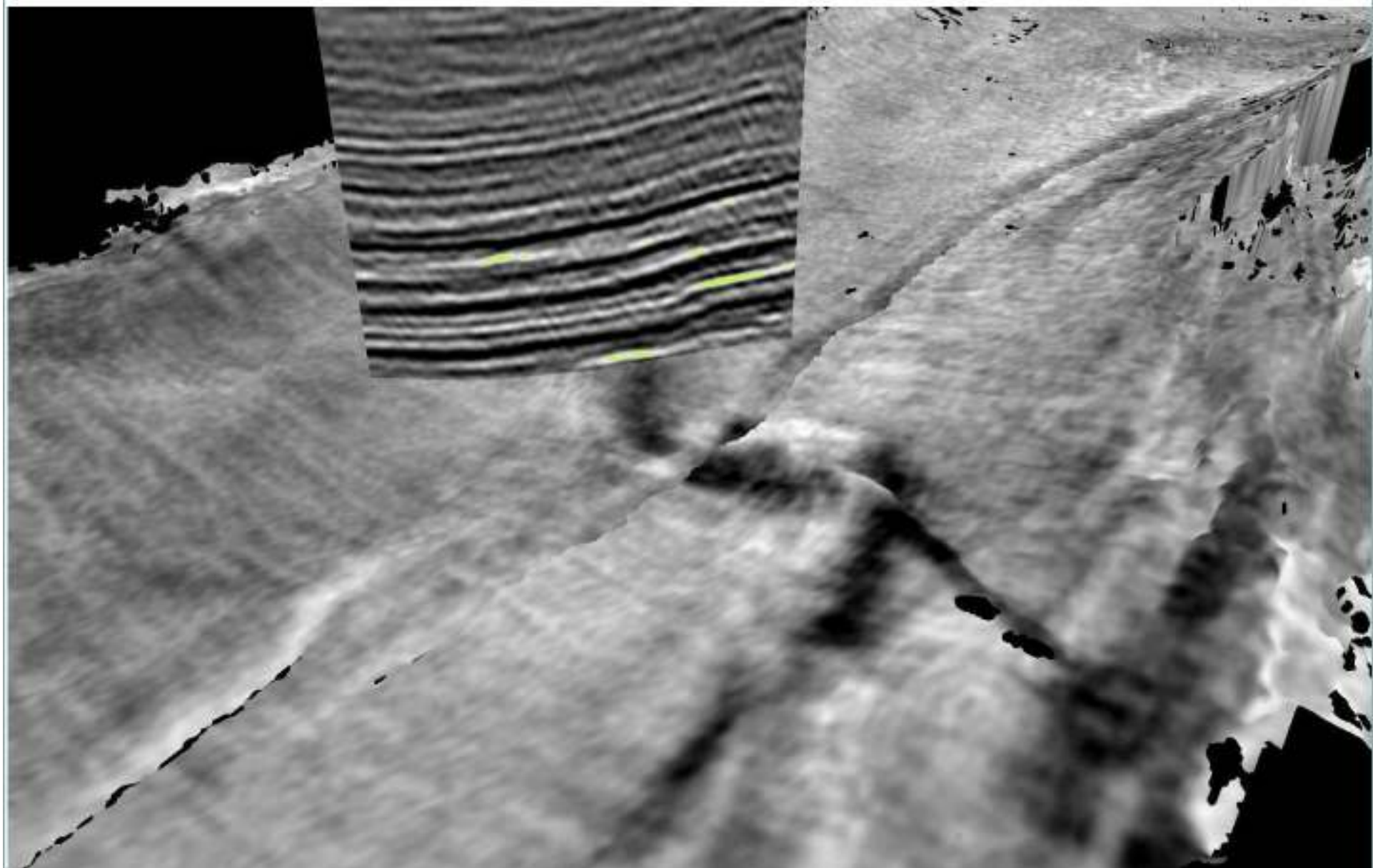




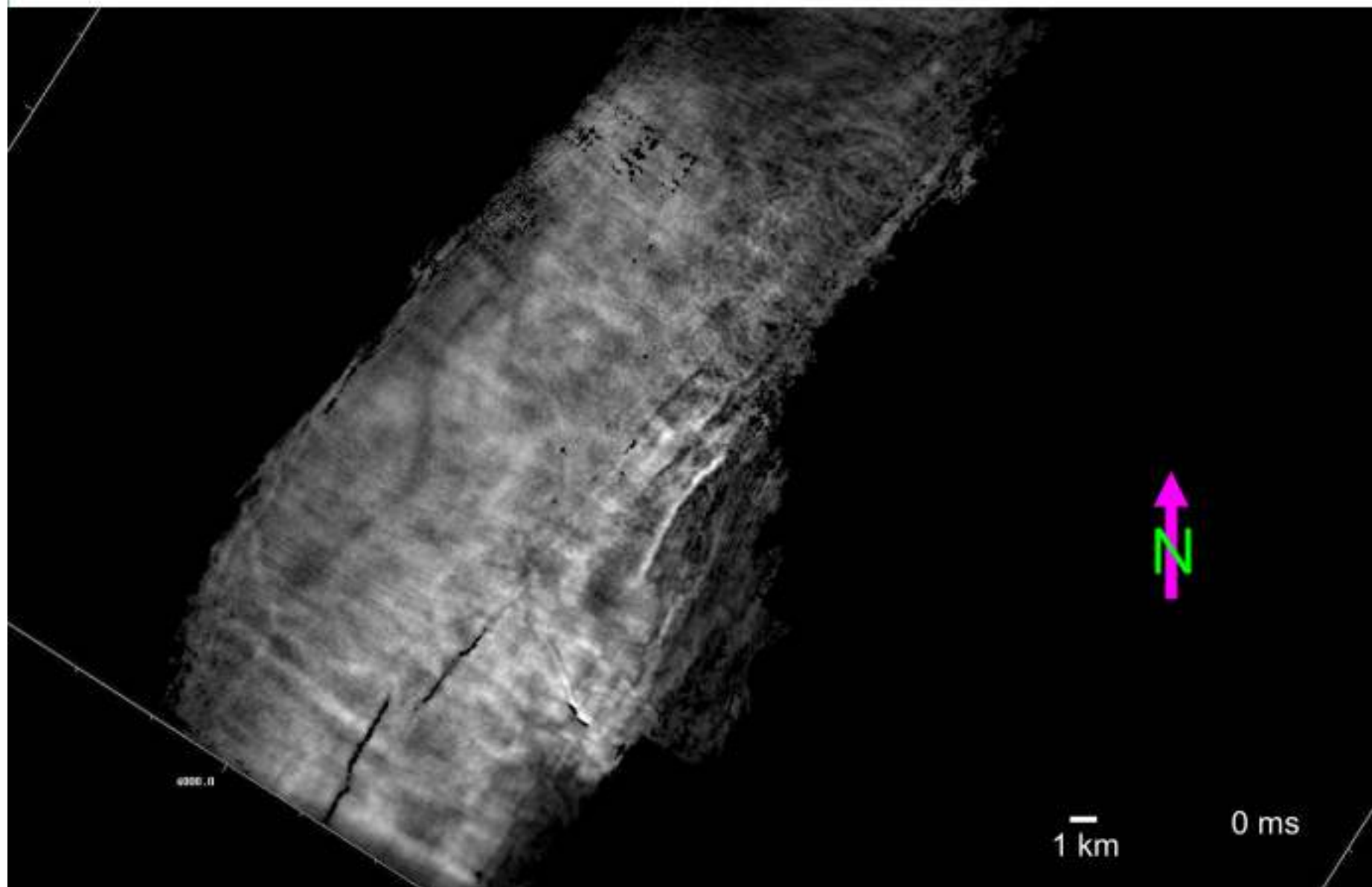




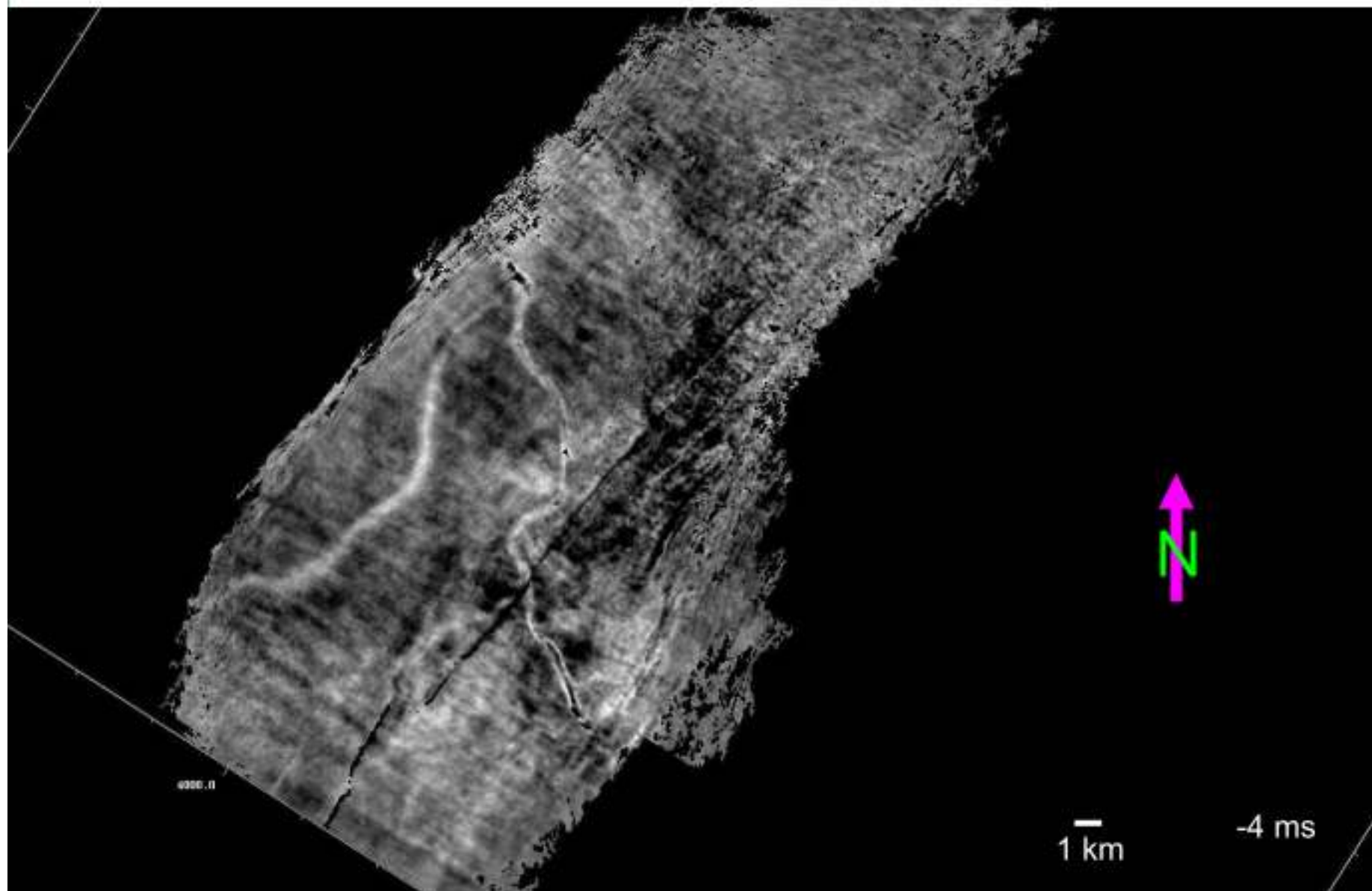




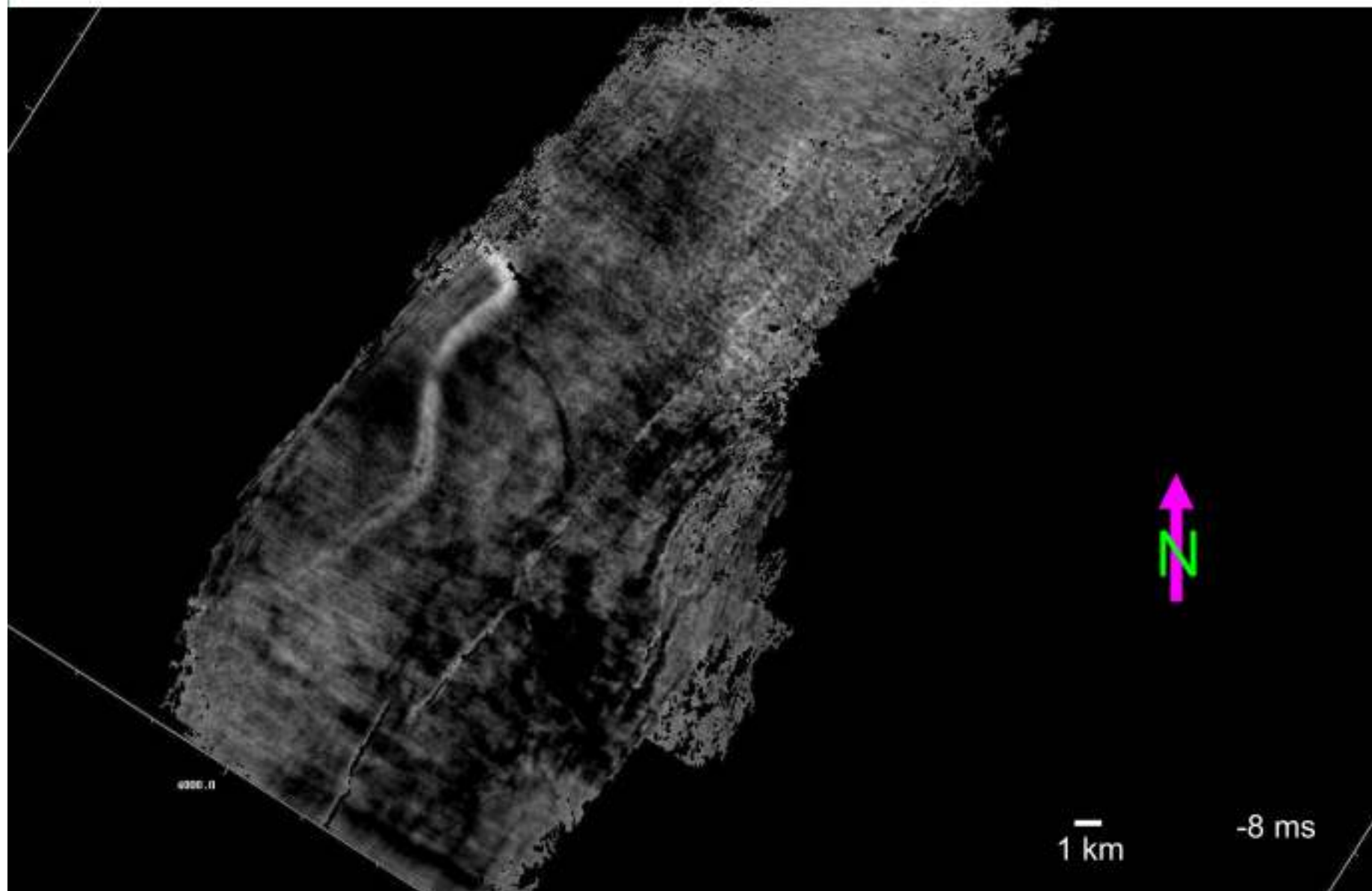
~T200 Leveed Channel



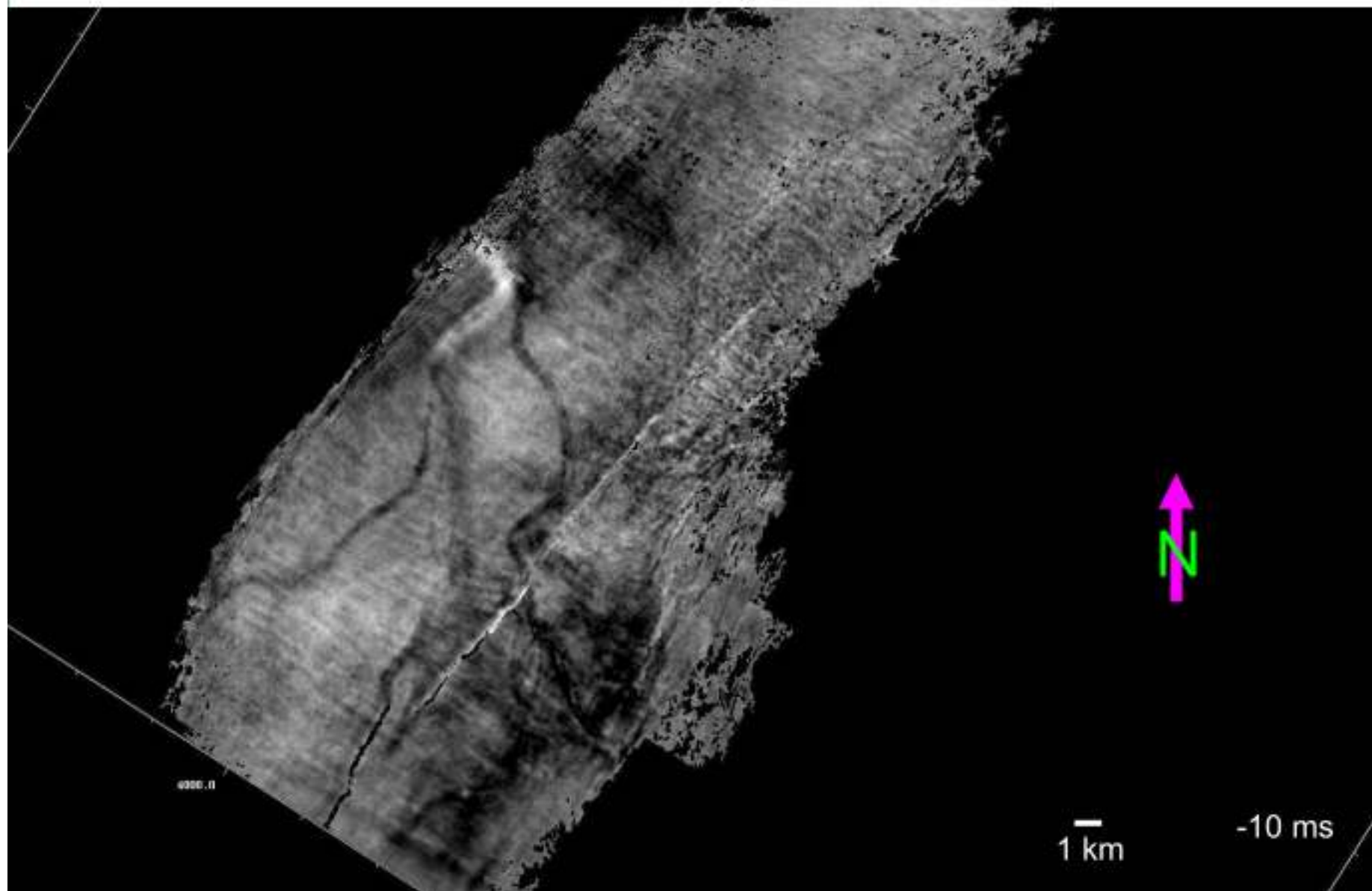
~T200 Leveed Channel



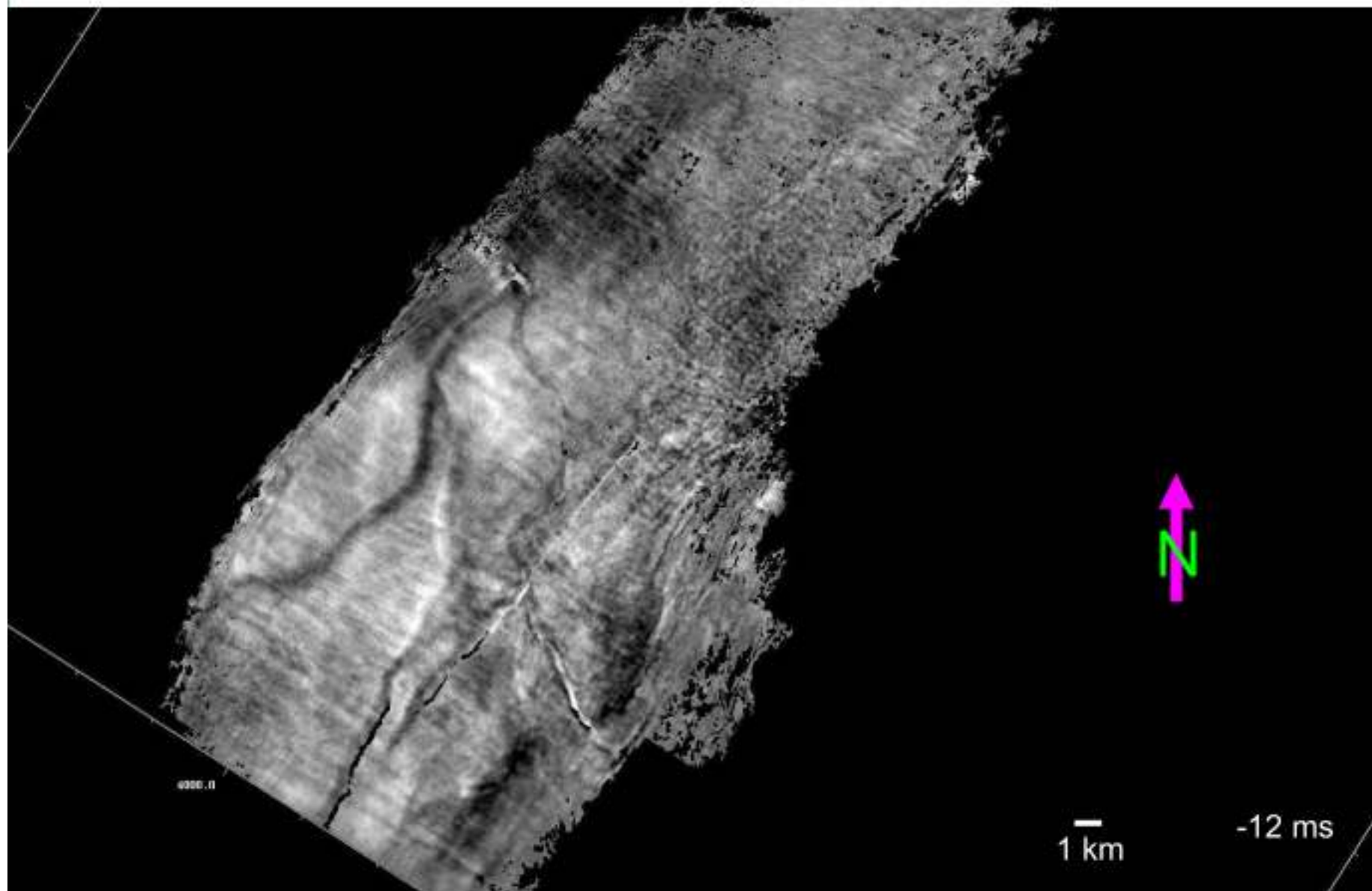
~T200 Leveed Channel



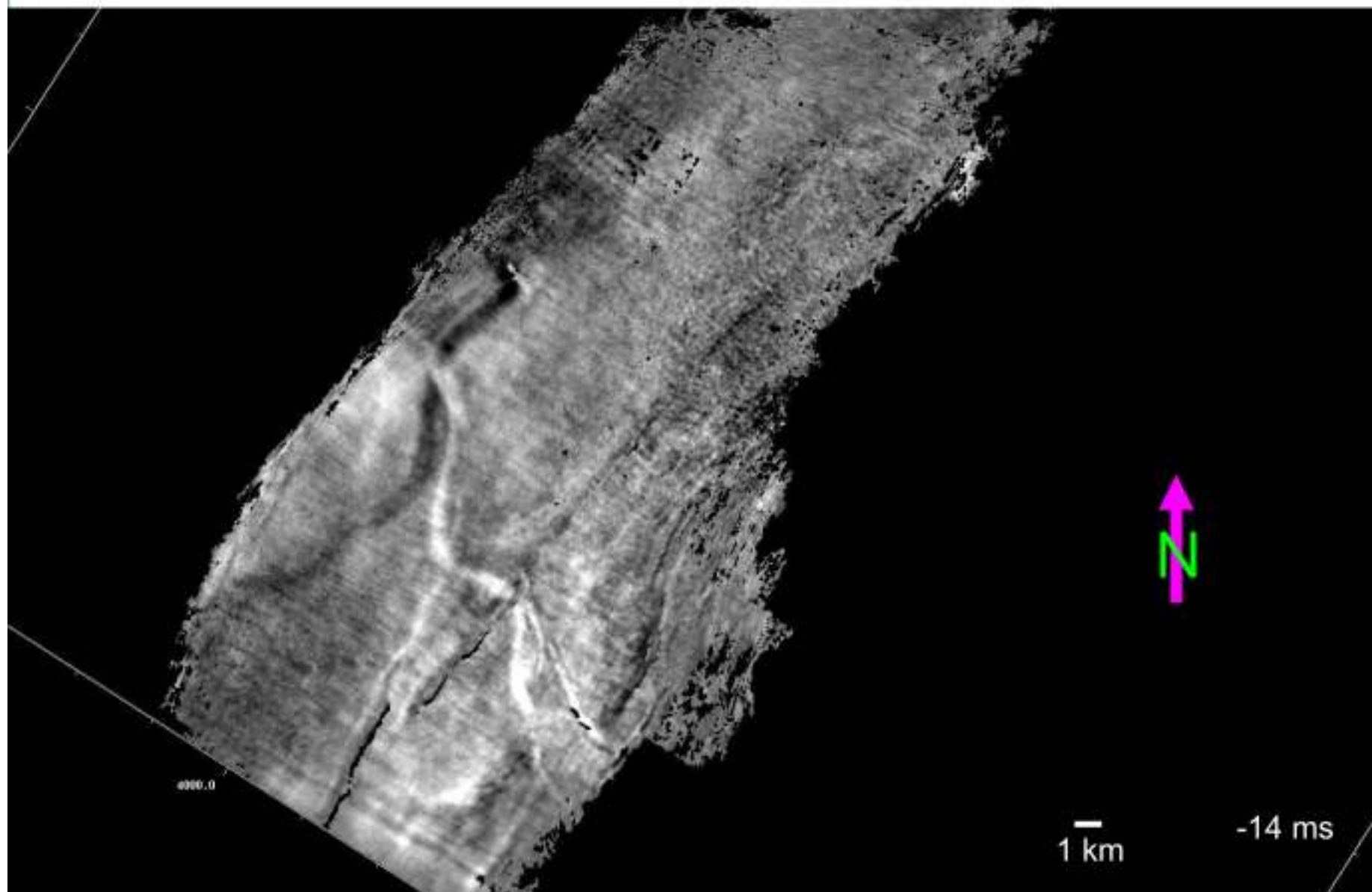
~T200 Leveed Channel



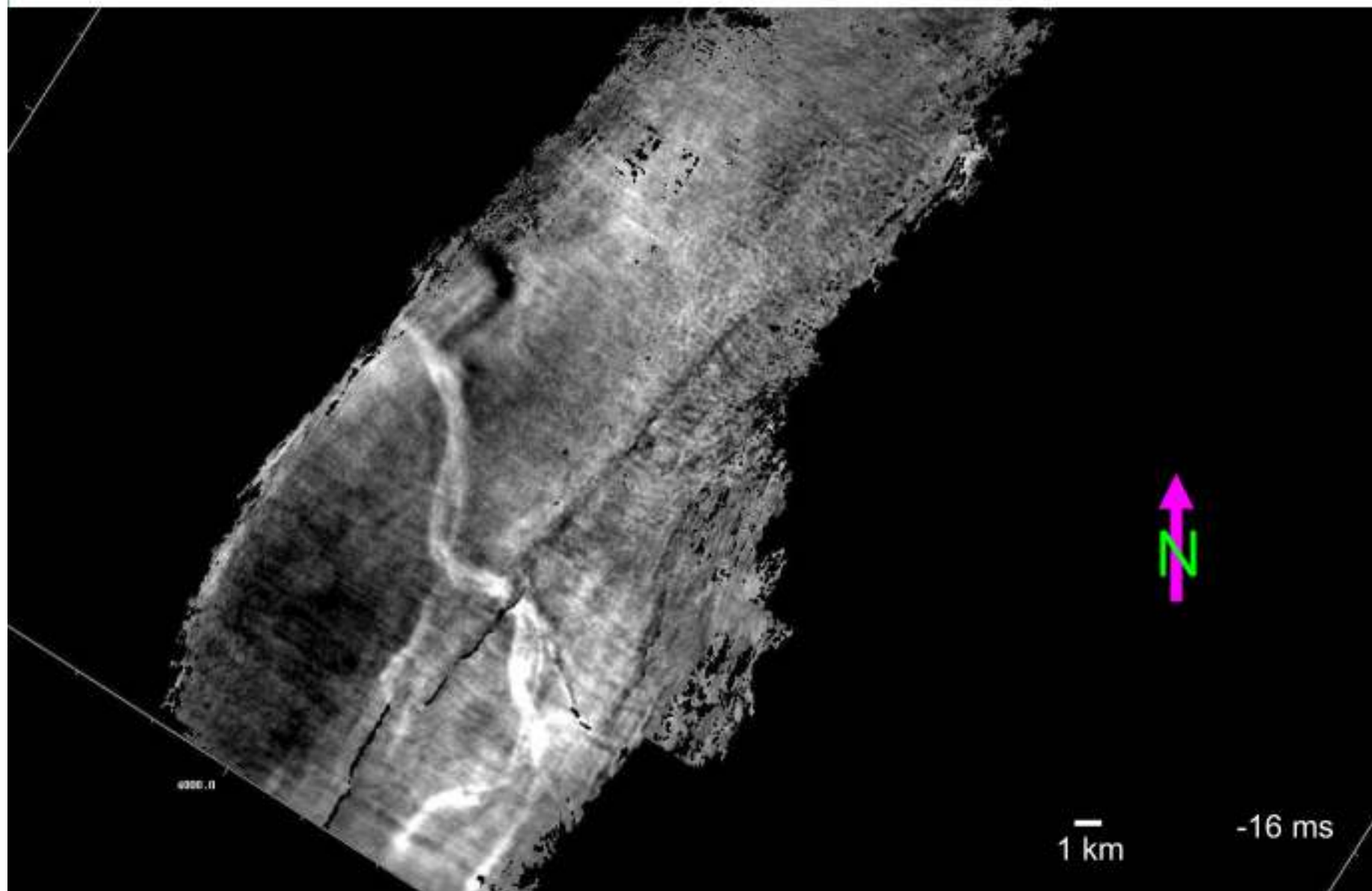
~T200 Leveed Channel



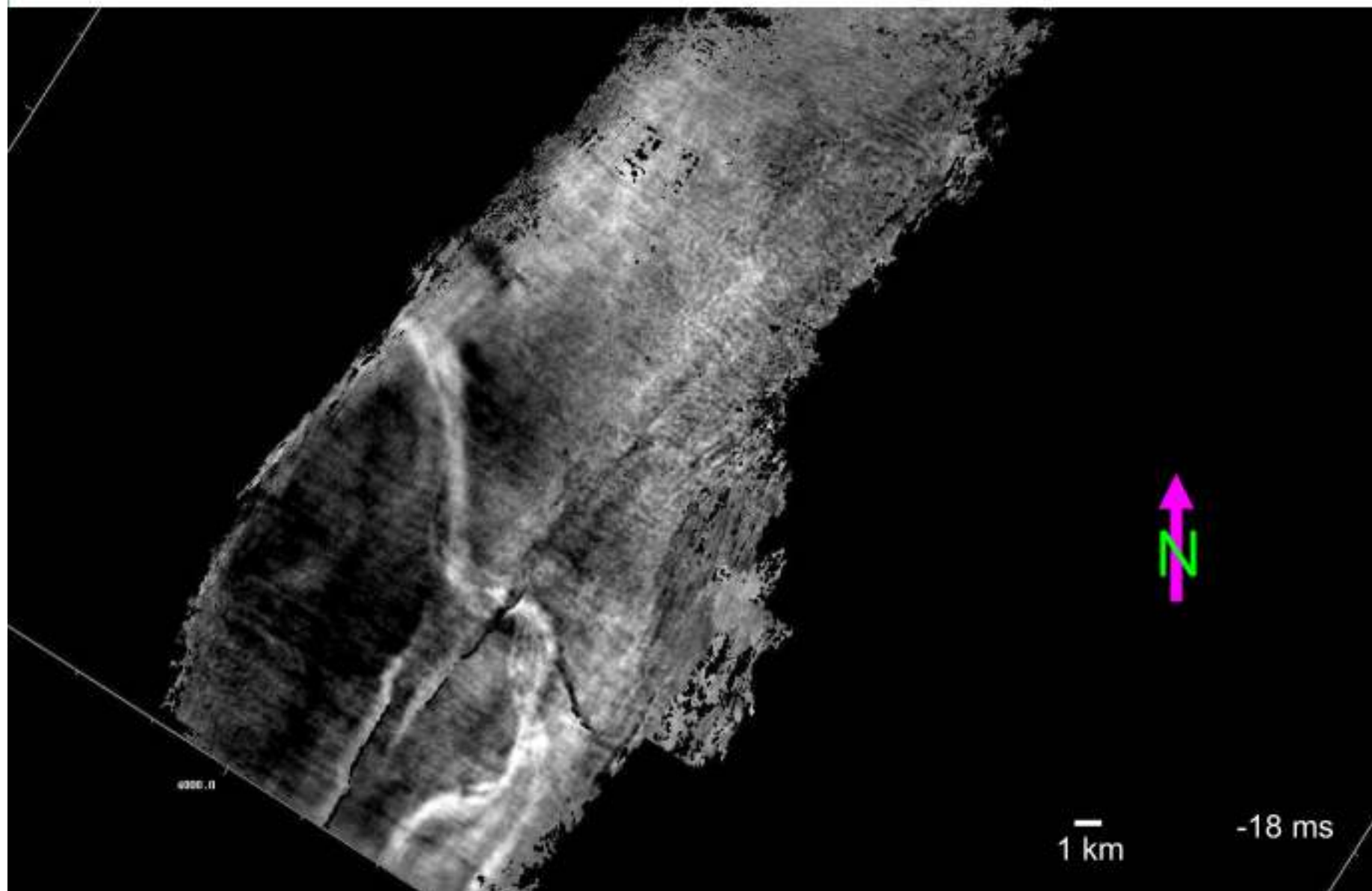
~T200 Leveed Channel



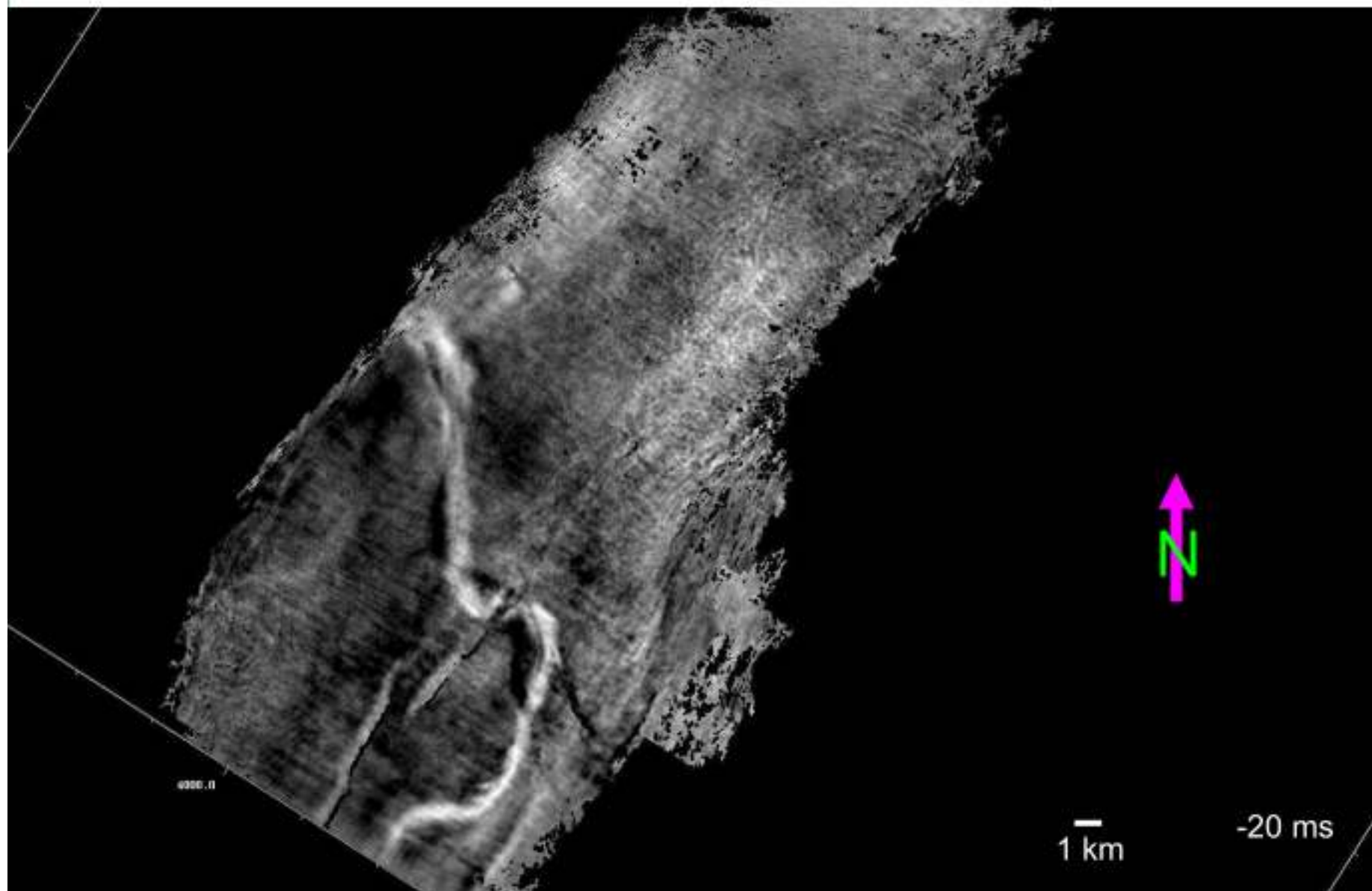
~T200 Leveed Channel



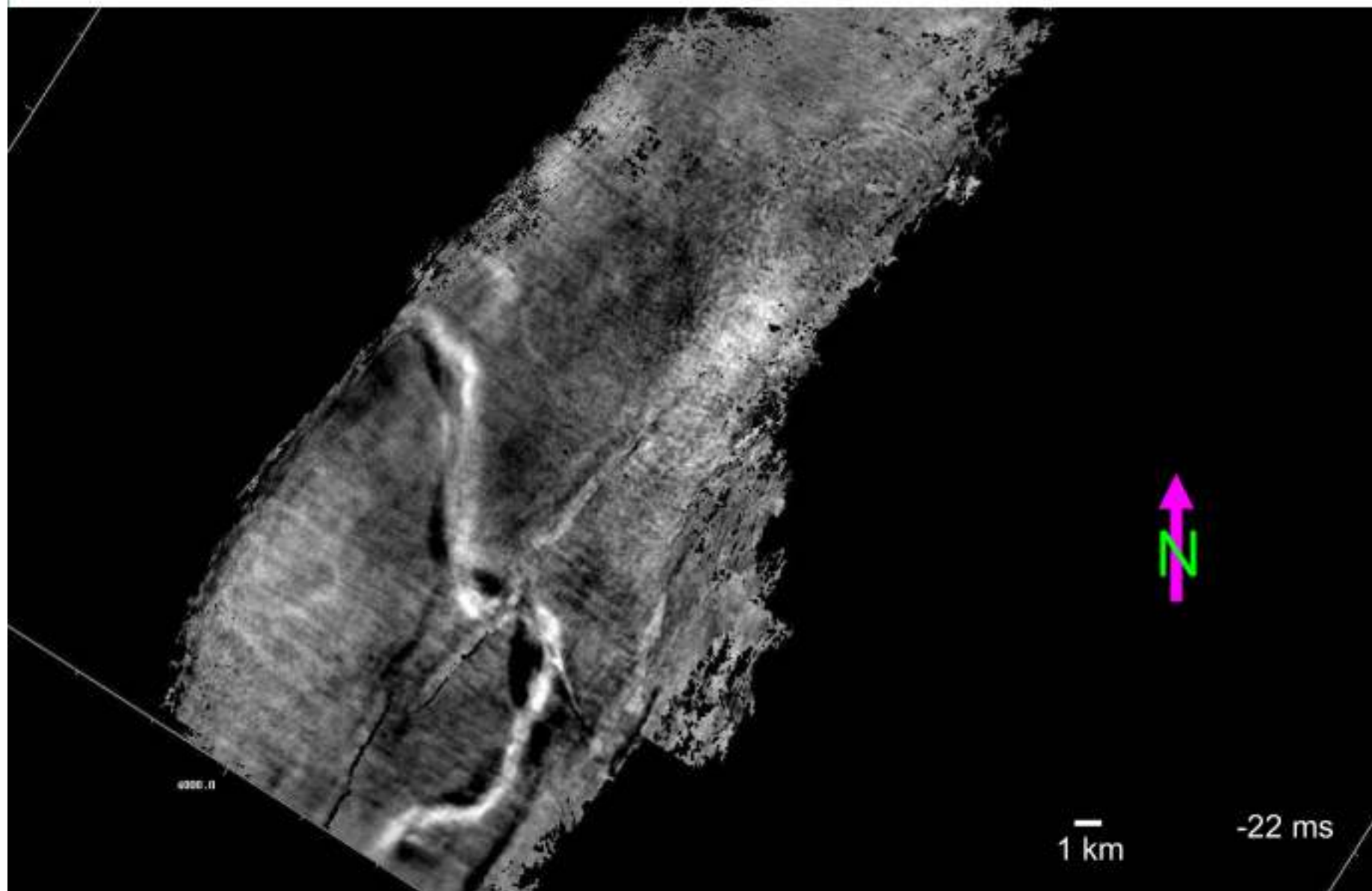
~T200 Leveed Channel



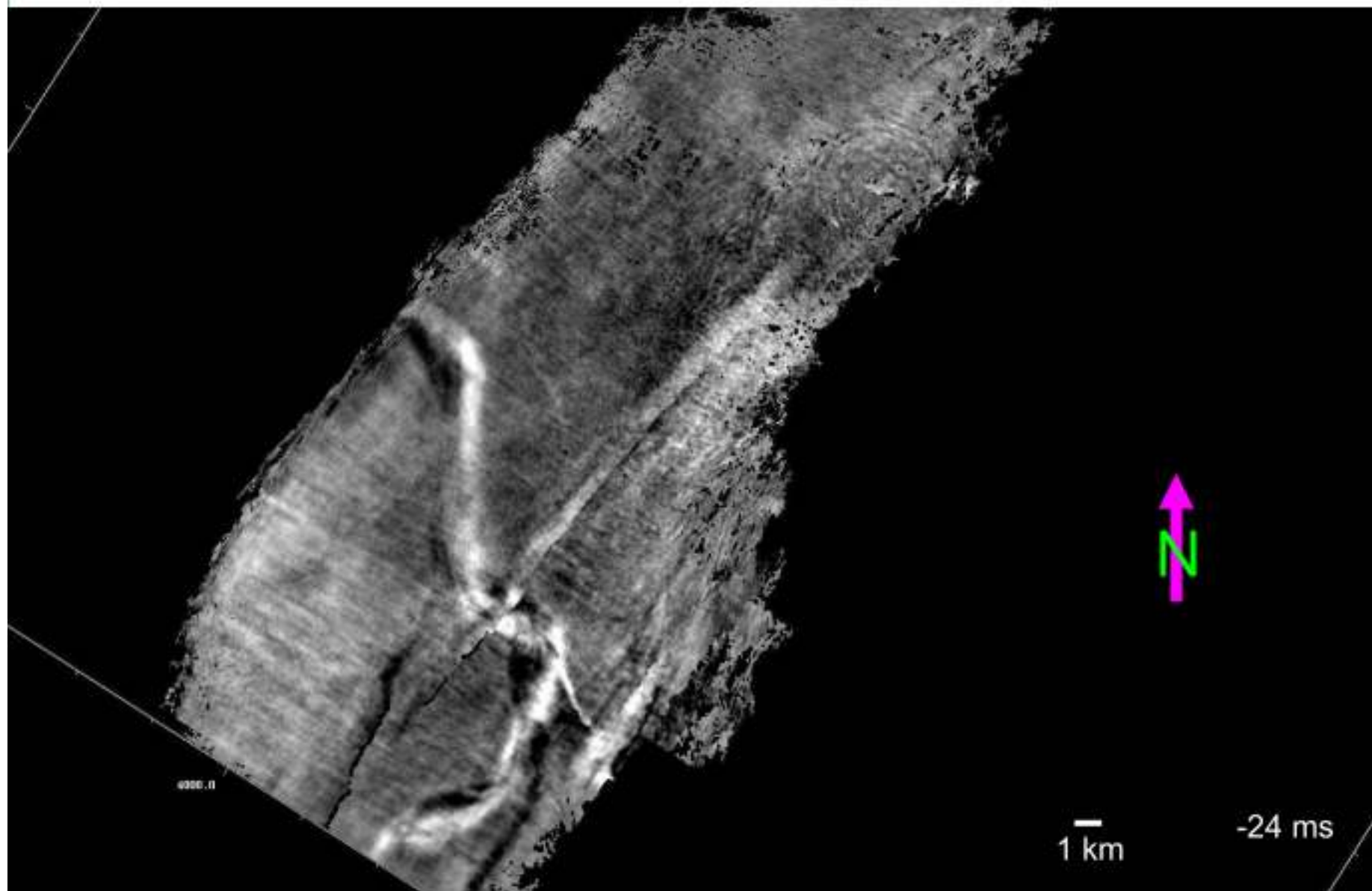
~T200 Leveed Channel



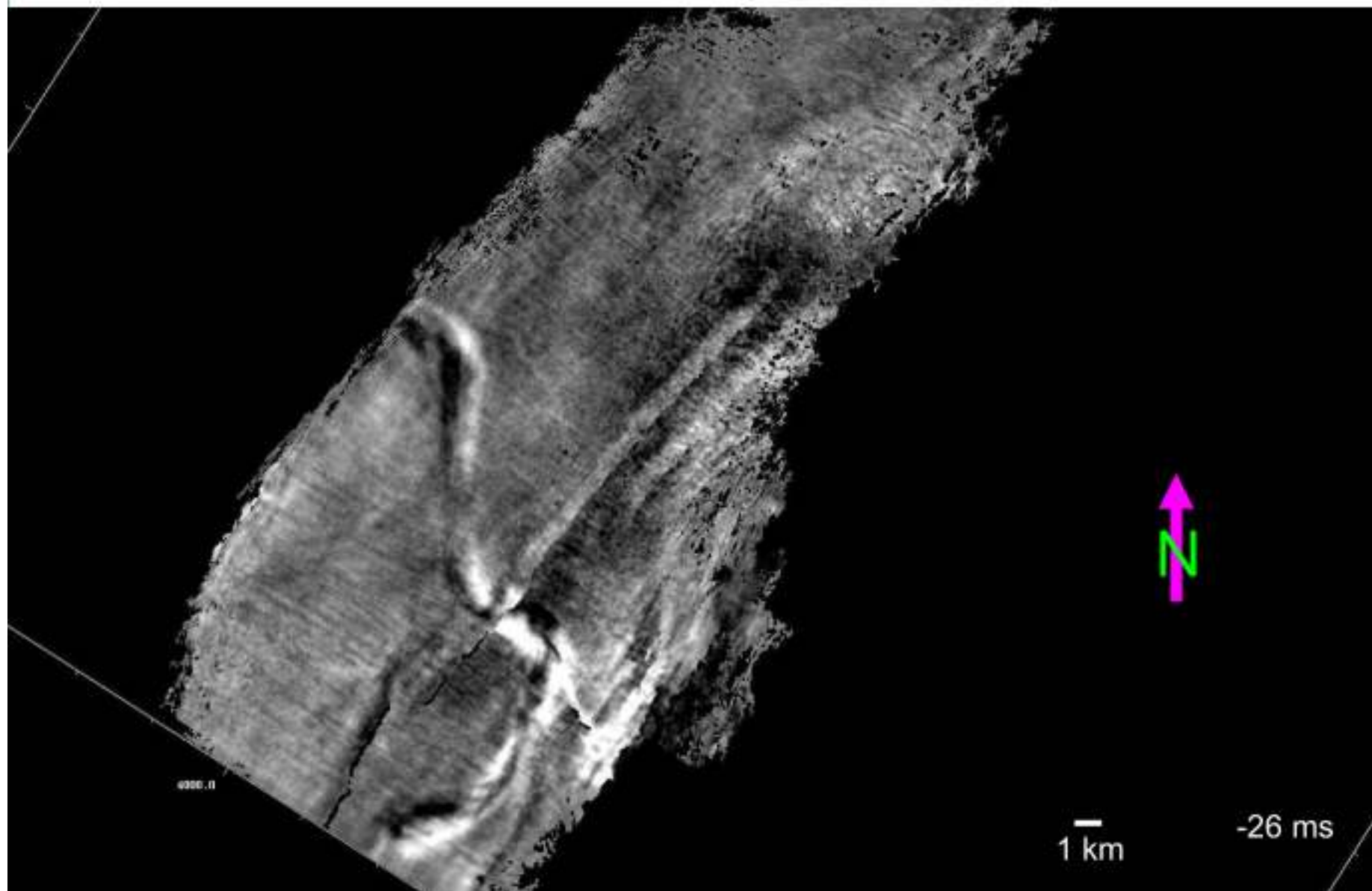
~T200 Leveed Channel



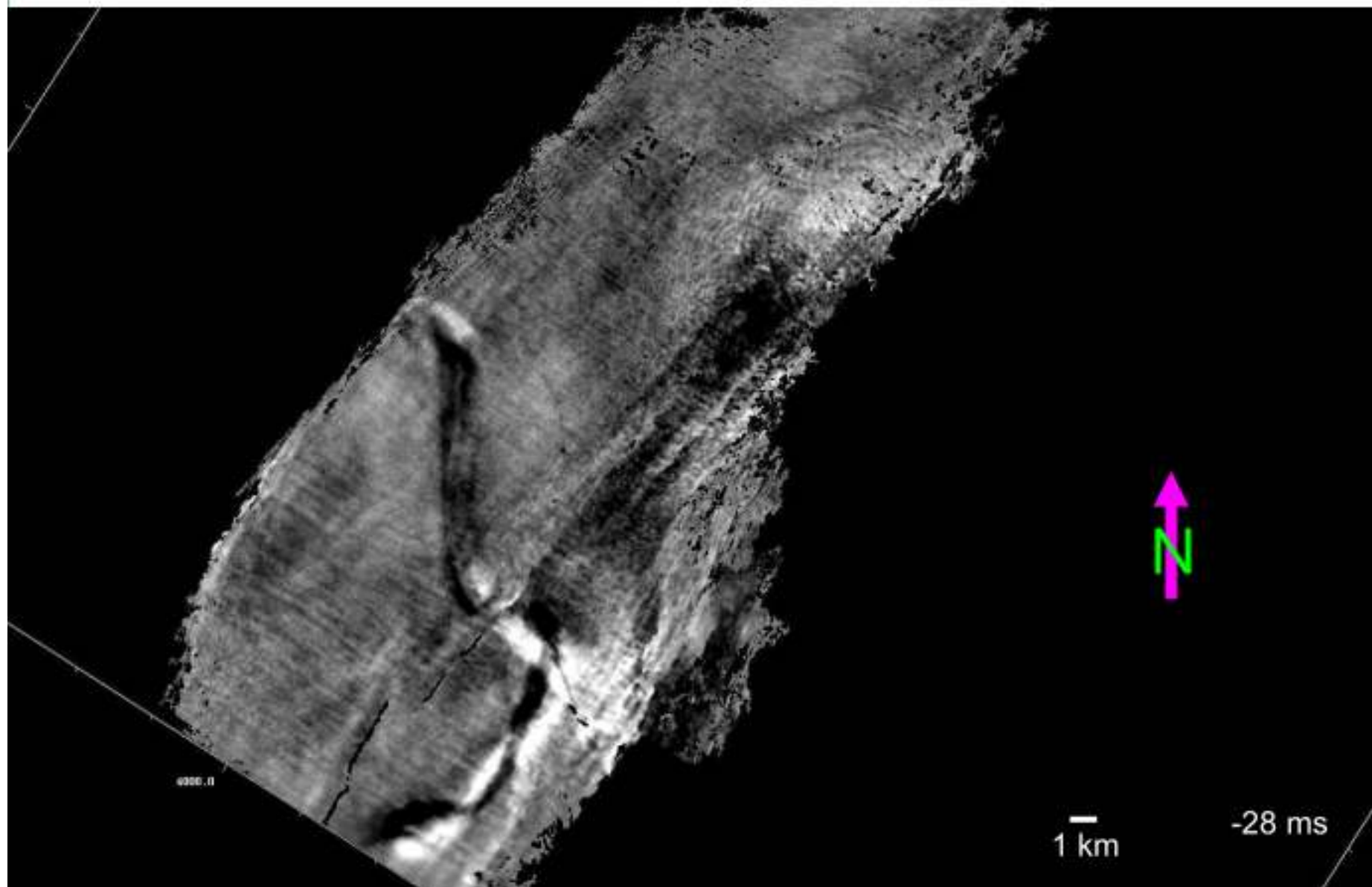
~T200 Leveed Channel



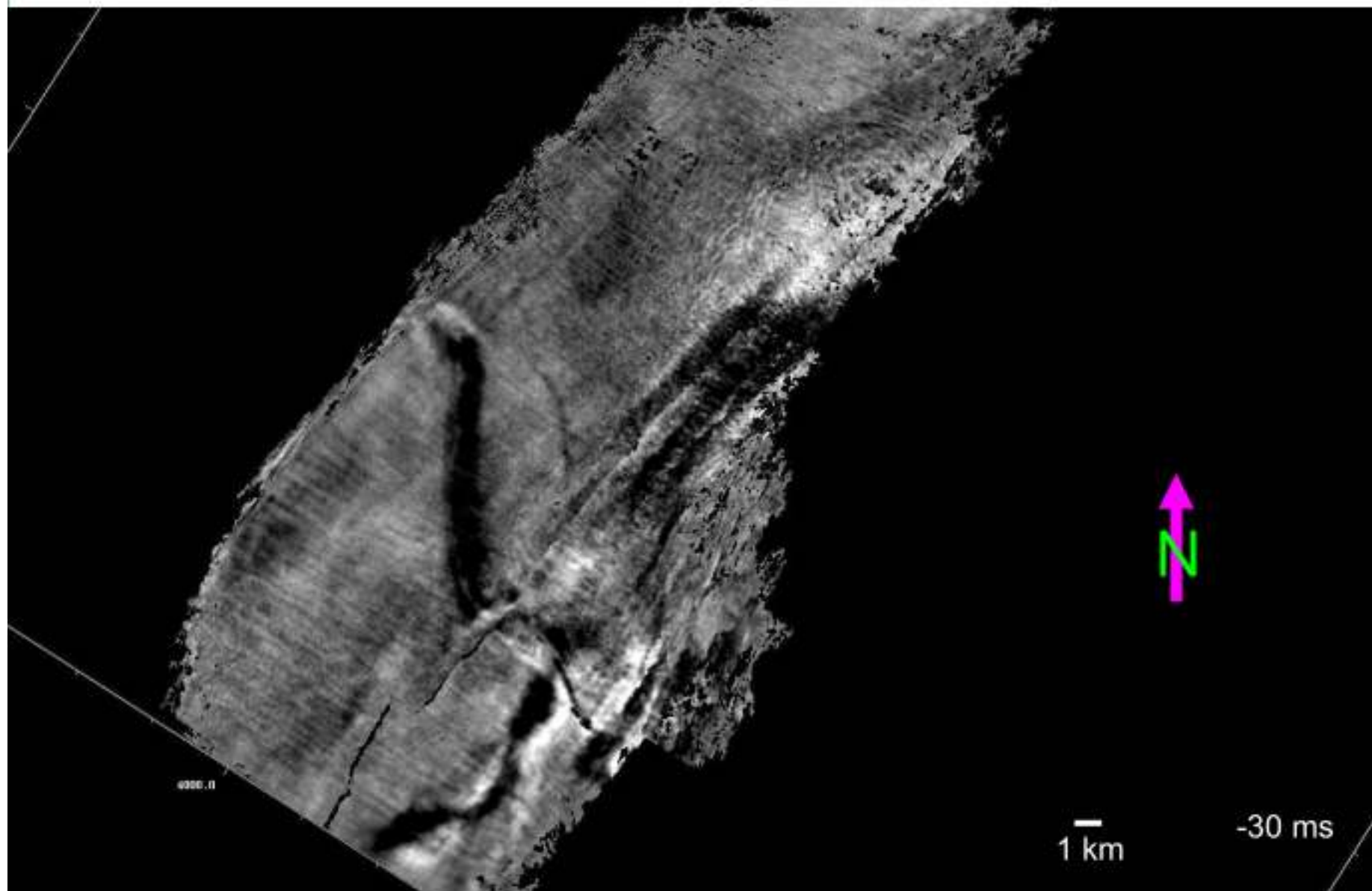
~T200 Leveed Channel

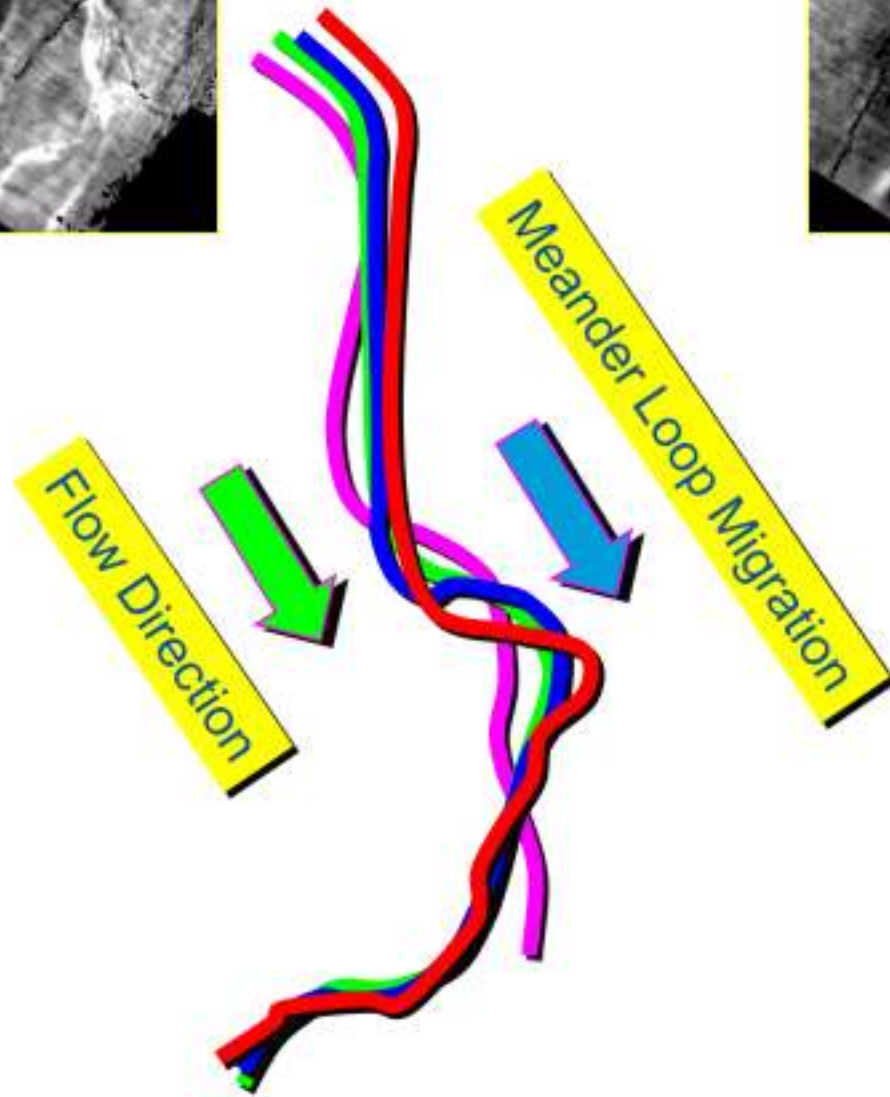
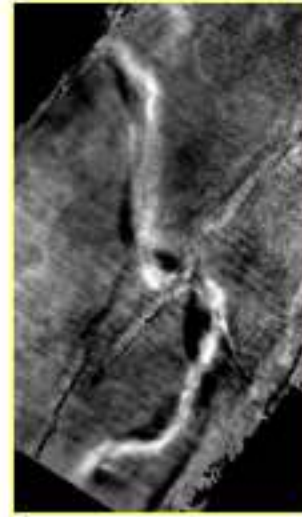
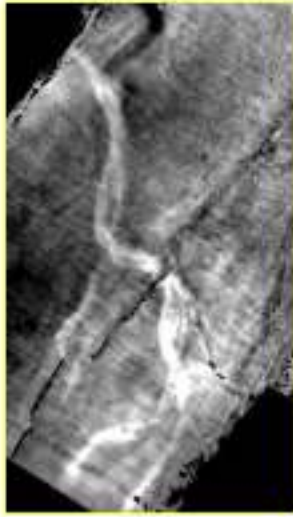
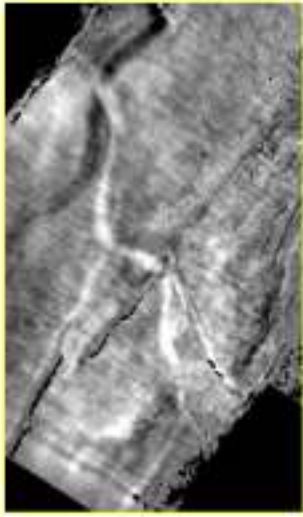


~T200 Leveed Channel

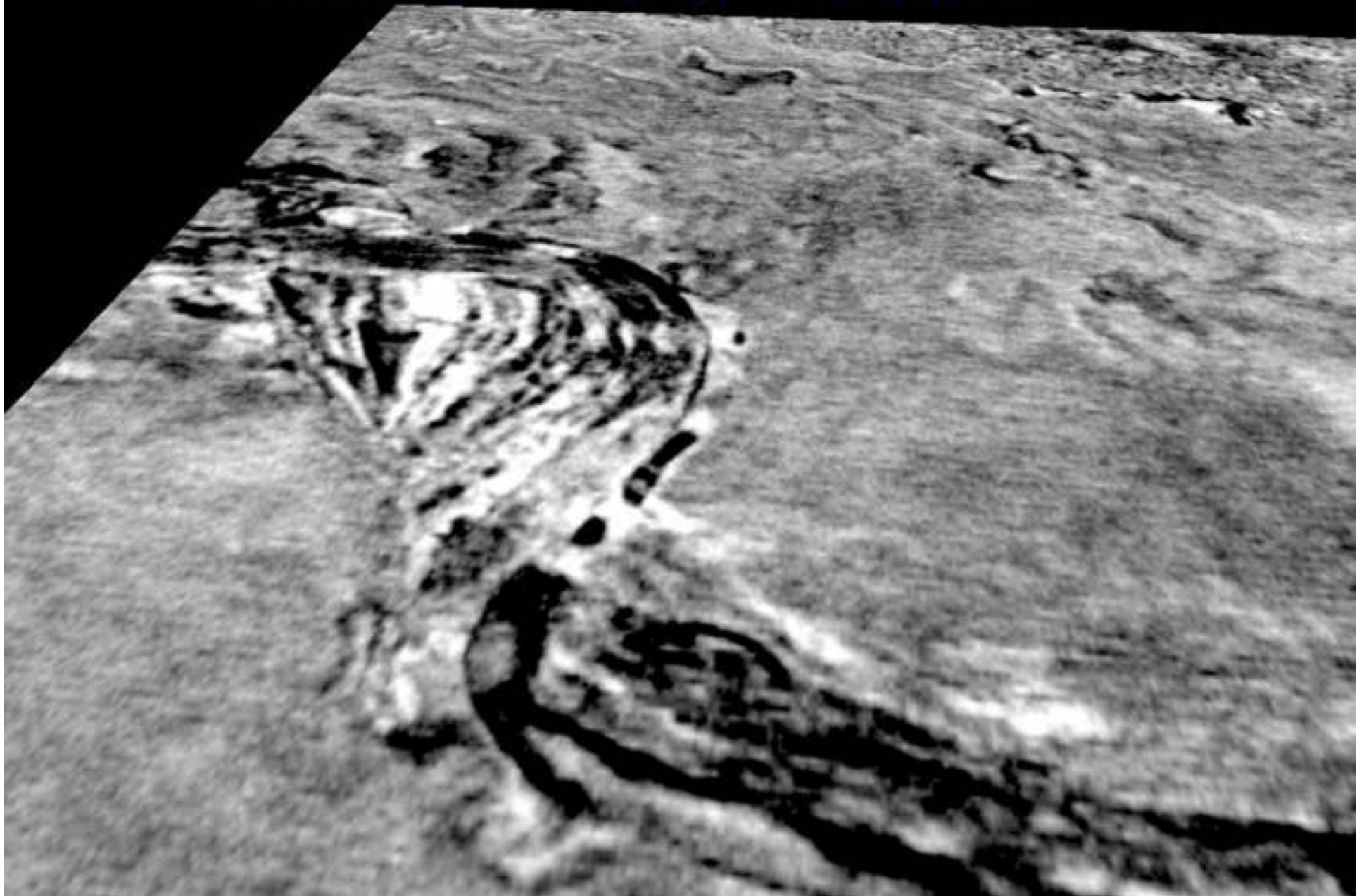


~T200 Leveed Channel

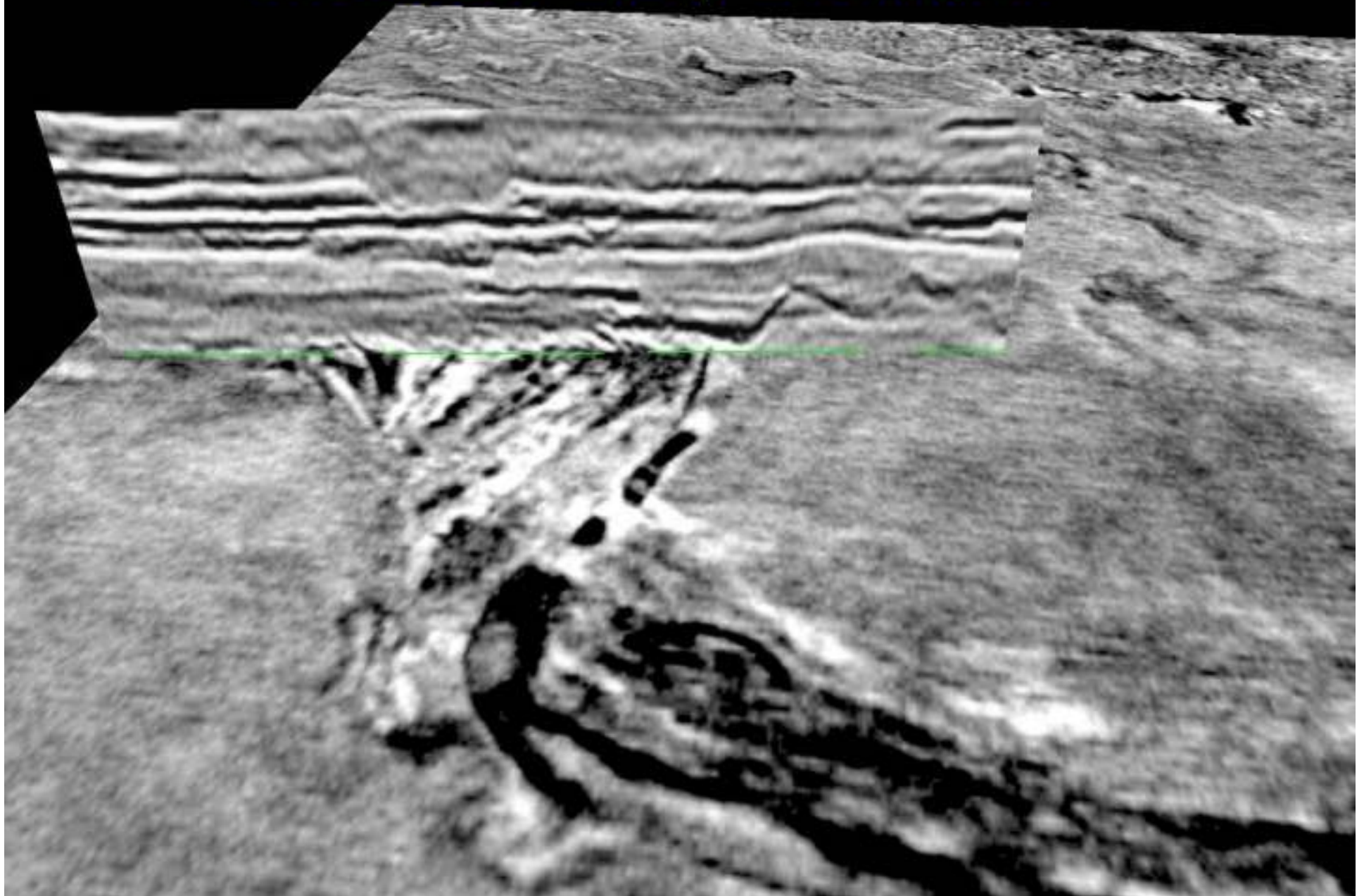




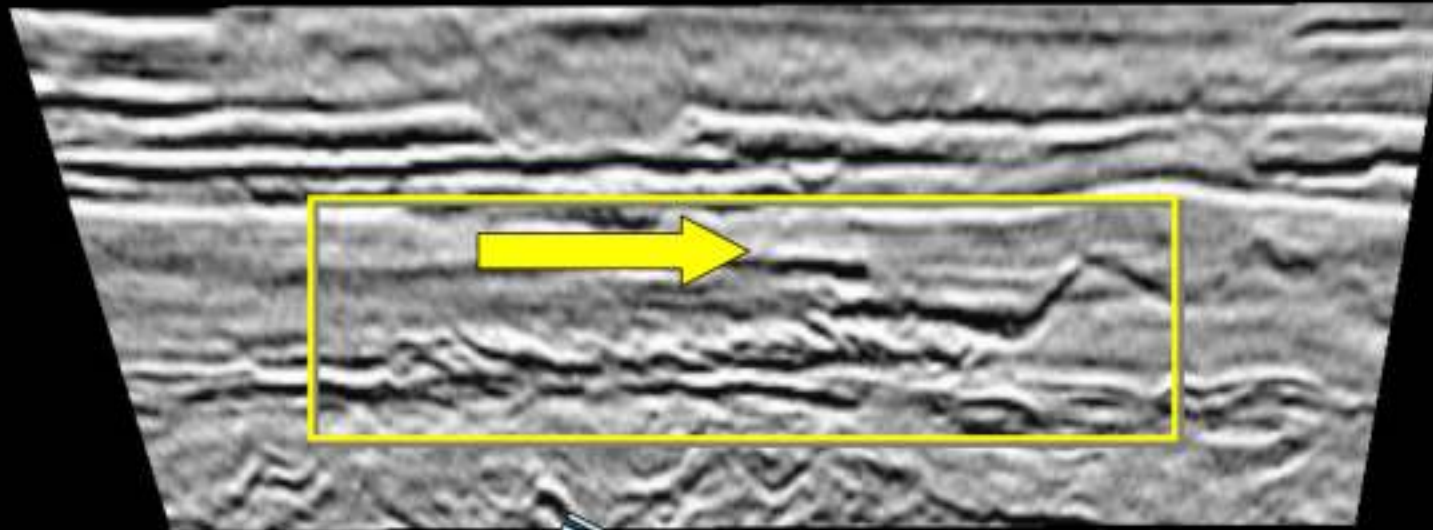
Meander Loop Evolution



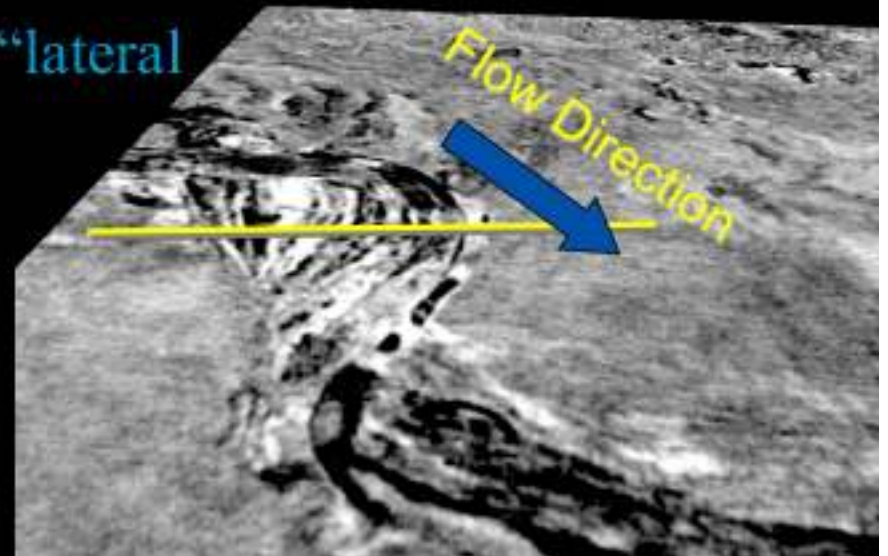
Meander Loop Evolution



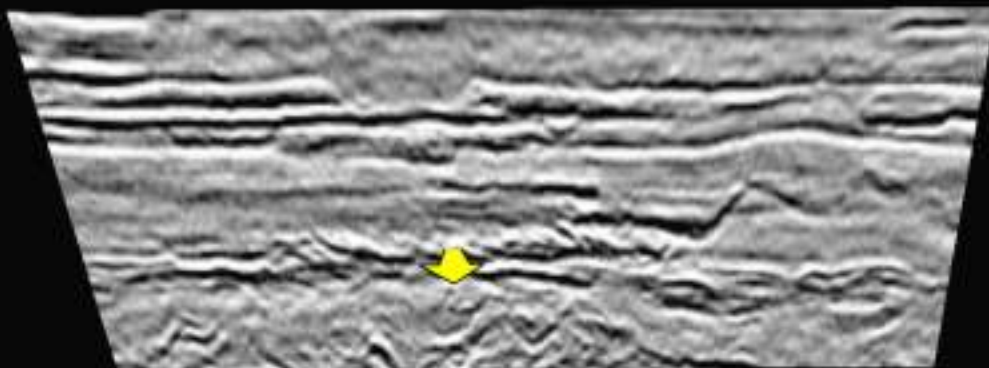
Meander Loop Evolution



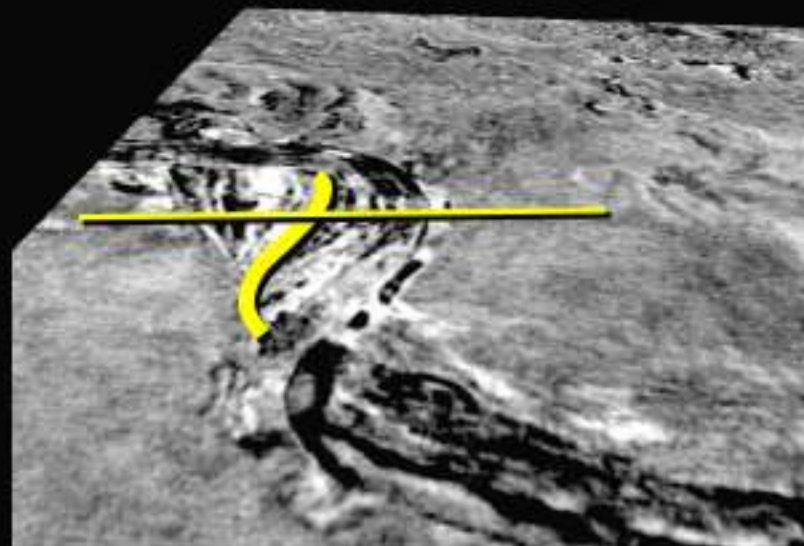
Note **apparent** “lateral accretion”



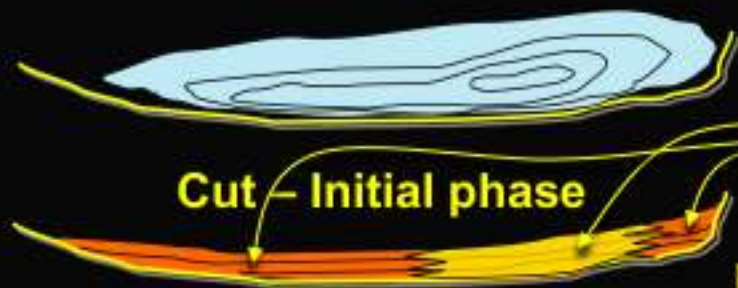
Organized Channel Complex Evolution



Time 1



Flow Velocity Contours



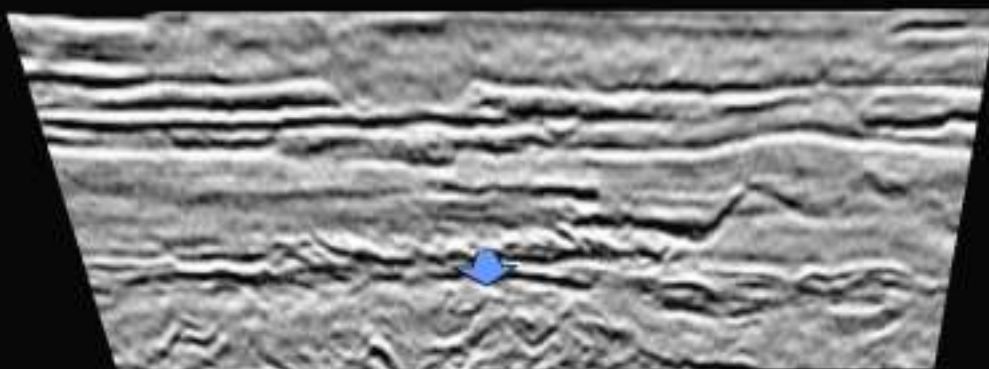
Turbidite Deposits

Axial Facies

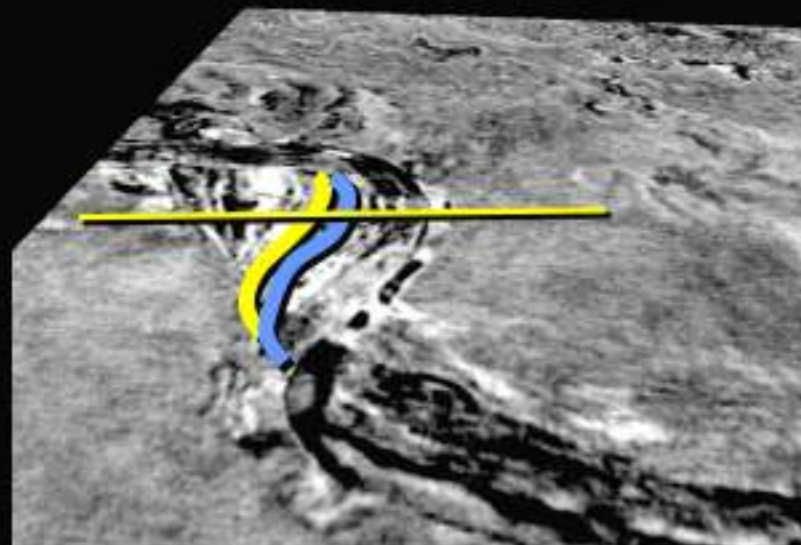
Off-axis to Marginal Facies

Fill - Late phase

Organized Channel Complex Evolution



Time 2



Flow Velocity Contours



Cut – Initial phase

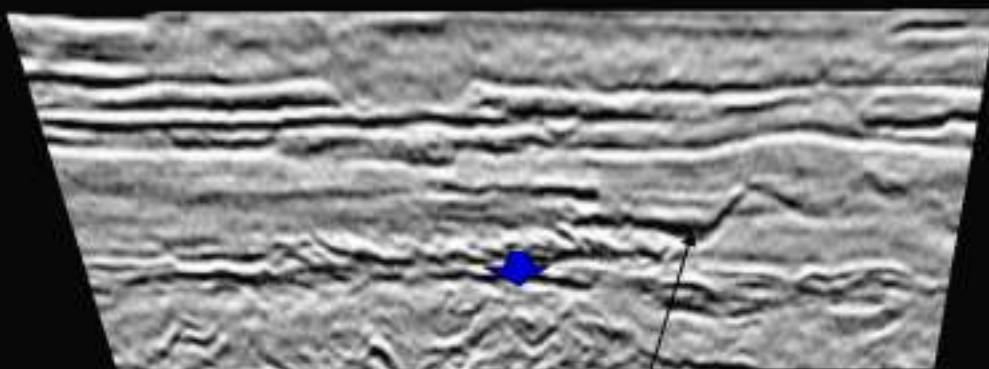


Turbidite Deposits

Note: Axial Facies from Time 1 eroded; only off-axis to marginal preserved

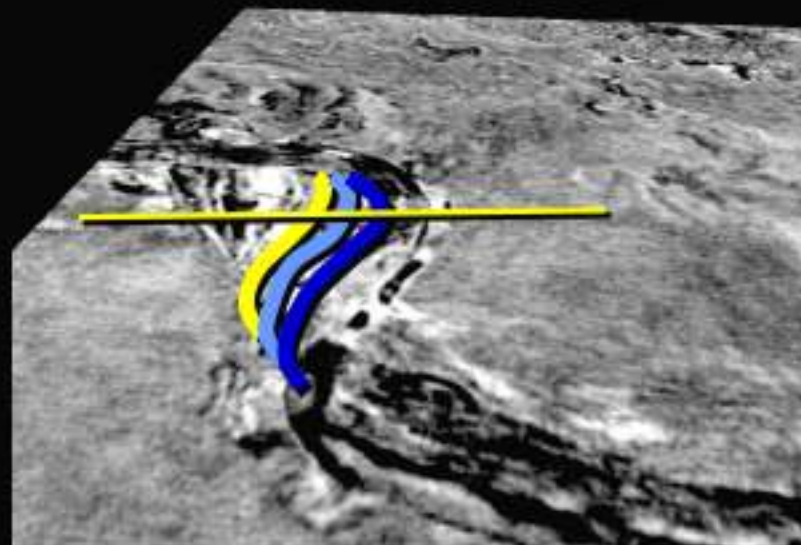
Fill – Late phase

Organized Channel Complex Evolution

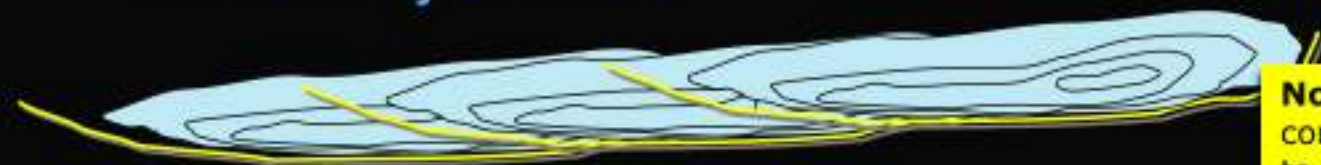


Time 3

Note: Final channel element likely is mud-filled



Flow Velocity Contours



Note: Most of the channel complex is made up of off-axis to marginal facies

Cut – Initial phase

Fill – Late phase

Turbidite Deposits

Slope Valley Channels Drivers

Channel Fill

Channel fill ratio and effect on successive flows



Low fill ratio

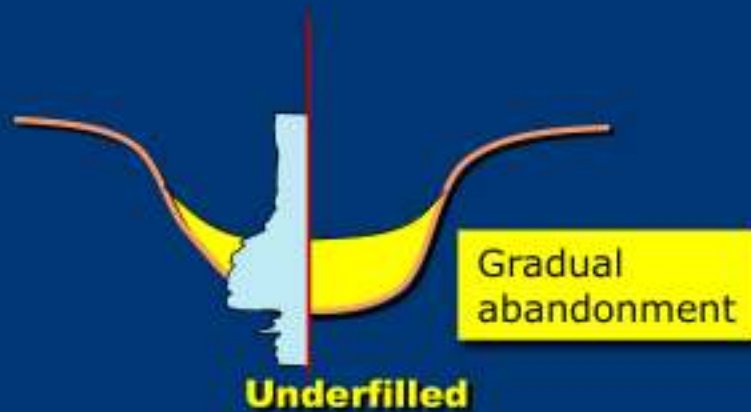
"attracts" successive flows

High fill ratio

"repels" successive flows

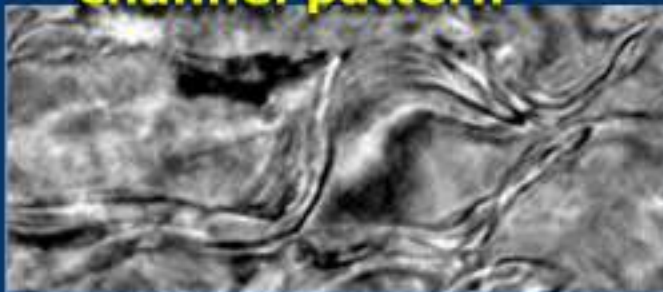
Controls on Channel Patterns (organized vs. disorganized)

Channel element fill at the end of turbidite episode



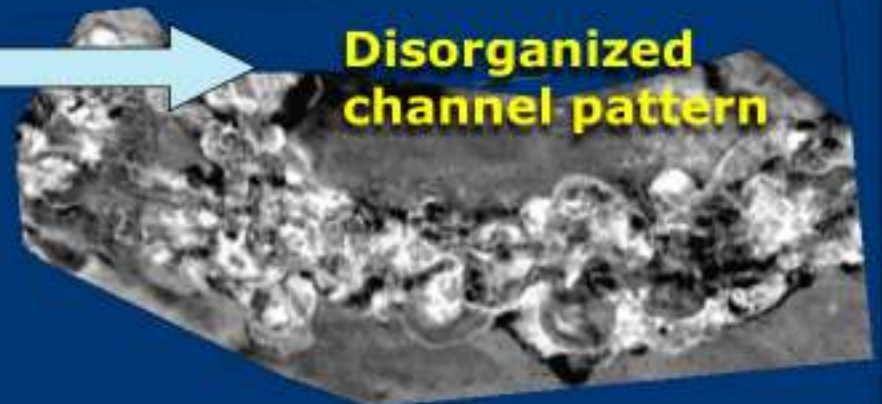
"attracts" successive flows

**Organized
channel pattern**



"repels" successive flows

**Disorganized
channel pattern**



Time 1

Disorganized Channel Complex Evolution

Flow Velocity Contours



Cut – Initial phase



Fill – Late phase

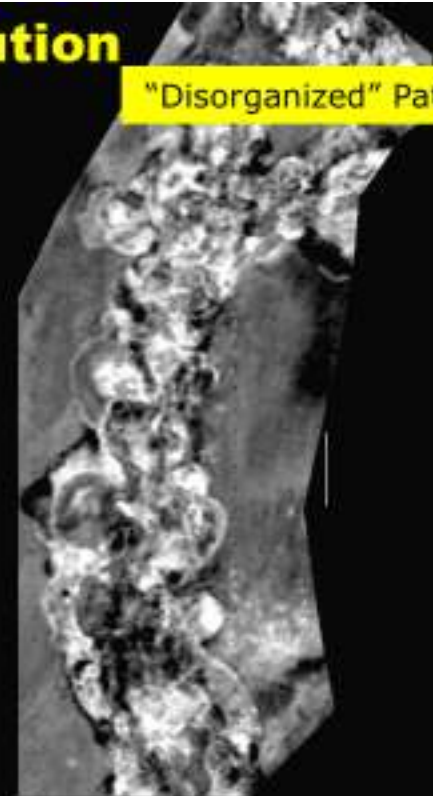
Channel Margin

Channel Axis

Time 2-4



"Disorganized" Pattern



High fill ratio

"repels" successive flows

Time 1

Disorganized Channel Complex Evolution

Flow Velocity Contours



Cut – Initial phase



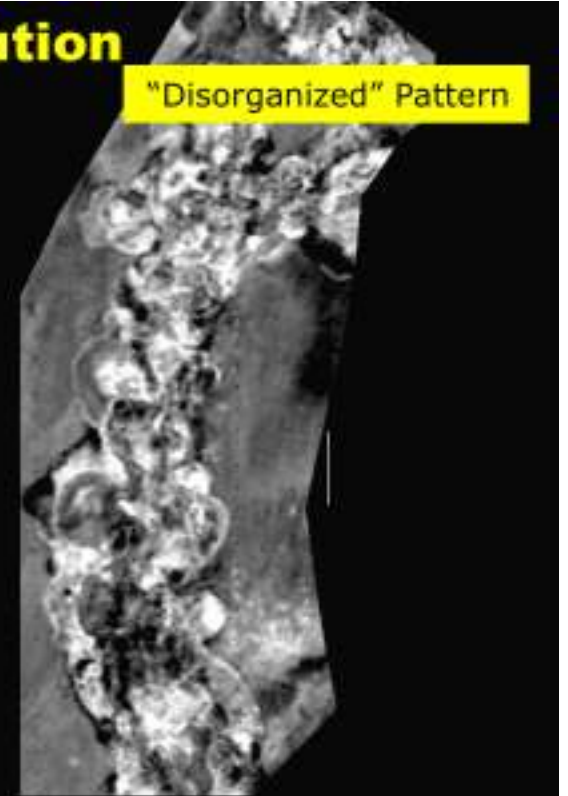
Fill – Late phase

Channel Axis

Time 2-4



"Disorganized" Pattern



High fill ratio

"repels" successive flows

Time 1

Disorganized Channel Complex Evolution

Flow Velocity Contours



Cut – Initial phase



Fill – Late phase

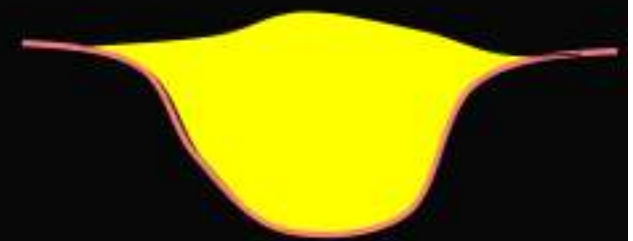
Channel Margin

Channel Axis

Time 2-4



"Disorganized" Pattern



High fill ratio

"repels" successive flows

Time 1

Disorganized Channel Complex Evolution

Flow Velocity Contours



Cut – Initial phase



Channel Margin

Channel Axis

Time 2-4



Note: Preferential preservation of channel axis deposits

"Disorganized" Pattern



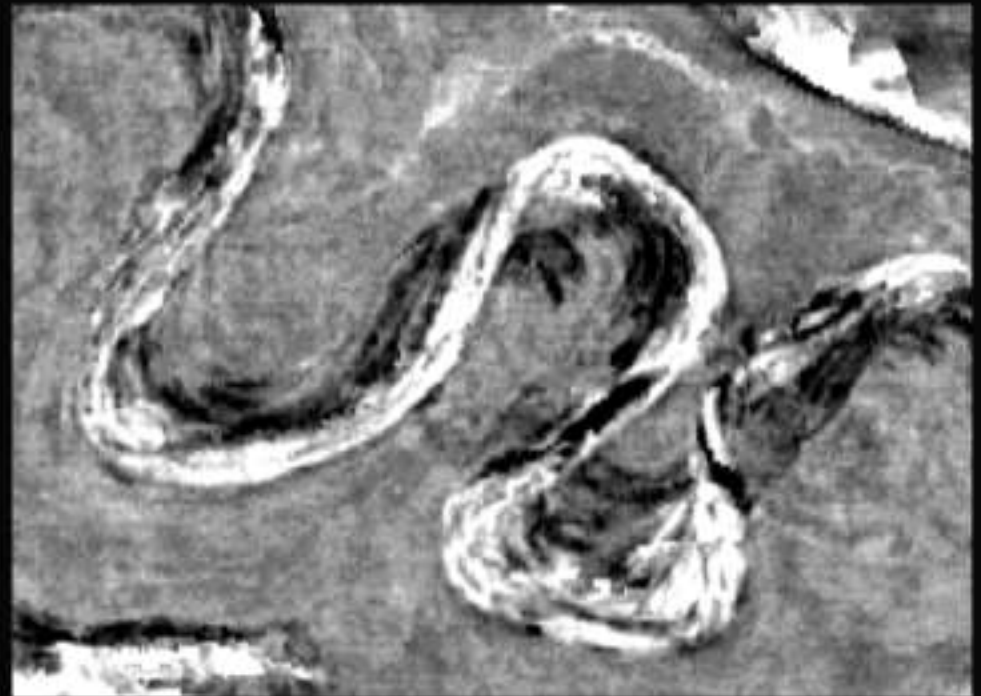
High fill ratio

"repels" successive flows

Slope Valley Channels Observations

"Organized" vs. "Disorganized"

Disorganized



Organized
(Low fill ratio)

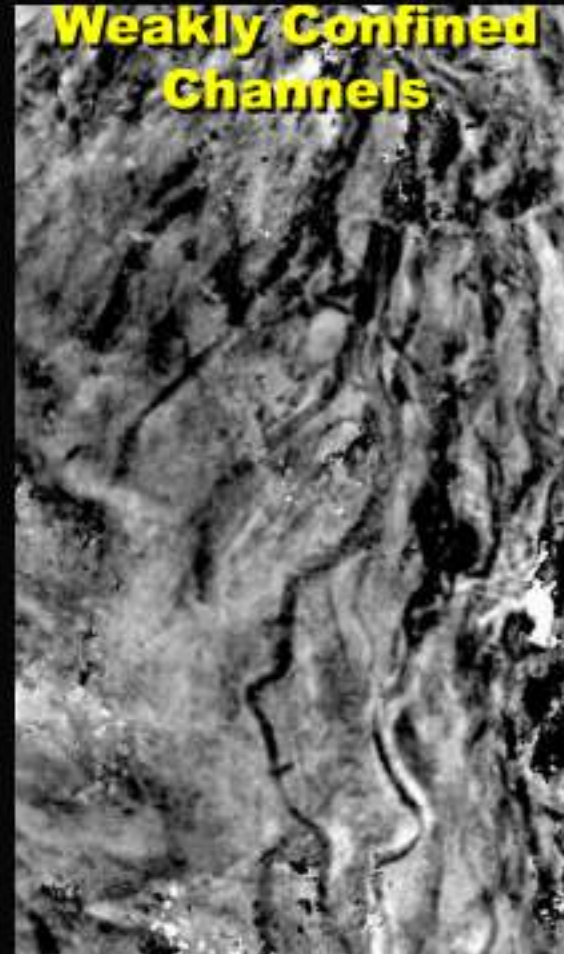
Note the difference between disorganized and weakly confined channels

Disorganized Channels



- Characterized by discontinuous channel segments
- Can be described as a "channel belt"
- Commonly constrained by levee or slope-valley walls

Weakly Confined Channels



- Characterized by generally lower sinuosity
- Typically spread over a broader area

Organized vs. Disorganized Channel Complexes - Summary

Disorganized



- Preferential preservation of channel axis facies
- Sharp-based as well as sharp topped sandstones

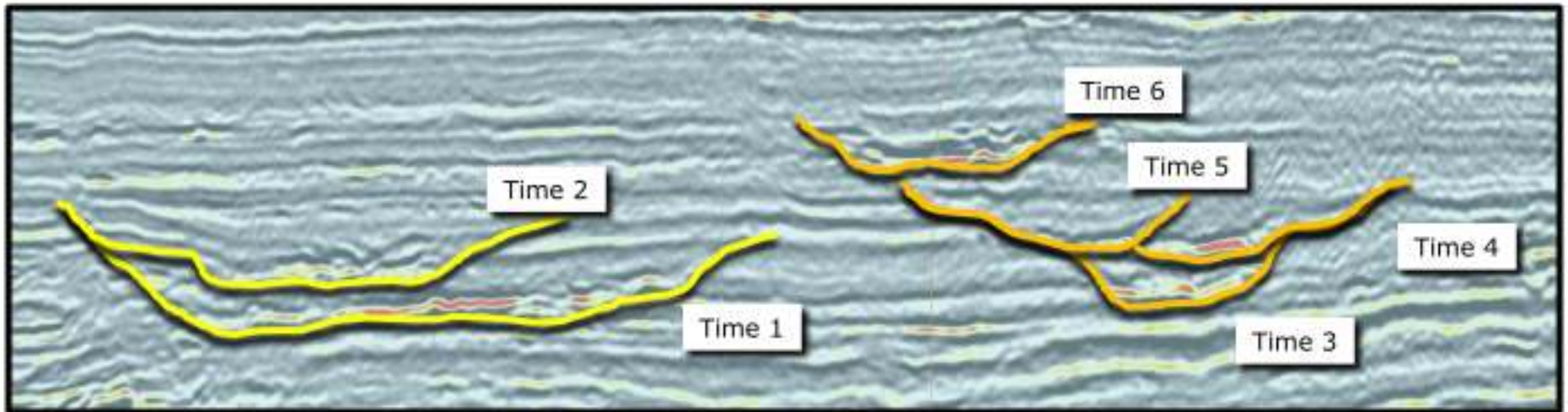
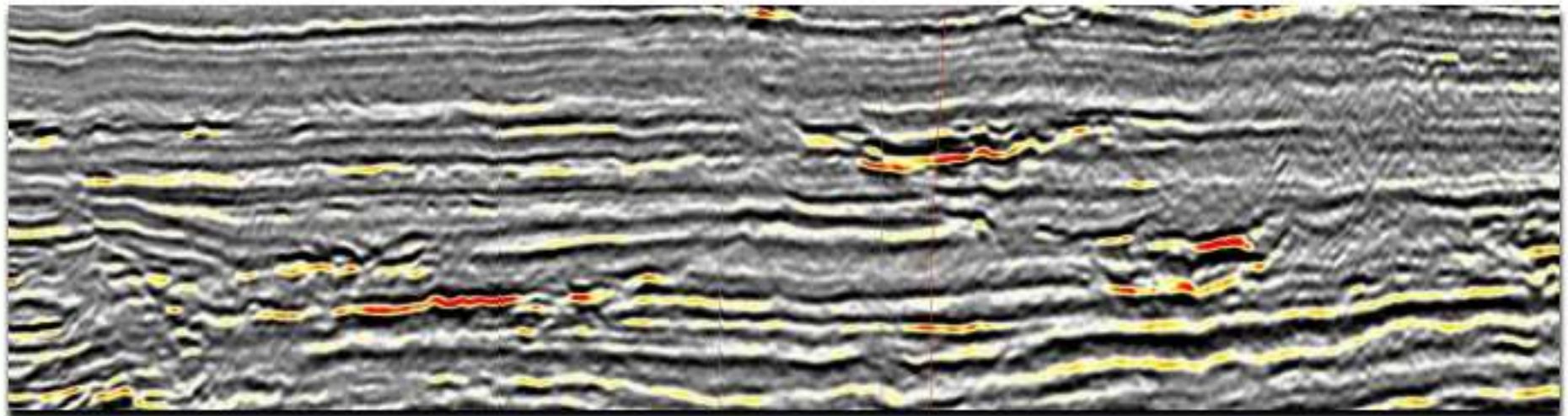
Organized



- Preferential preservation of channel margin to off-axis facies
- Sharp based and gradational-topped sandstone

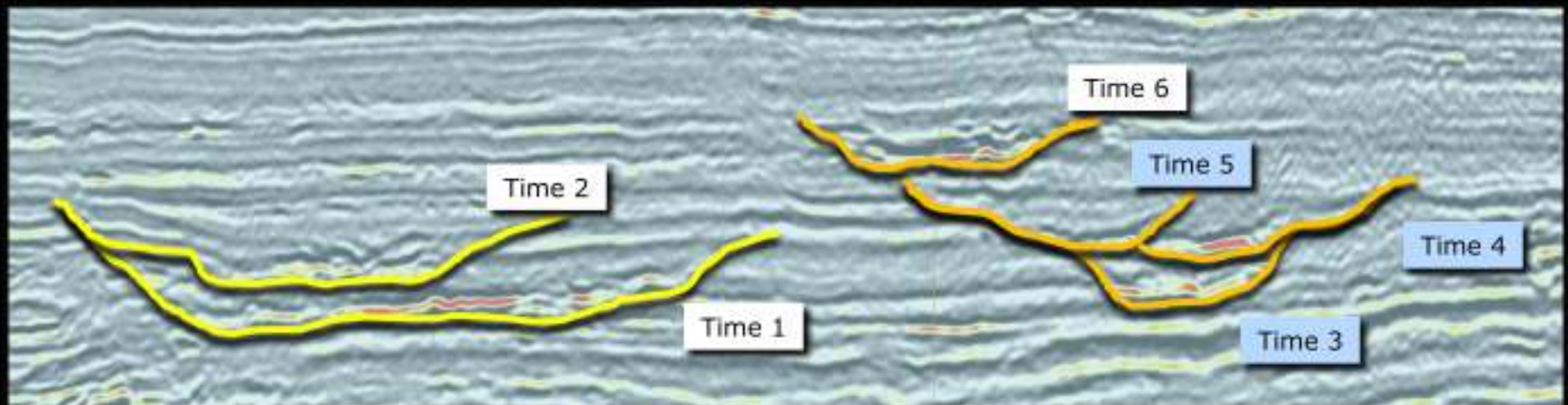
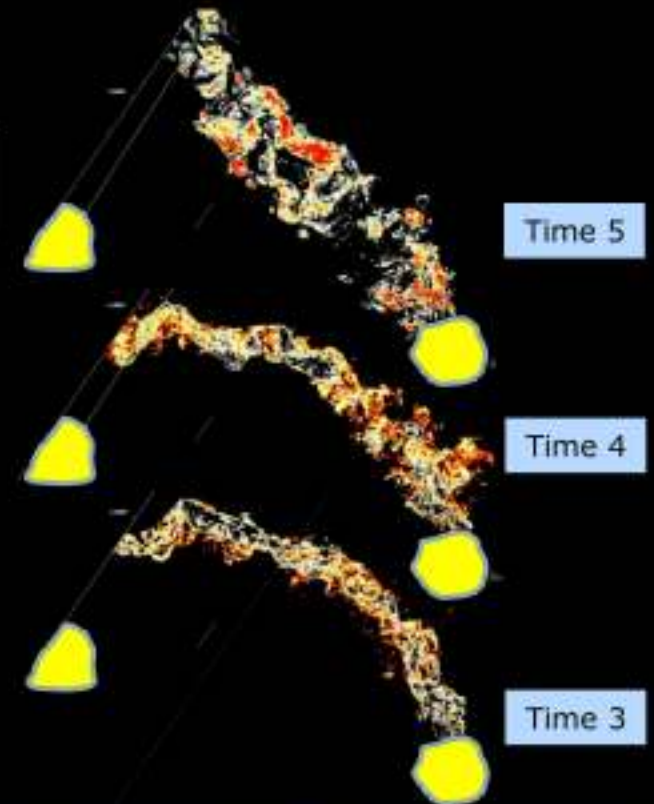
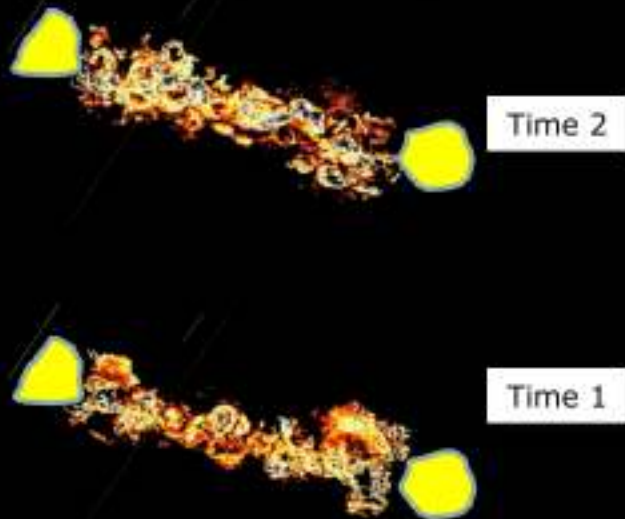
West Africa

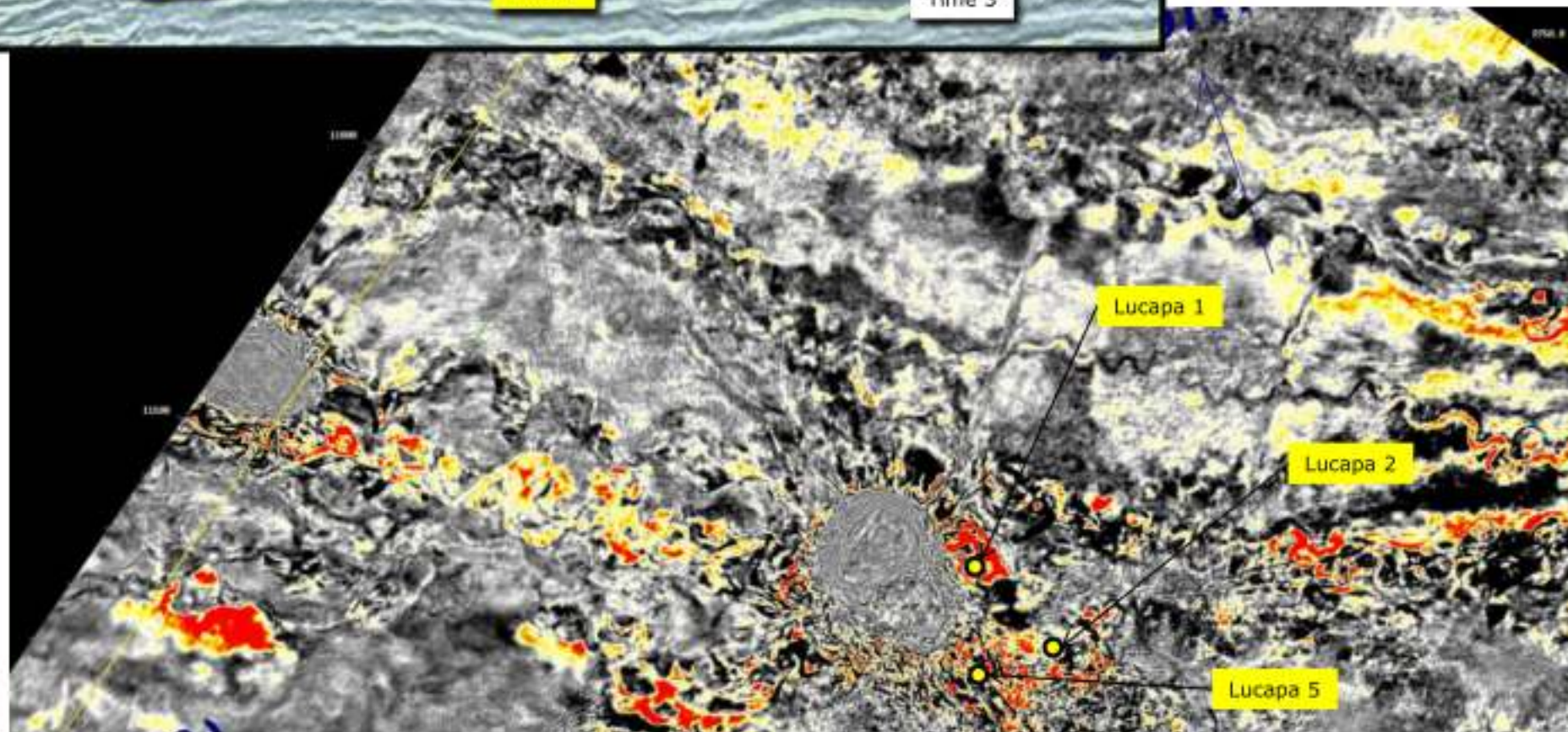
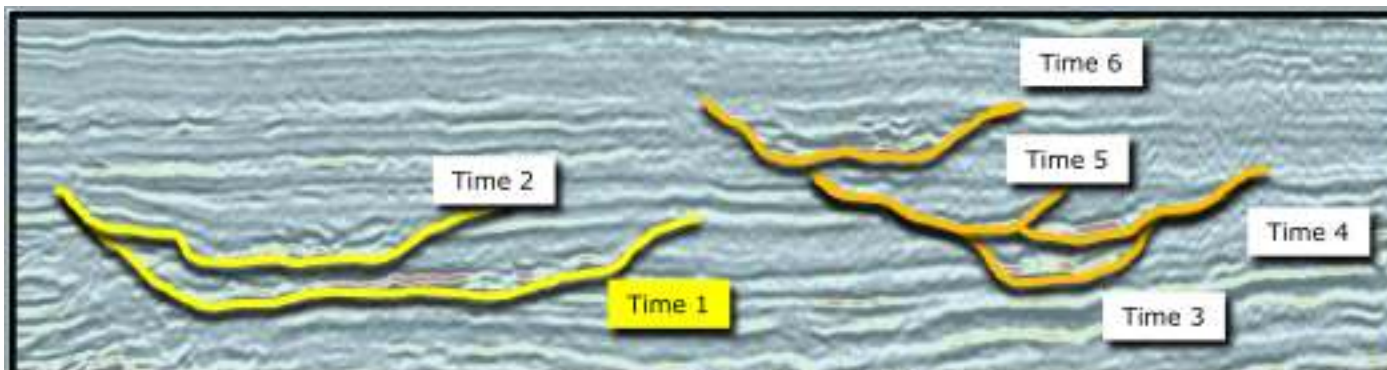
"Slope Valley" Architecture – each containing channel complexes



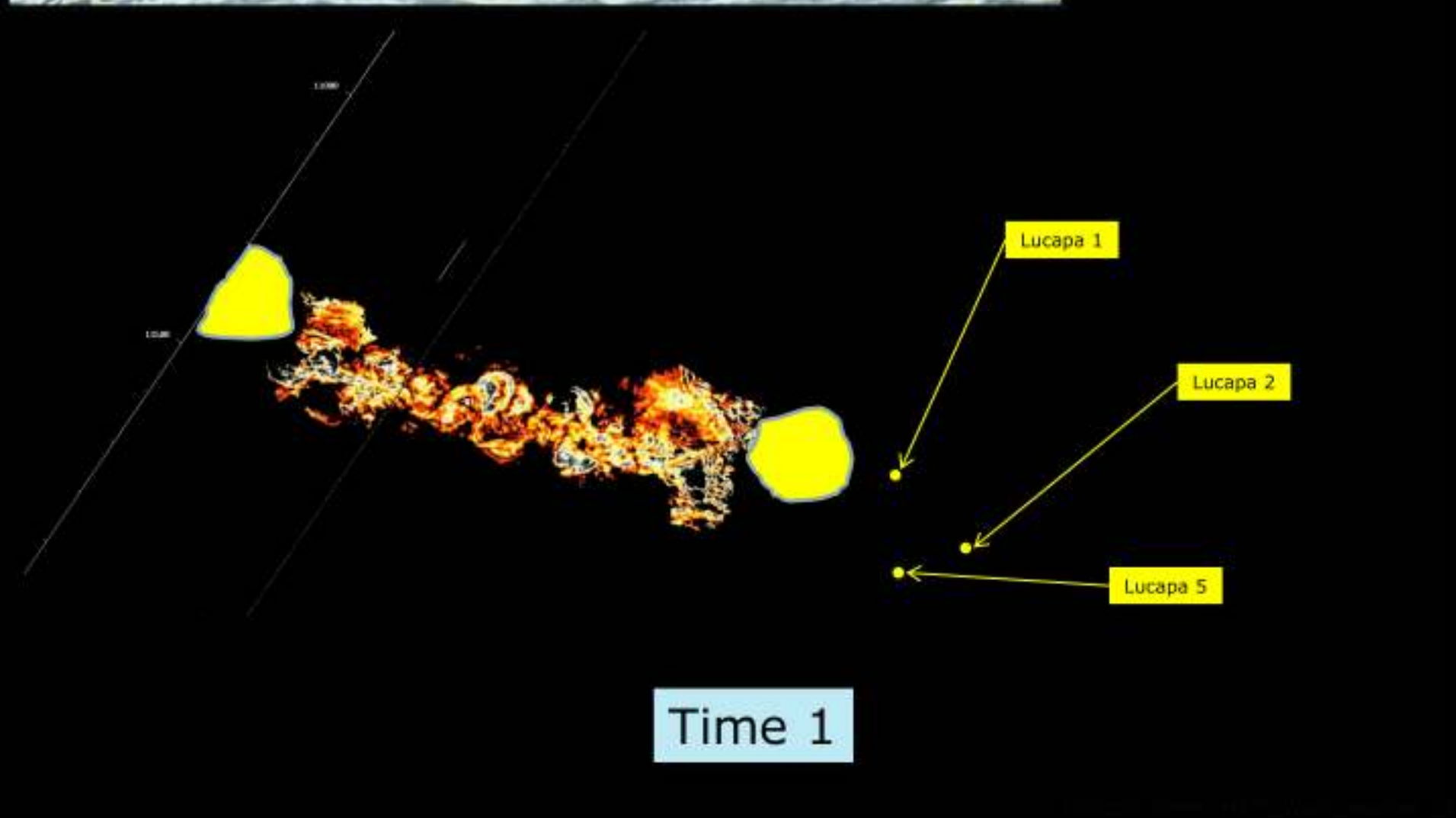
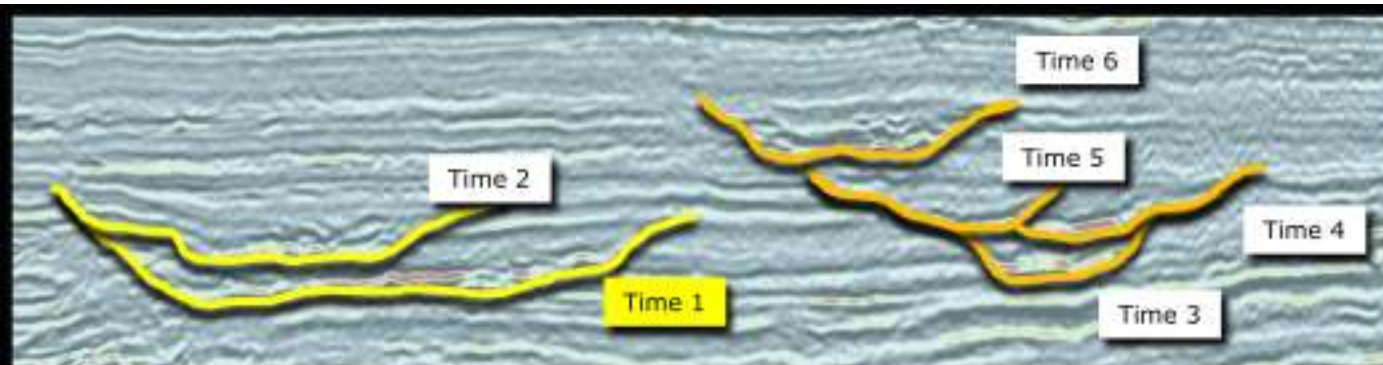
"Slope Valley" Architecture

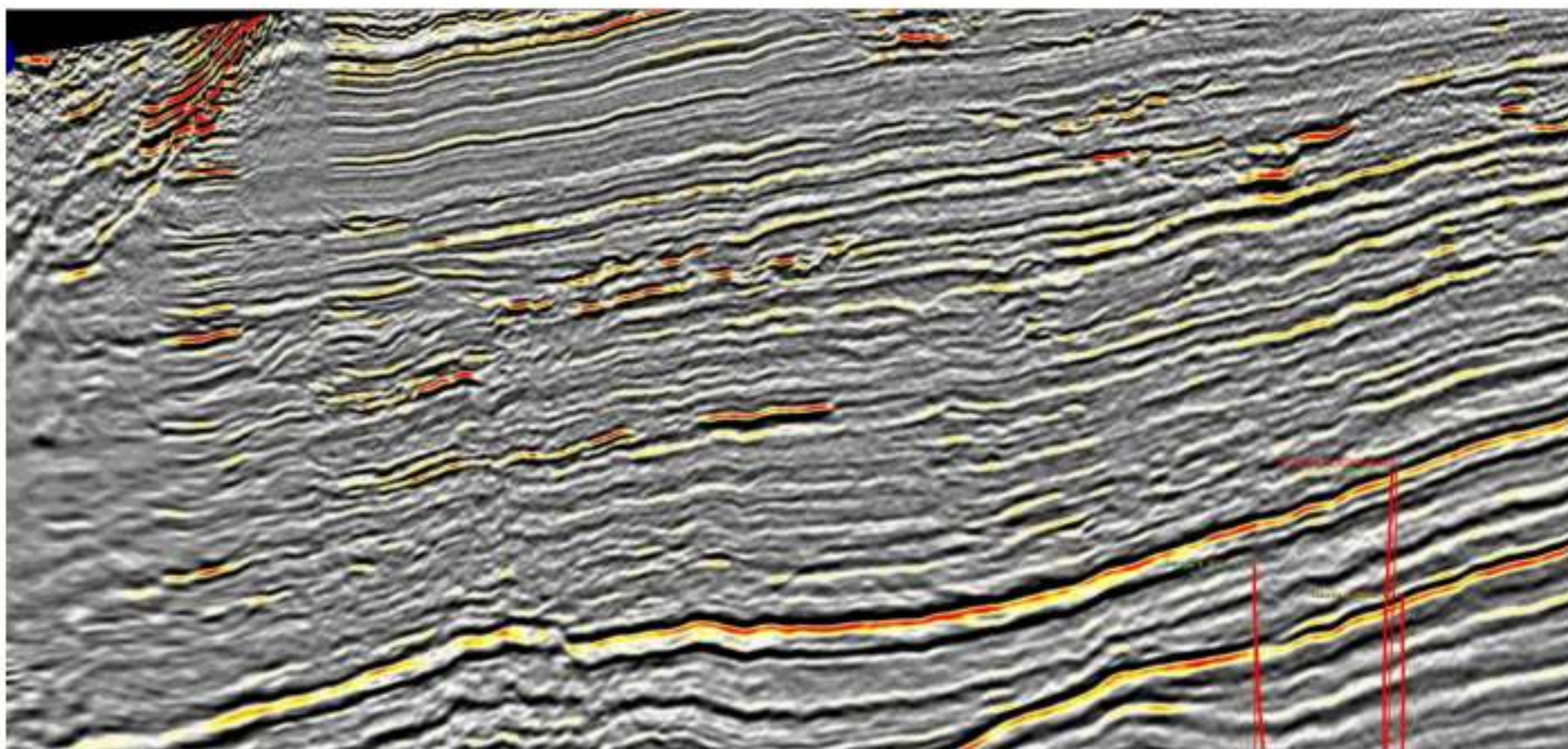
Note that successive slope valleys follow similar paths



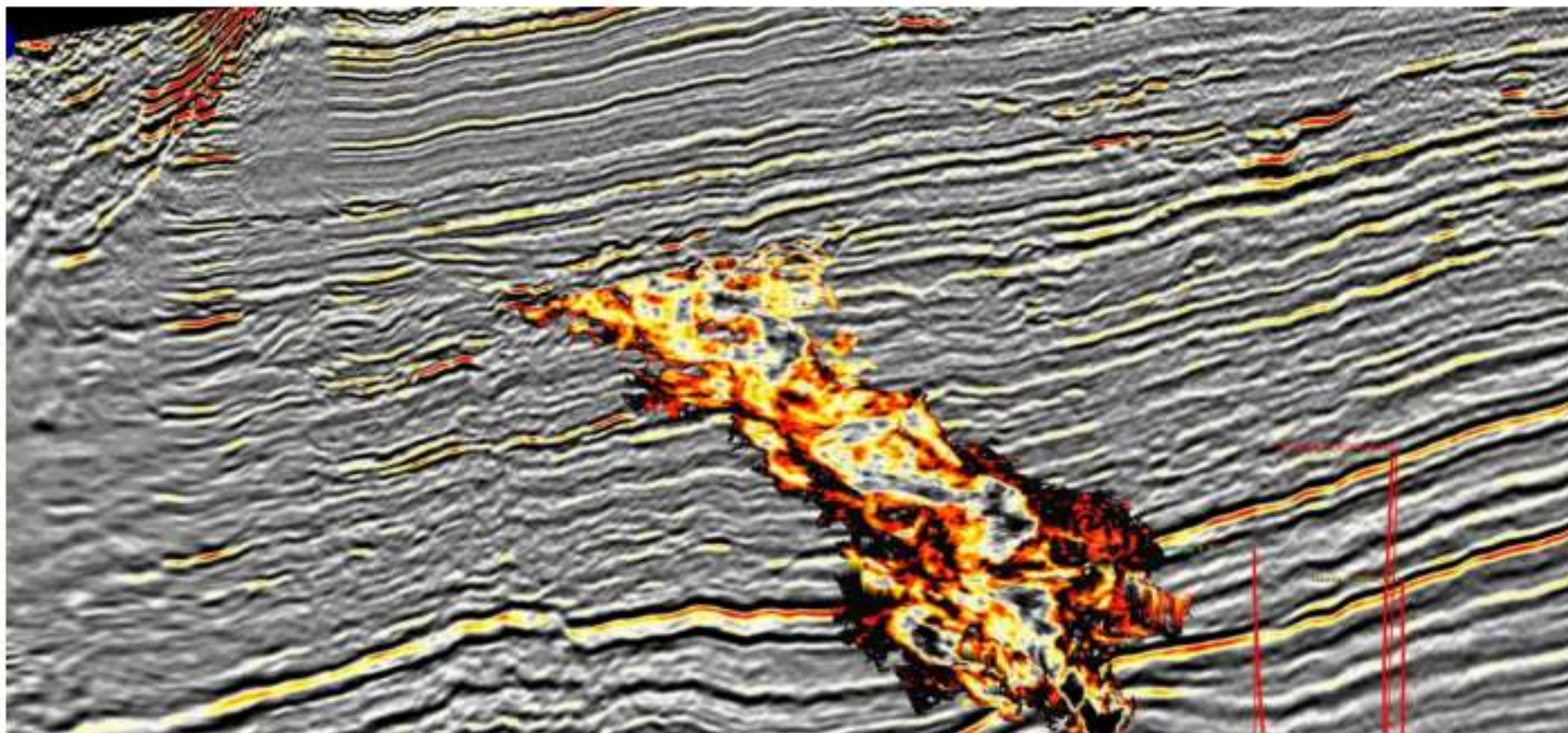


Time 1



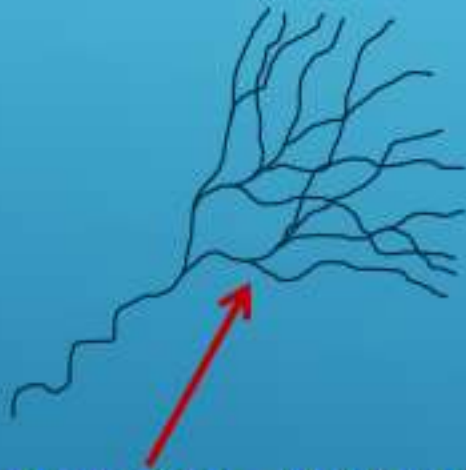


Time 1

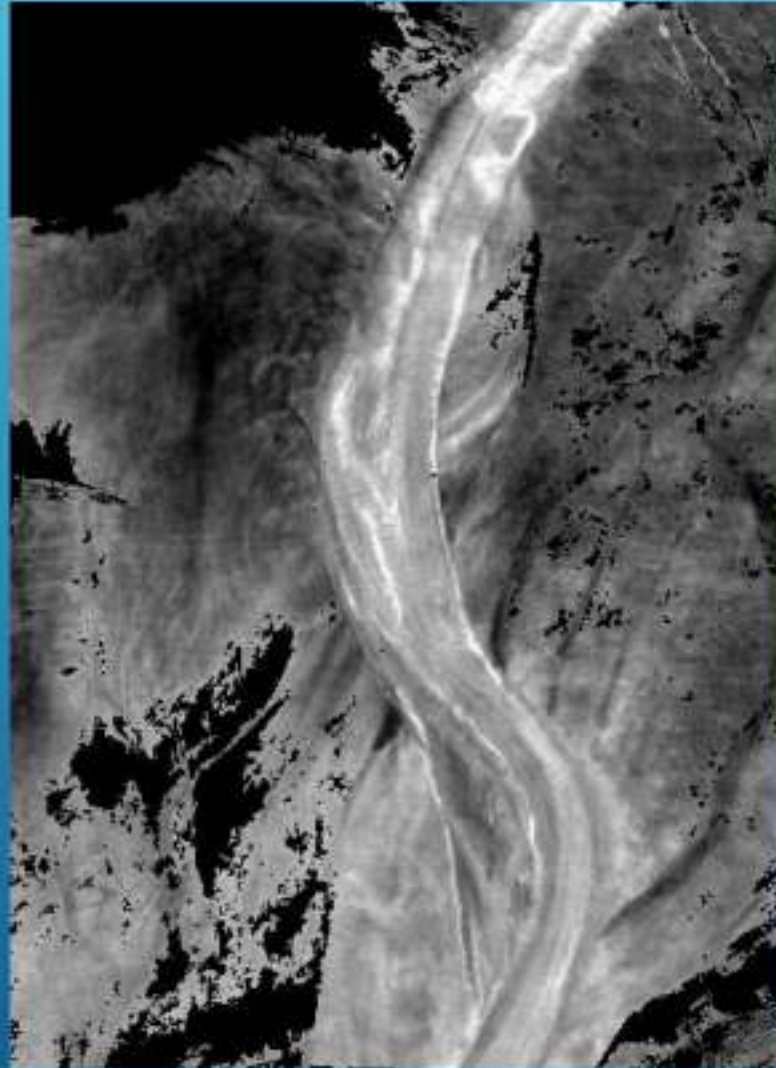


Time 1

LARGE TURBIDITE CHANNEL CONTAINING WEAKLY CONFINED CHANNEL ELEMENTS

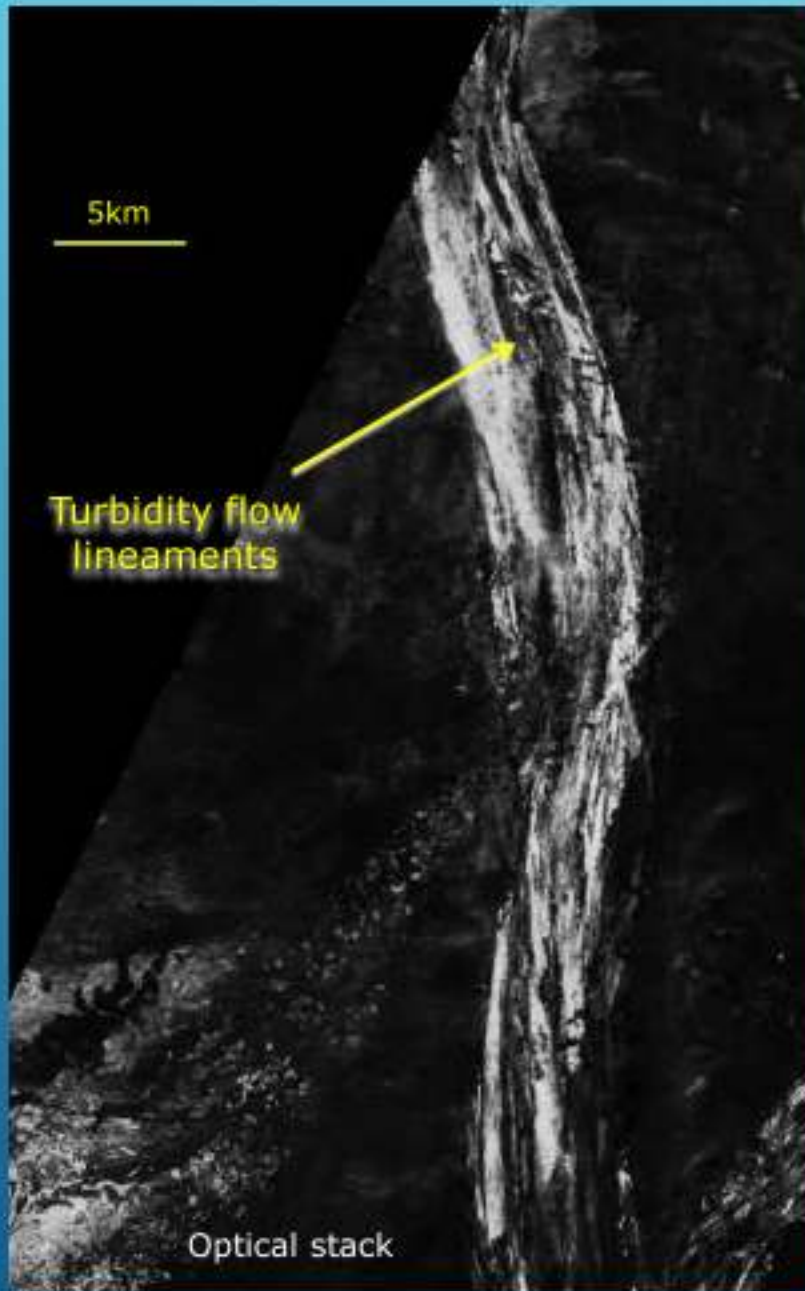


Terminal fan – populated with weakly-confined channels (sand-rich)



Large channels (containers) – populated with weakly-confined channels (sand-rich)

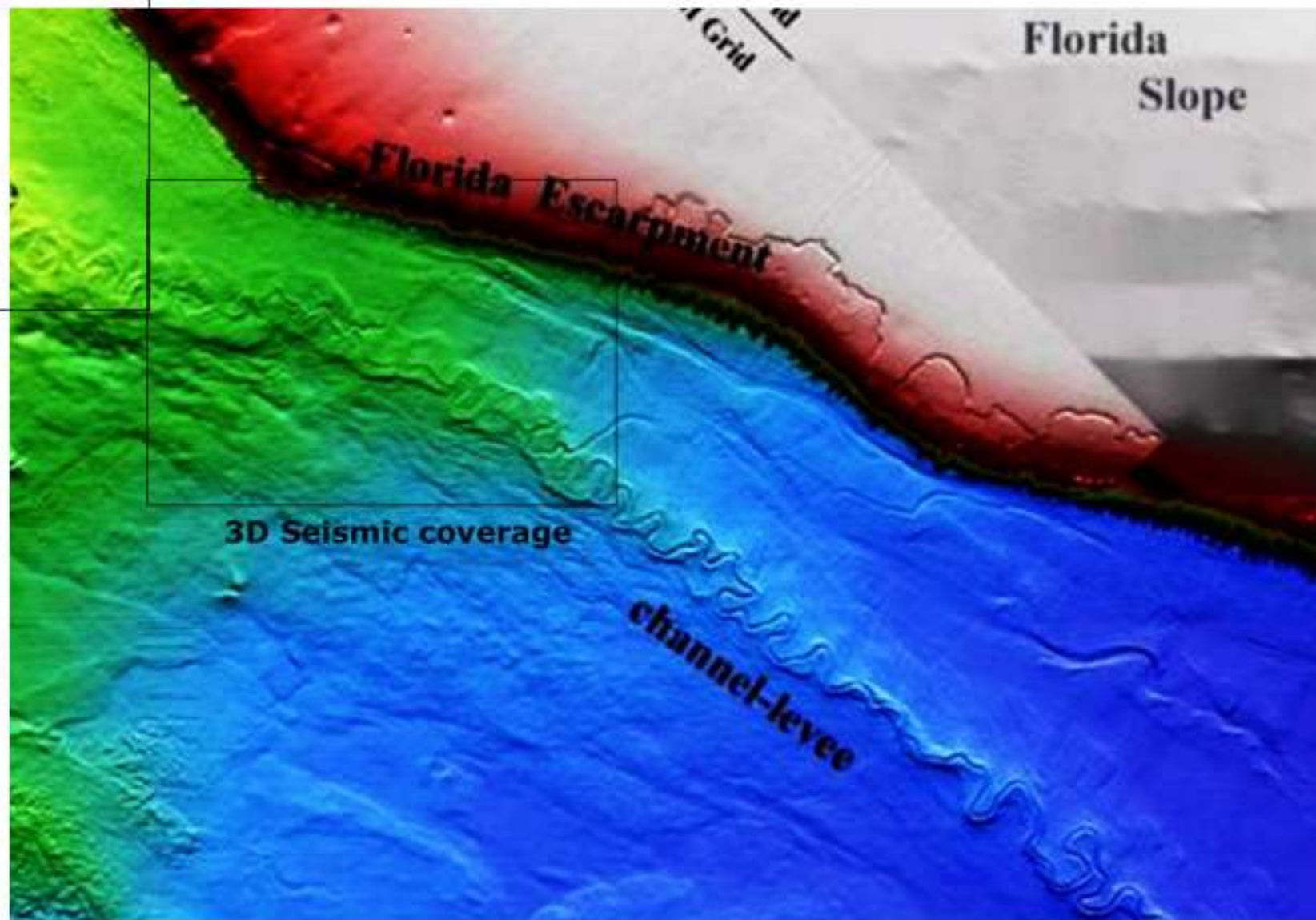


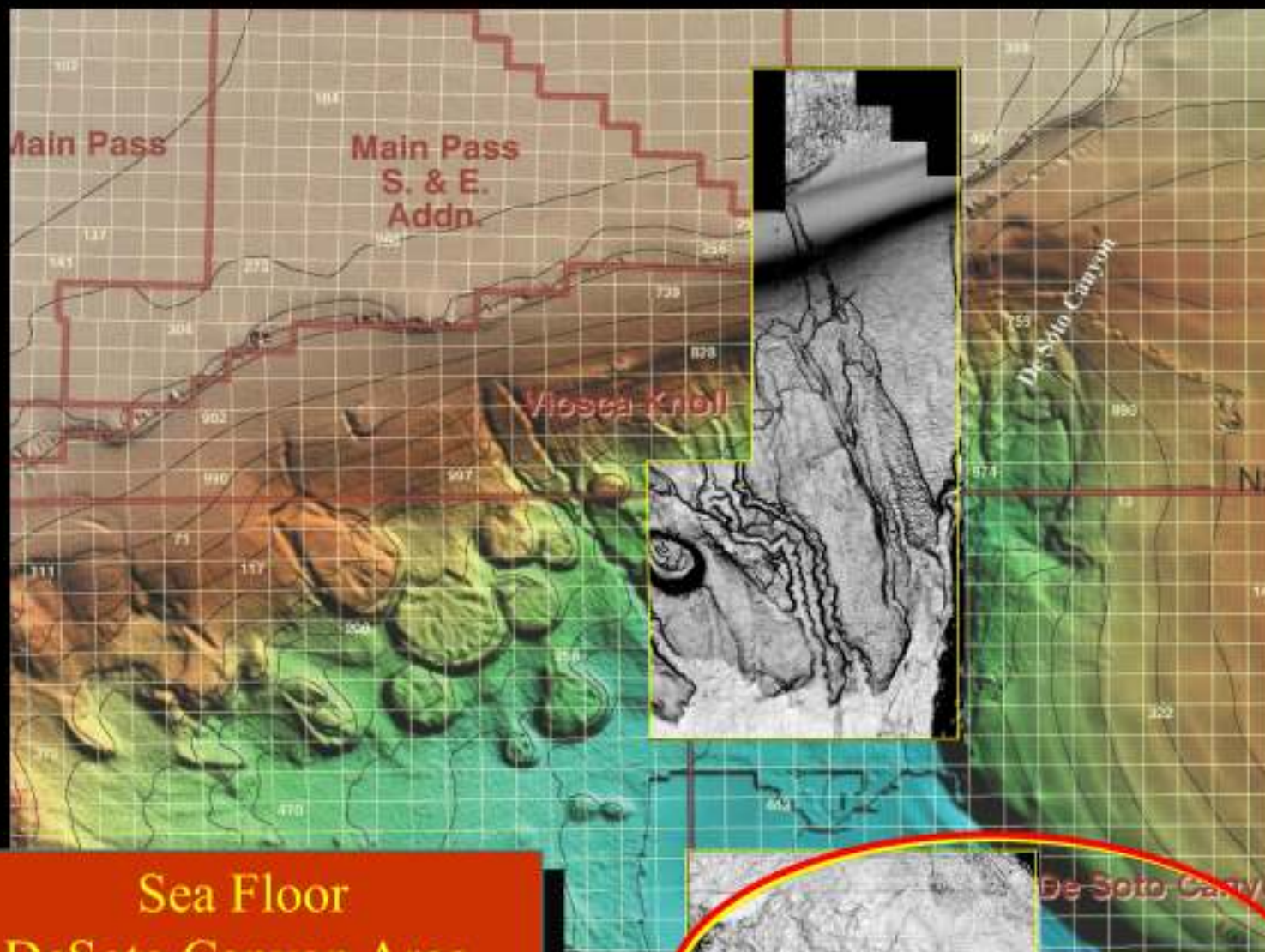


Large channels
(containers) –
populated with
weakly-confined
channels (sand-rich)



"Joshua" Channel – Gulf of Mexico

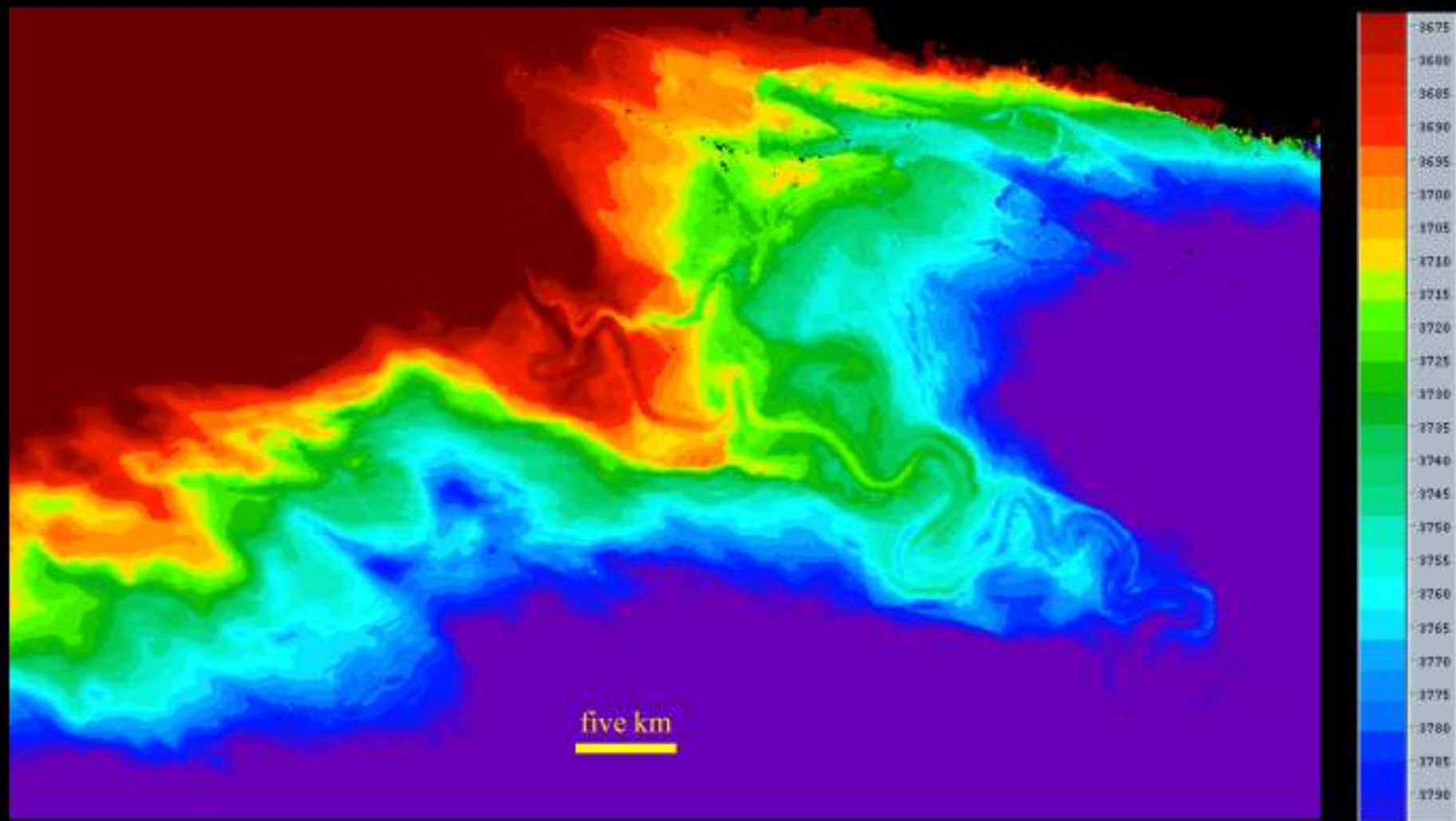




Sea Floor
DeSoto Canyon Area,
Gulf of Mexico

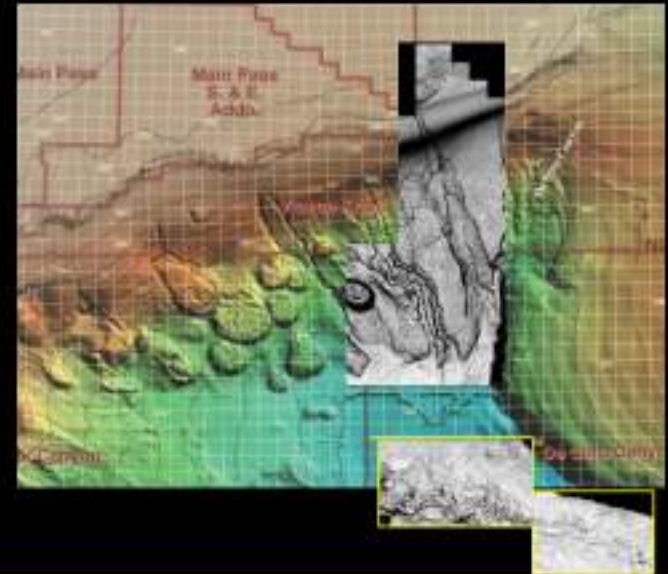
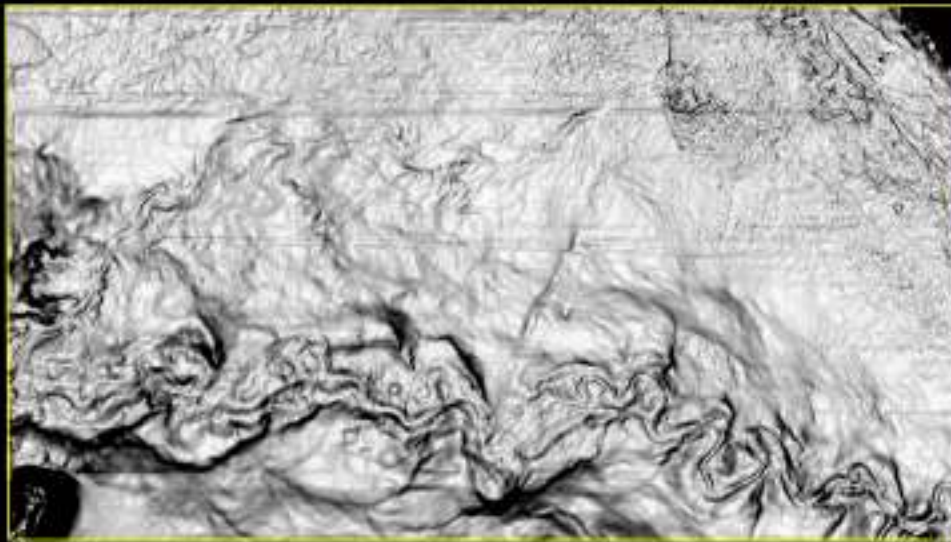
Base map courtesy of TGS Nopec

Leveed Channel Time Structure

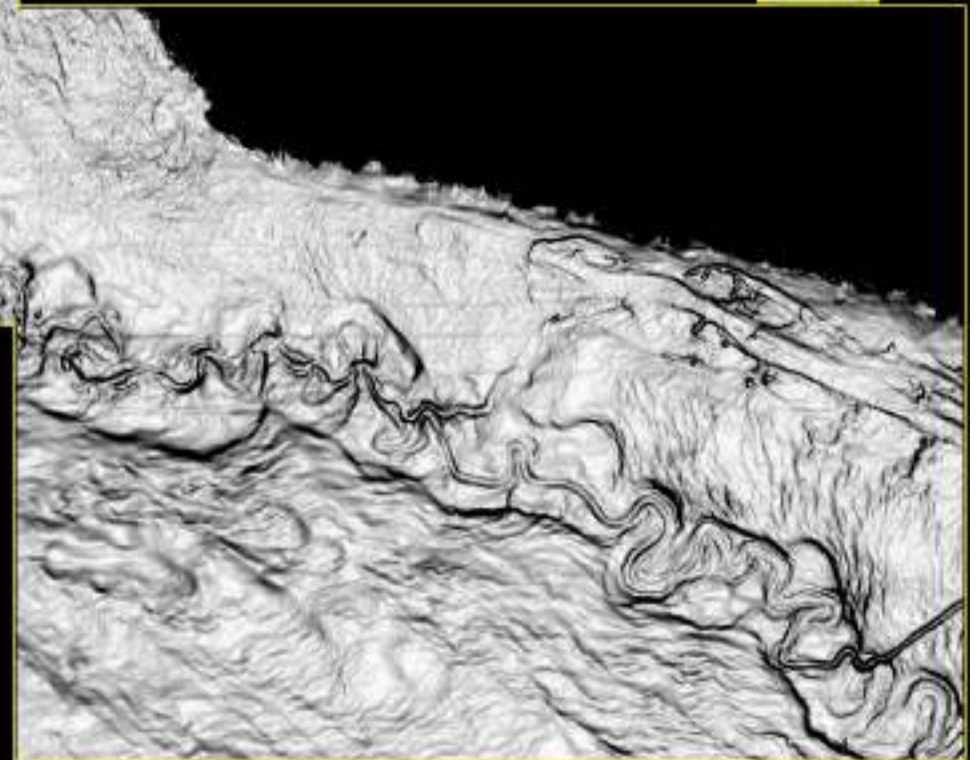


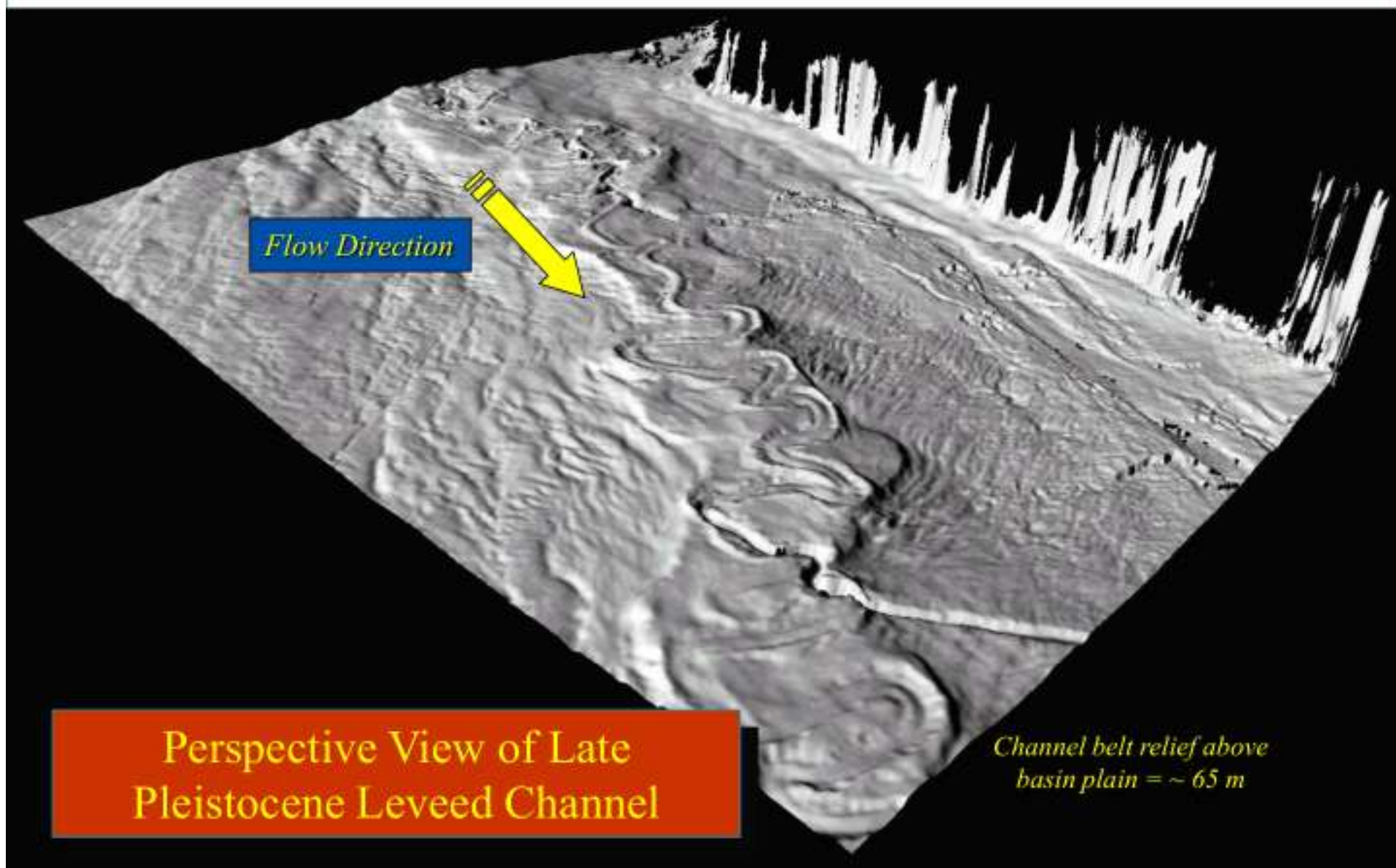
Relief from Channel ridge to basin plain: ~ 65 m

Basin Floor Leveed Channel System



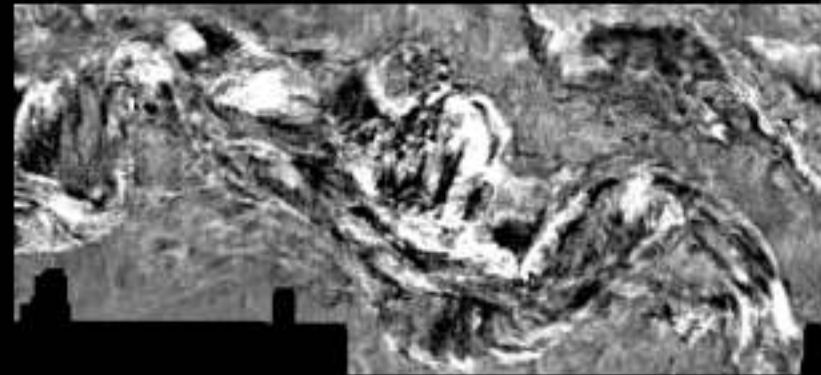
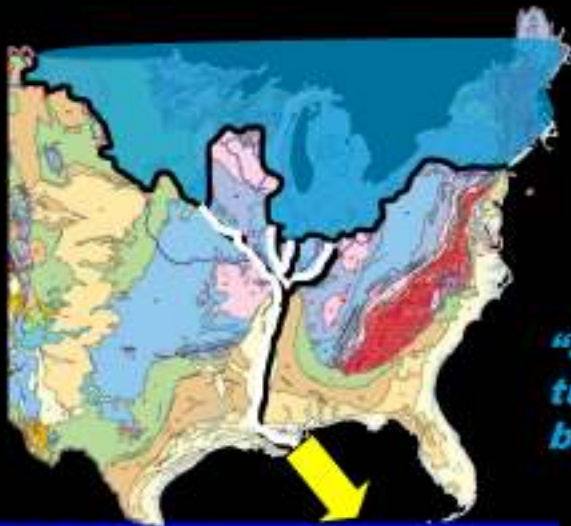
- Channel Belt Slope = $\sim 0.32^\circ$
- Channel Thalweg Slope = $\sim 0.07^\circ$
- Channel sinuosity = 2.31





Time 1:

High fluvial discharge (Mississippi), Significant sediment provided by source area (fluvio-glacial)



"Slope Valleys" form and sand-rich turbidite systems characterize the basin floor

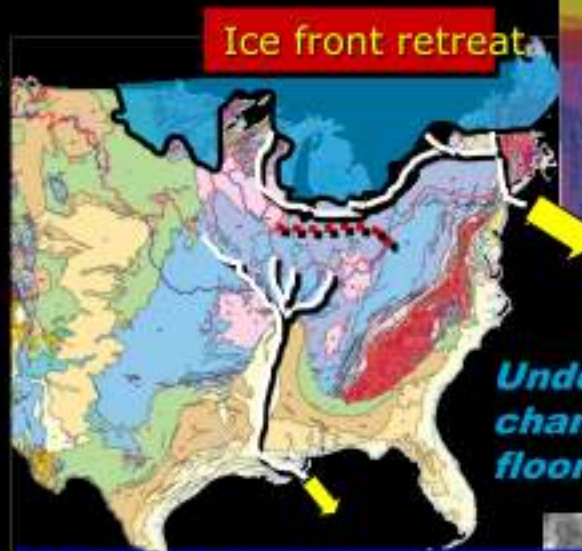
- ~ 18 kybp
- Laurentide meltwater directed down Mississippi River
- High discharge into deep-water

Time 2:

Ice retreat reveals drainage divide – glacial meltwater and associated sediments shunted out Mohawk/Hudson drainage – low sediment flux to Gulf of Mexico slope and basin floor

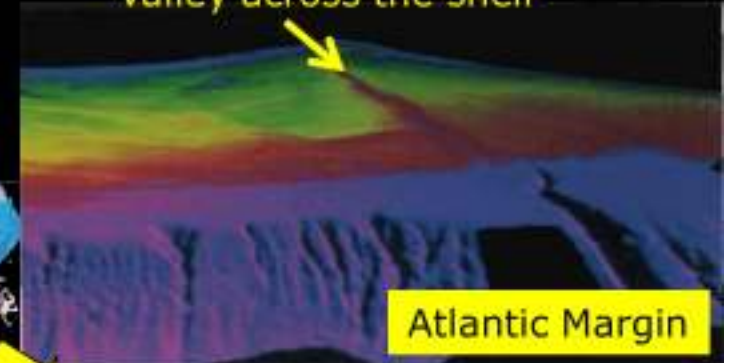


- ~ 18 kybp
- Laurentide meltwater directed down Mississippi River
- High discharge into deep-water

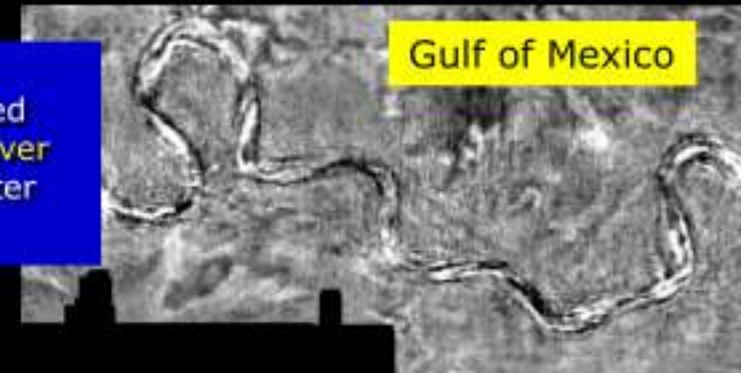


- ~ 12 kybp
- Laurentide meltwater directed down Mohawk/Hudson River
- Low discharge into deep-water

Deeply incised Hudson valley across the shelf



Underfit sand-poor channels form on basin floor



Time 3:

Renewed glacial advance; Mississippi River again receives significant sediment from glacial outwash – high sediment flux to slope and basin floor



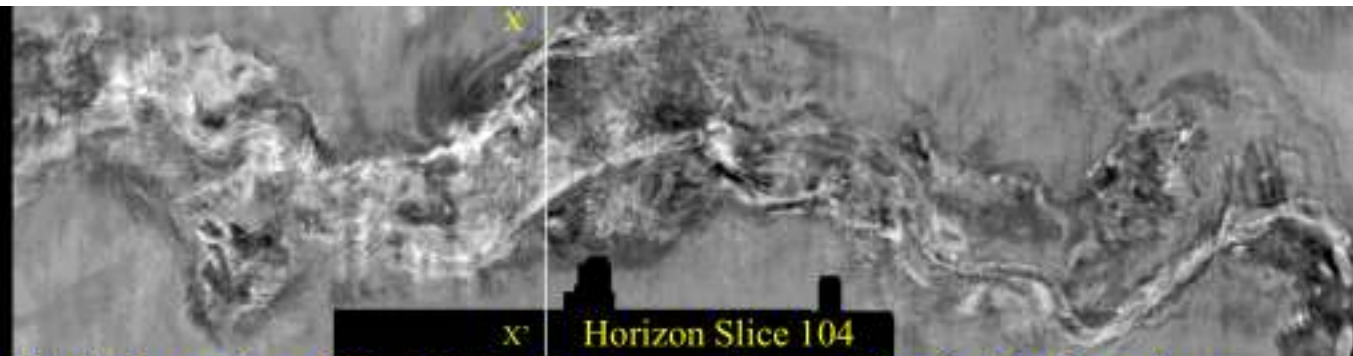
- ~ 18 kybp
- Laurentide meltwater directed down Mississippi River
- High discharge into deep-water



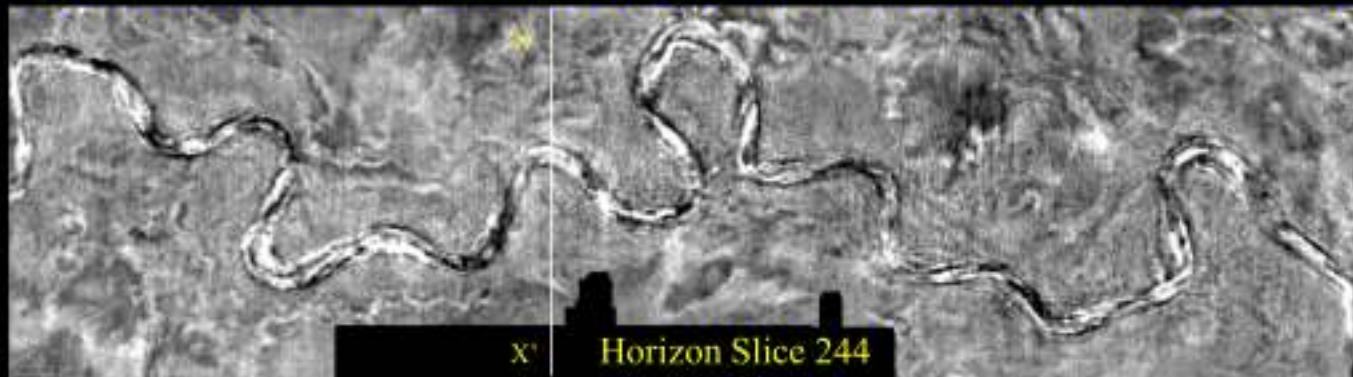
- ~ 12 kybp
- Laurentide meltwater directed down Mohawk/Hudson River
- Low discharge into deep-water



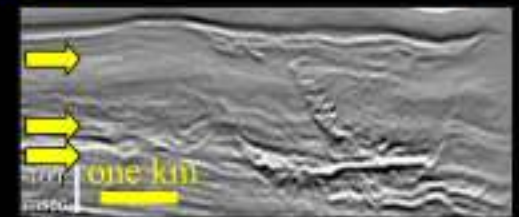
- ~ 11 kybp
- Laurentide meltwater re-directed down Mississippi River
- High discharge into deep-water



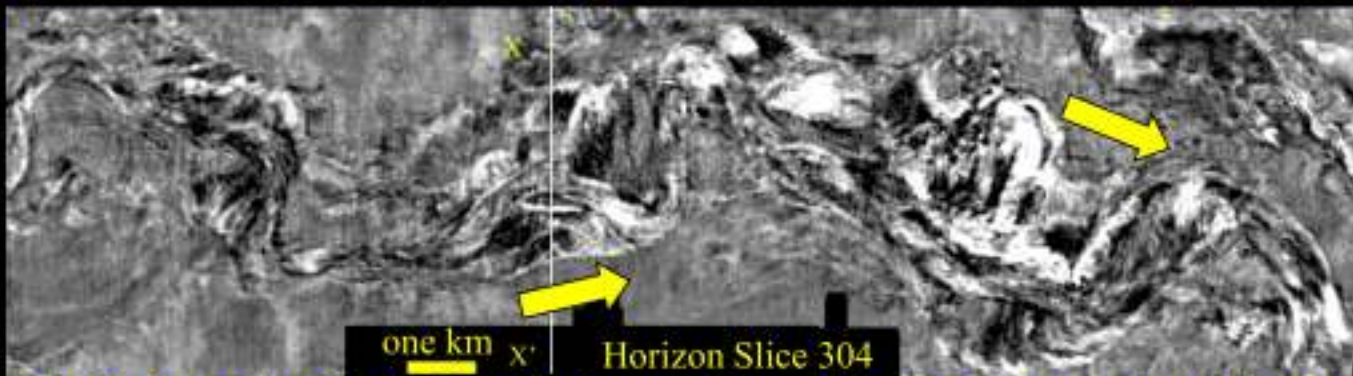
**Late Lowstand II – High discharge from Mississippi system
[Laurentide ice sheet drainage out the Mississippi River] overfit channel**



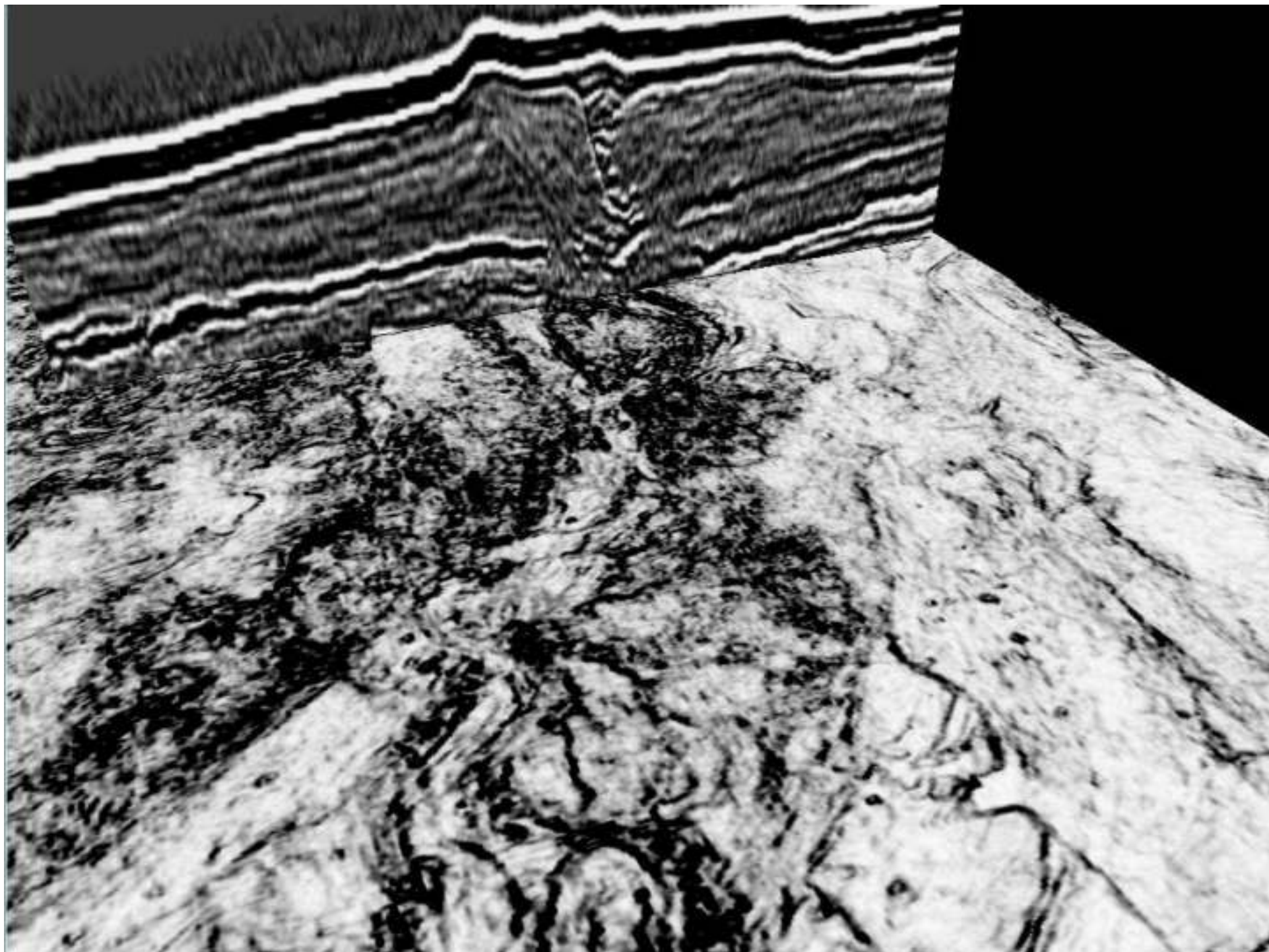
**Late Lowstand I – Low discharge from Mississippi system
[Laurentide ice sheet drainage out the St. Lawrence River] underfit channel**

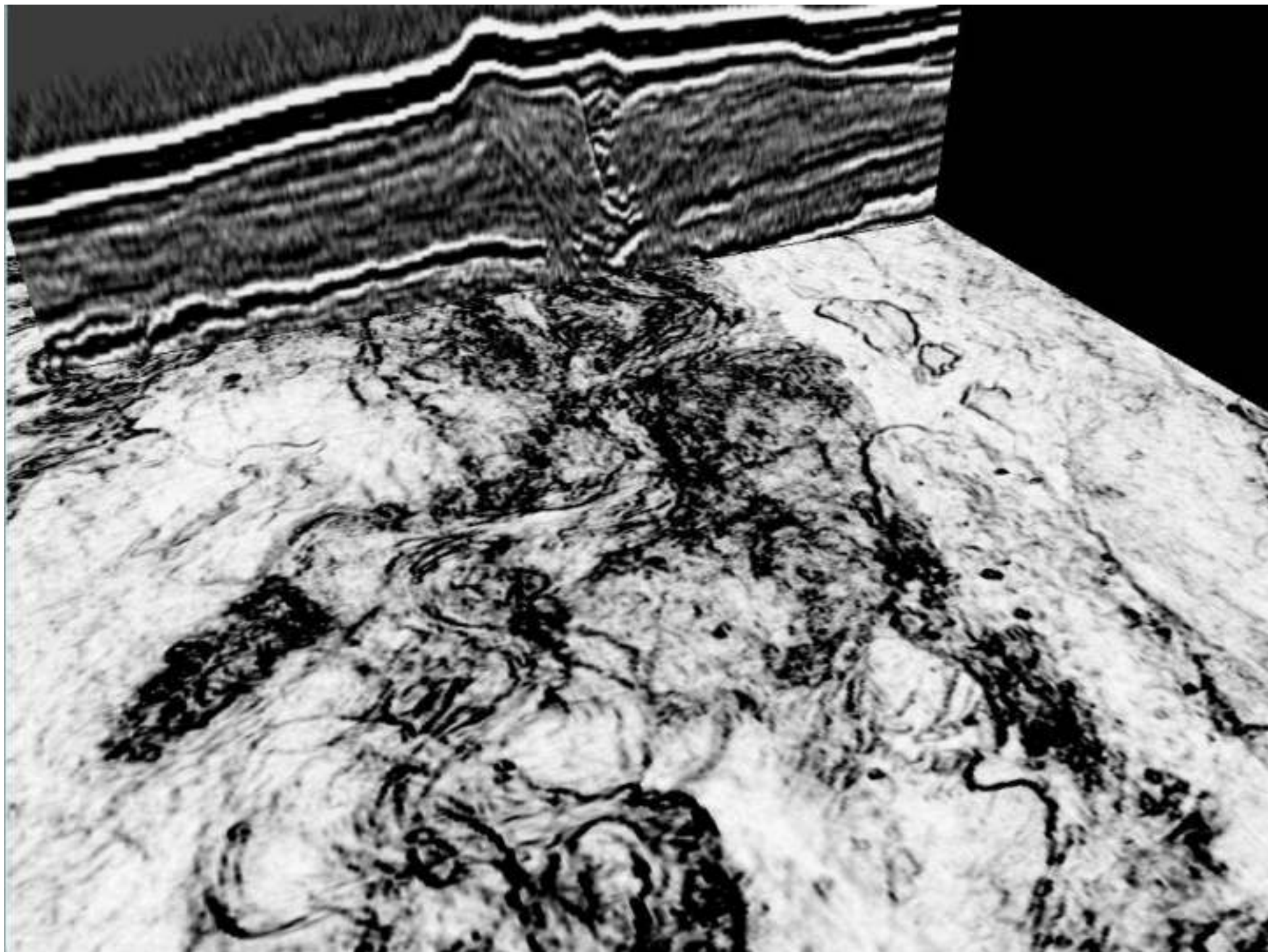


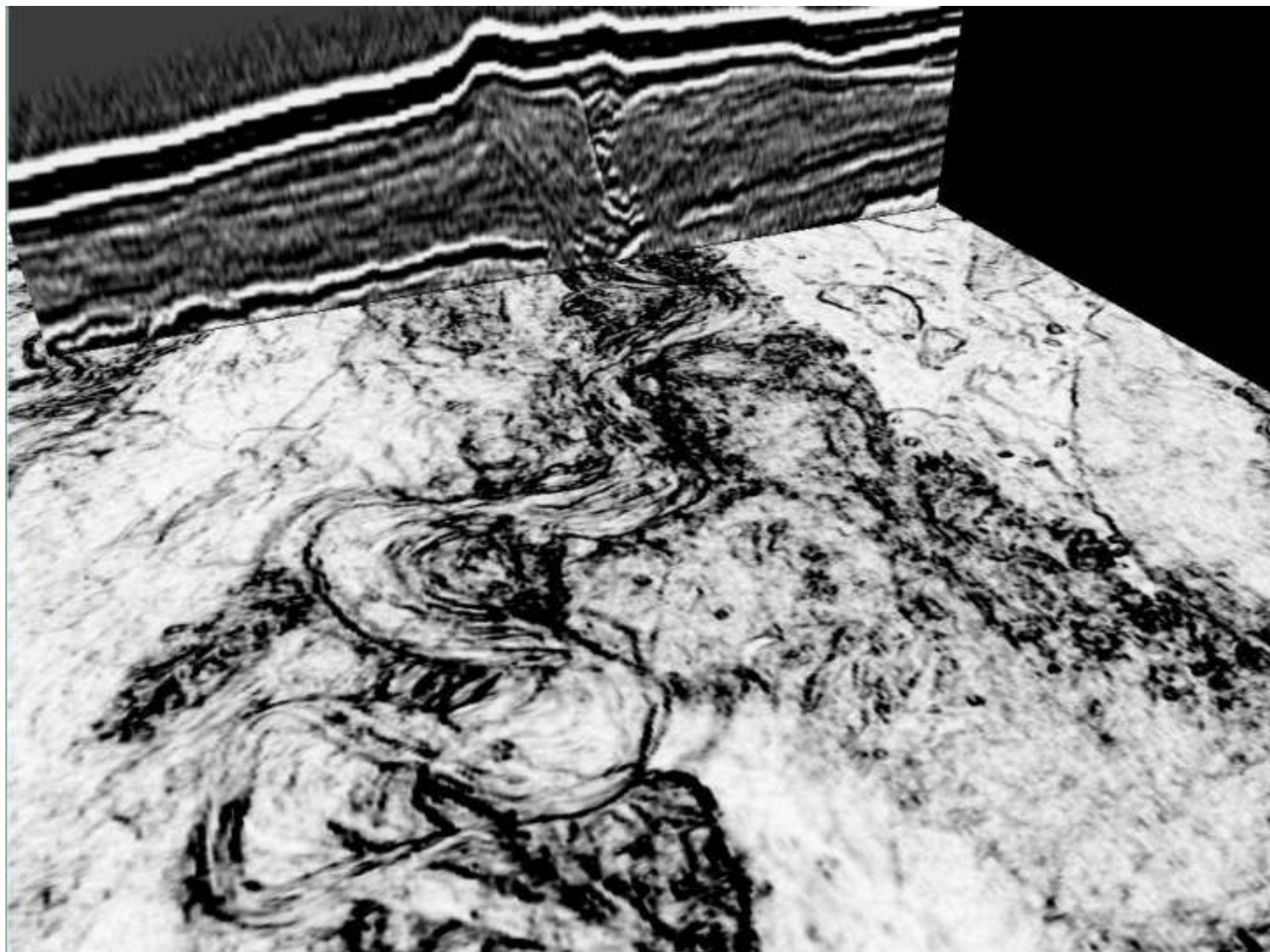
- Stage 3
- Stage 2
- Stage 1

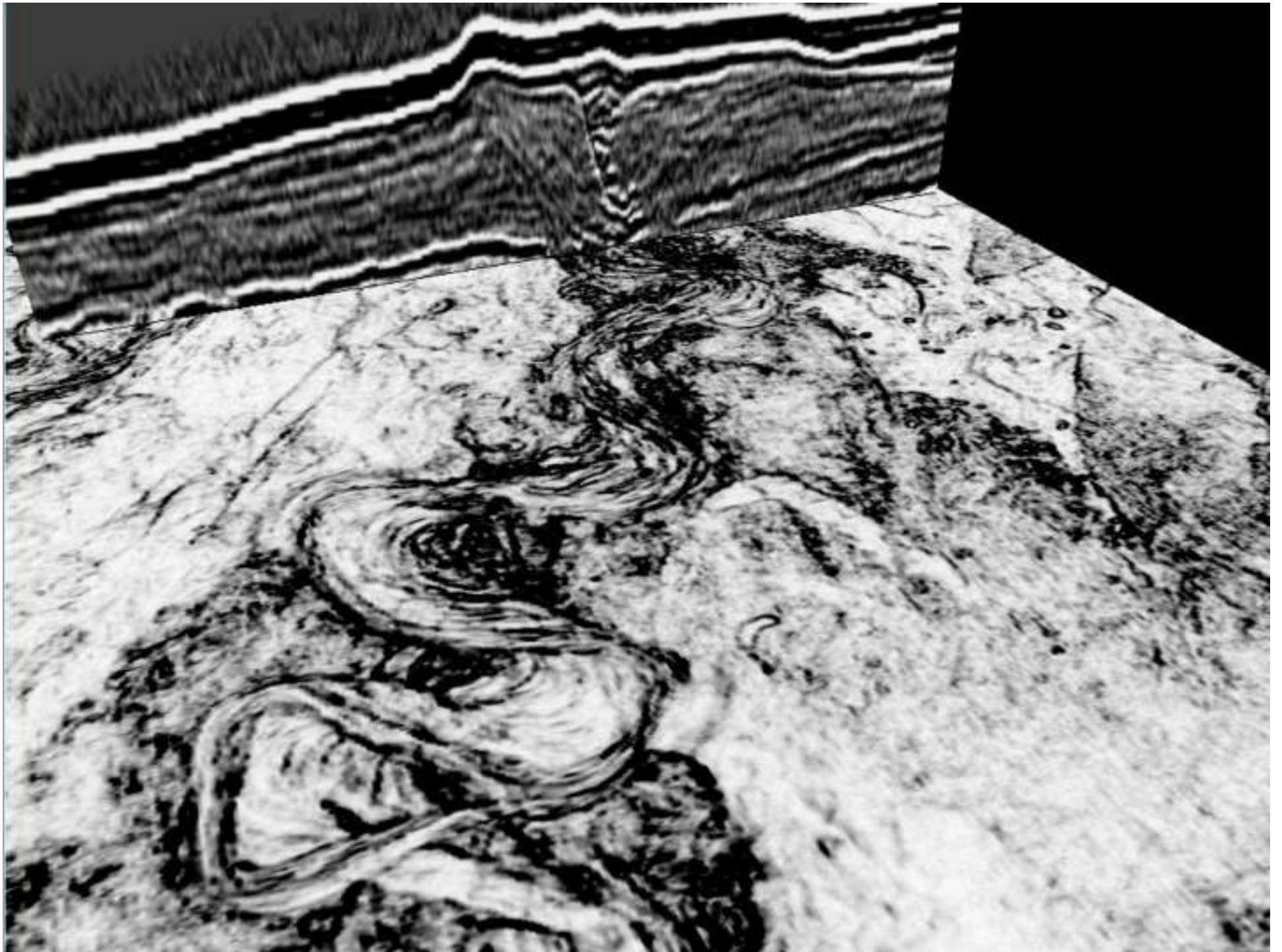


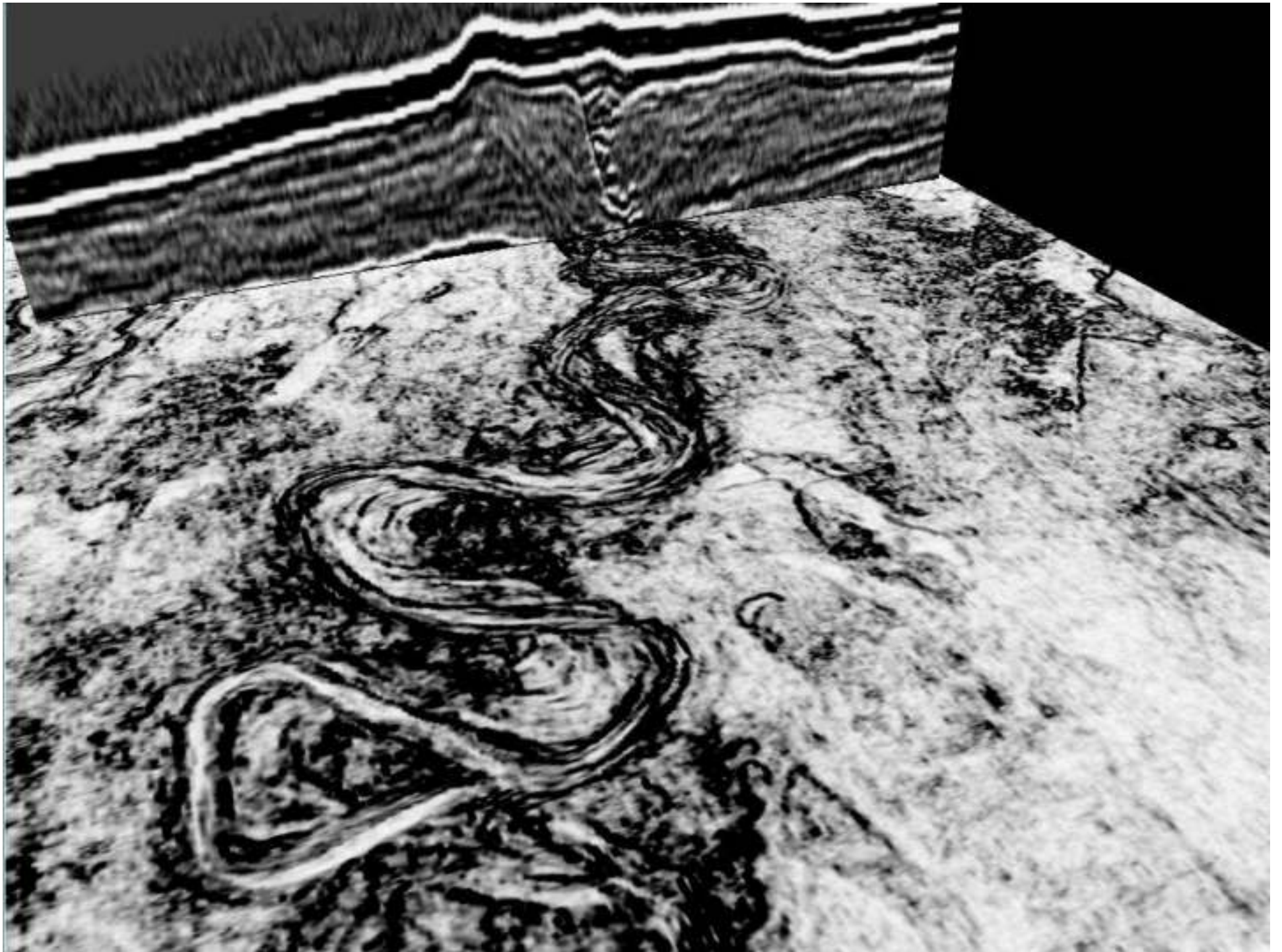
Early Lowstand – High discharge from Mississippi system [Laurentide ice sheet drainage out the St. Lawrence River]

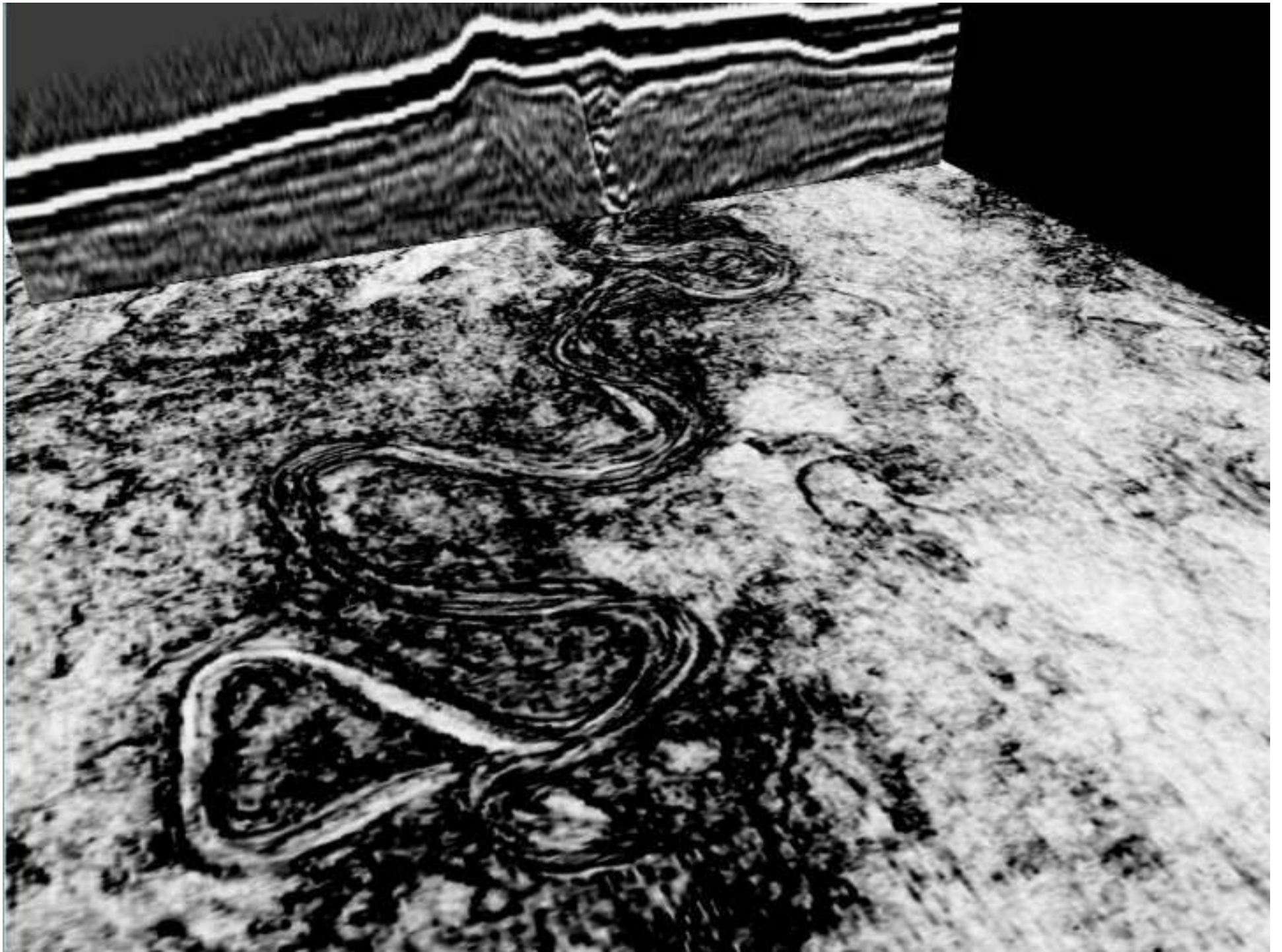


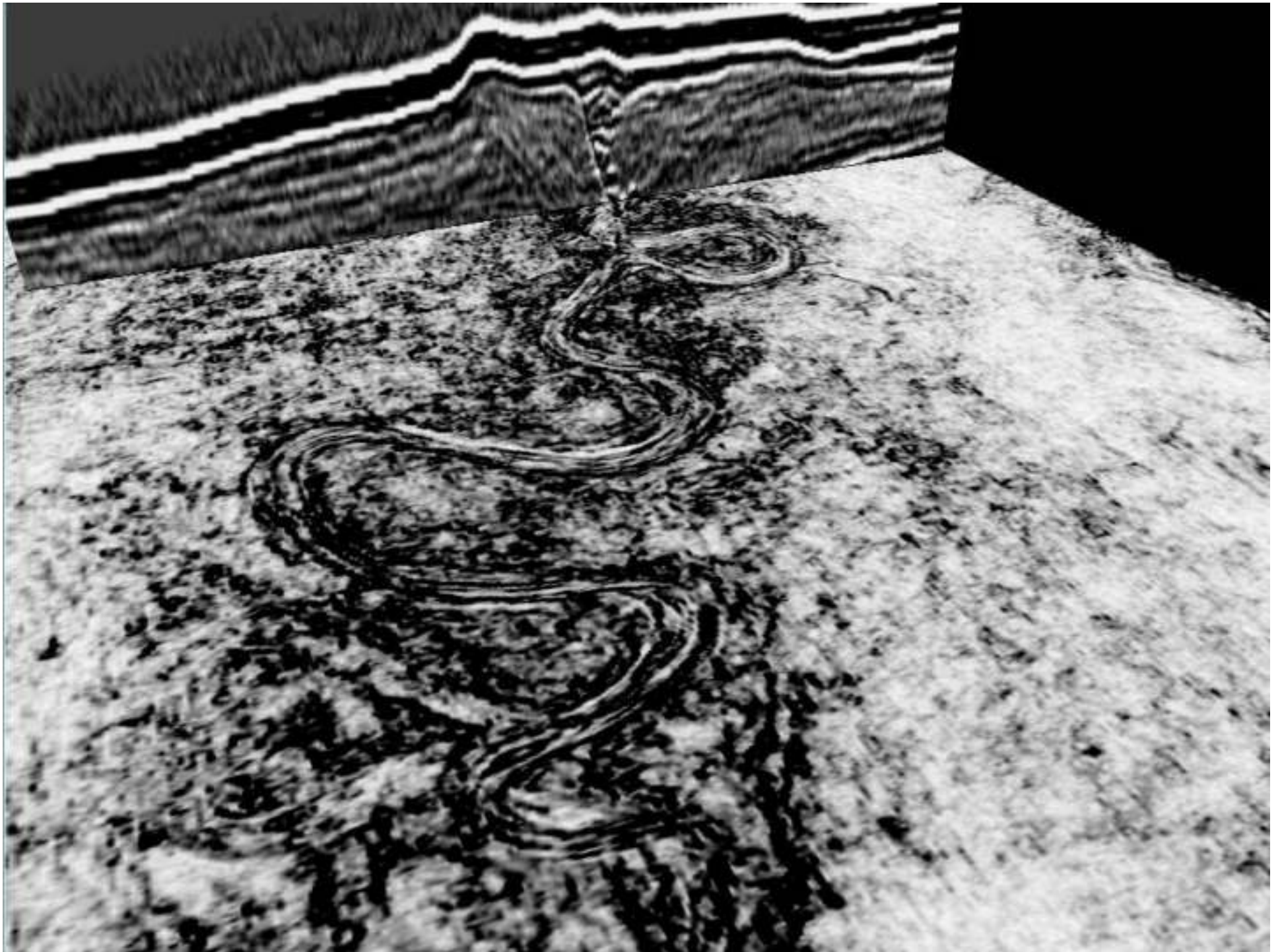


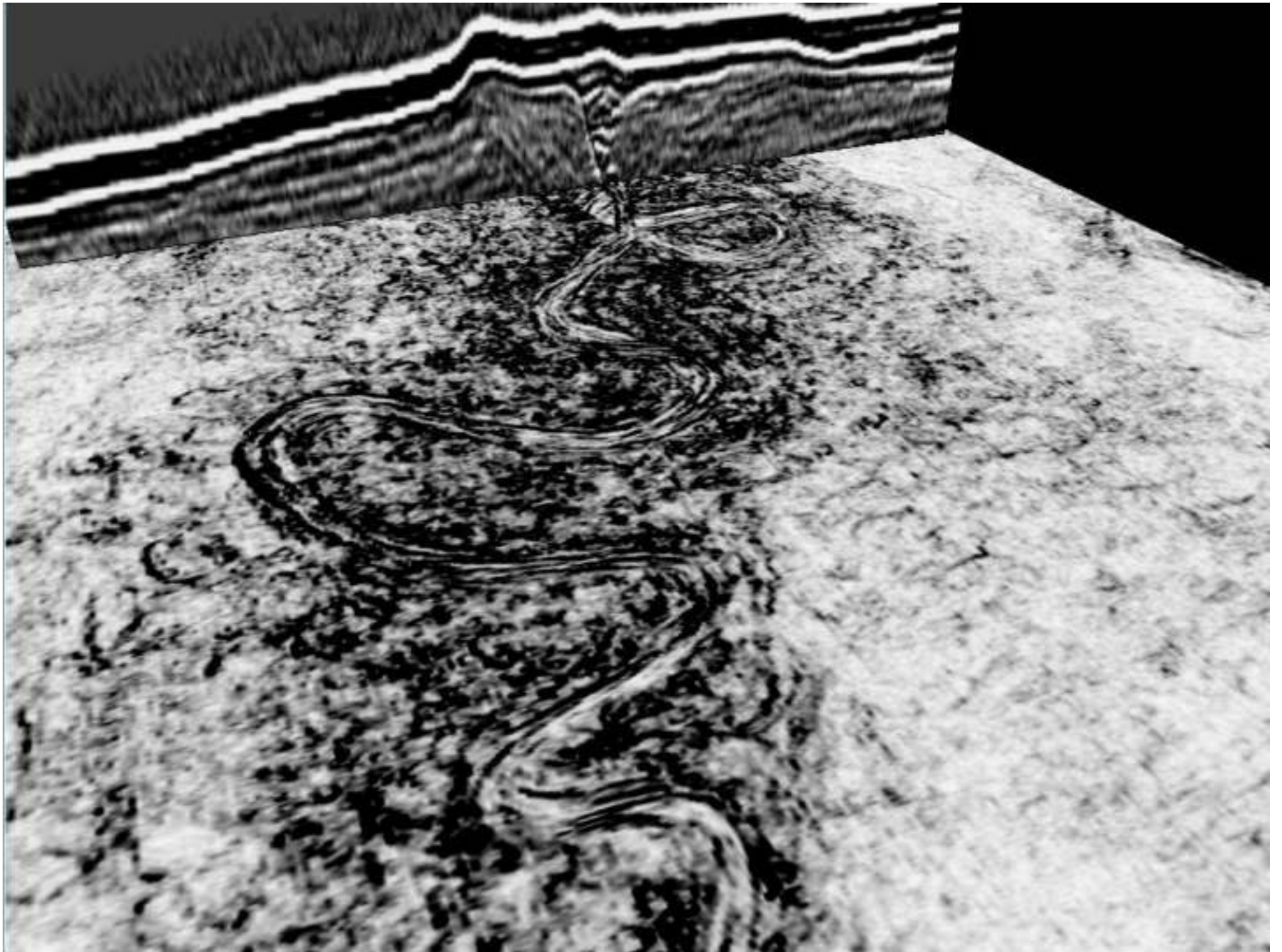


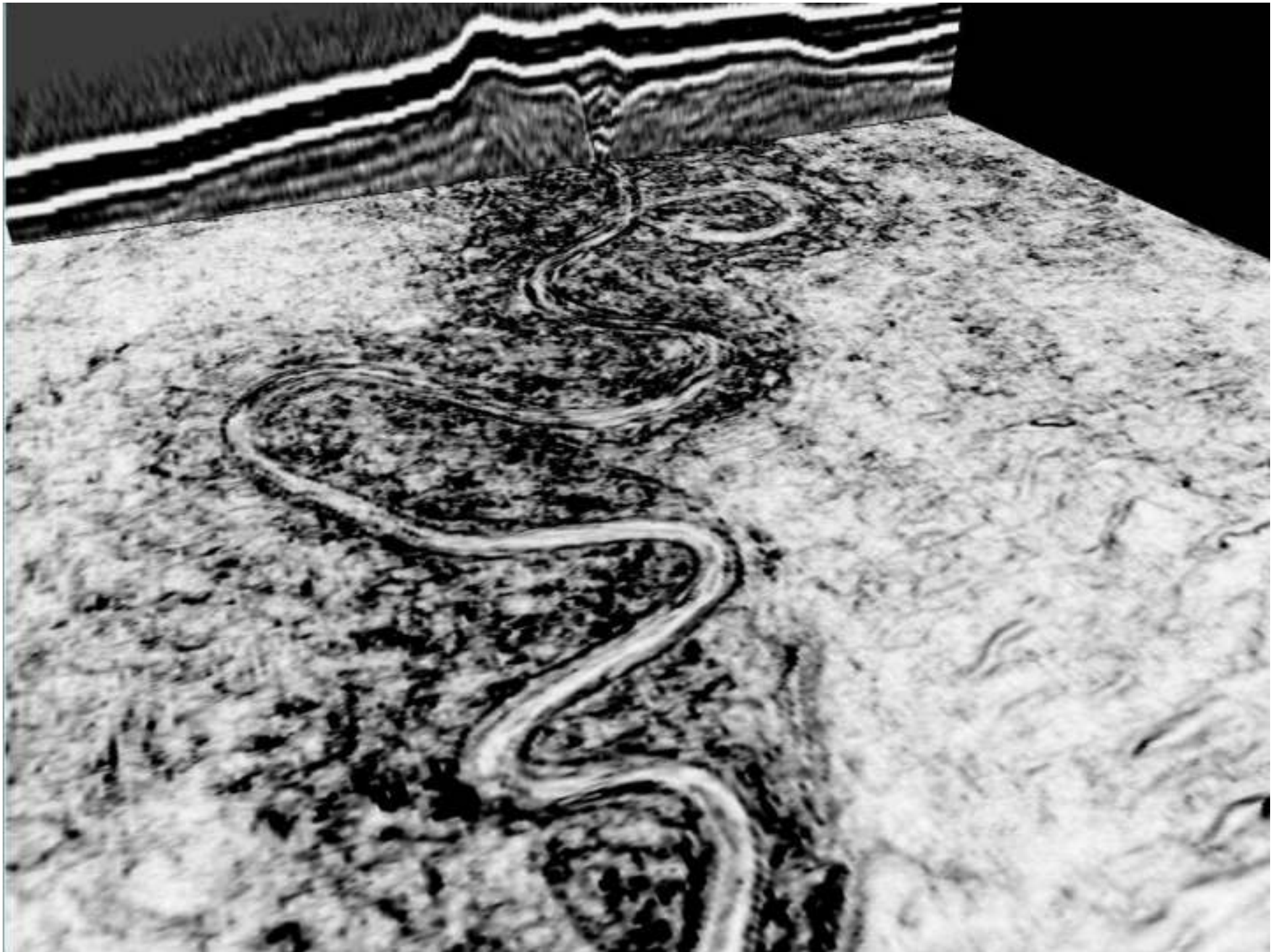


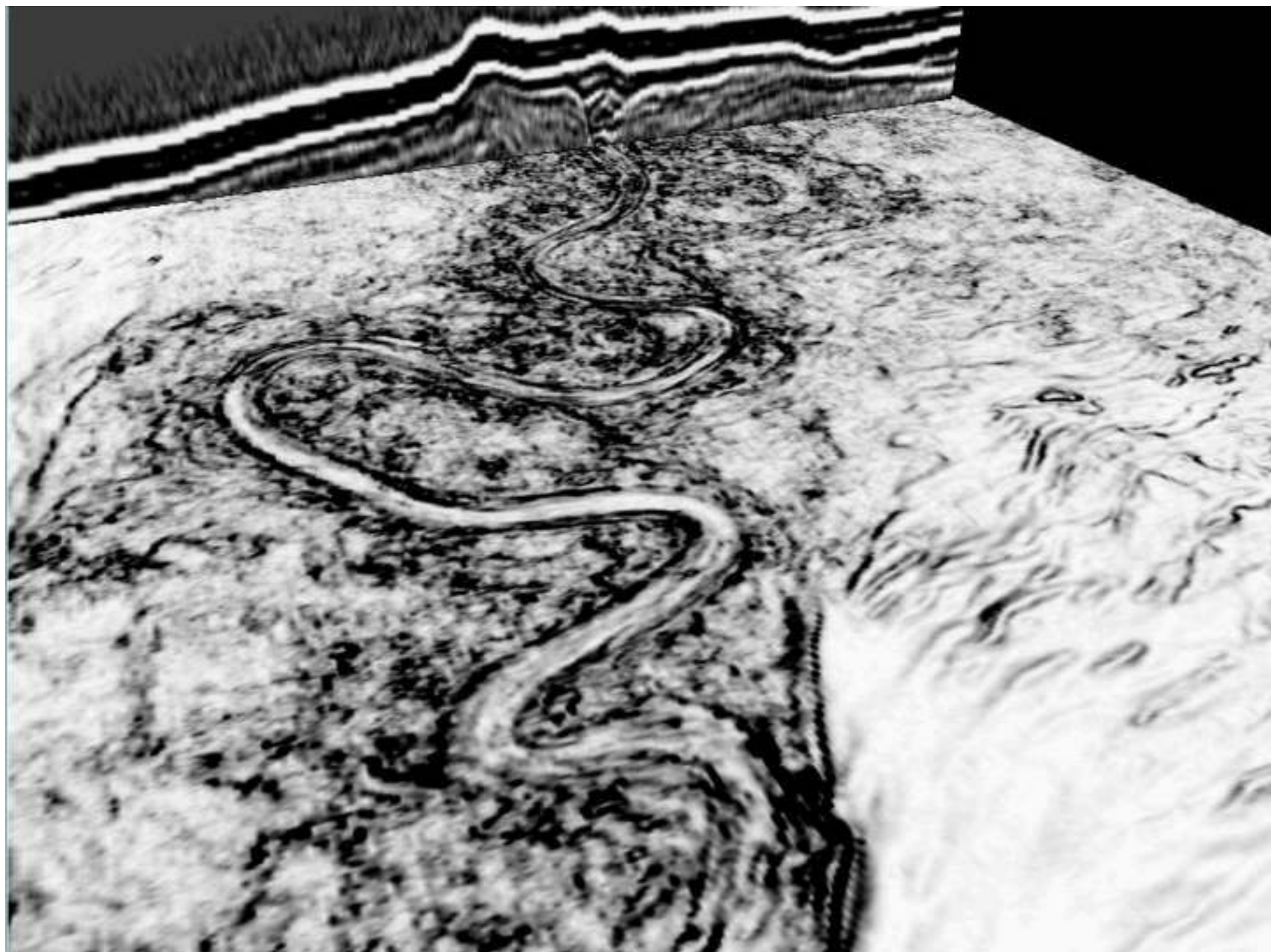


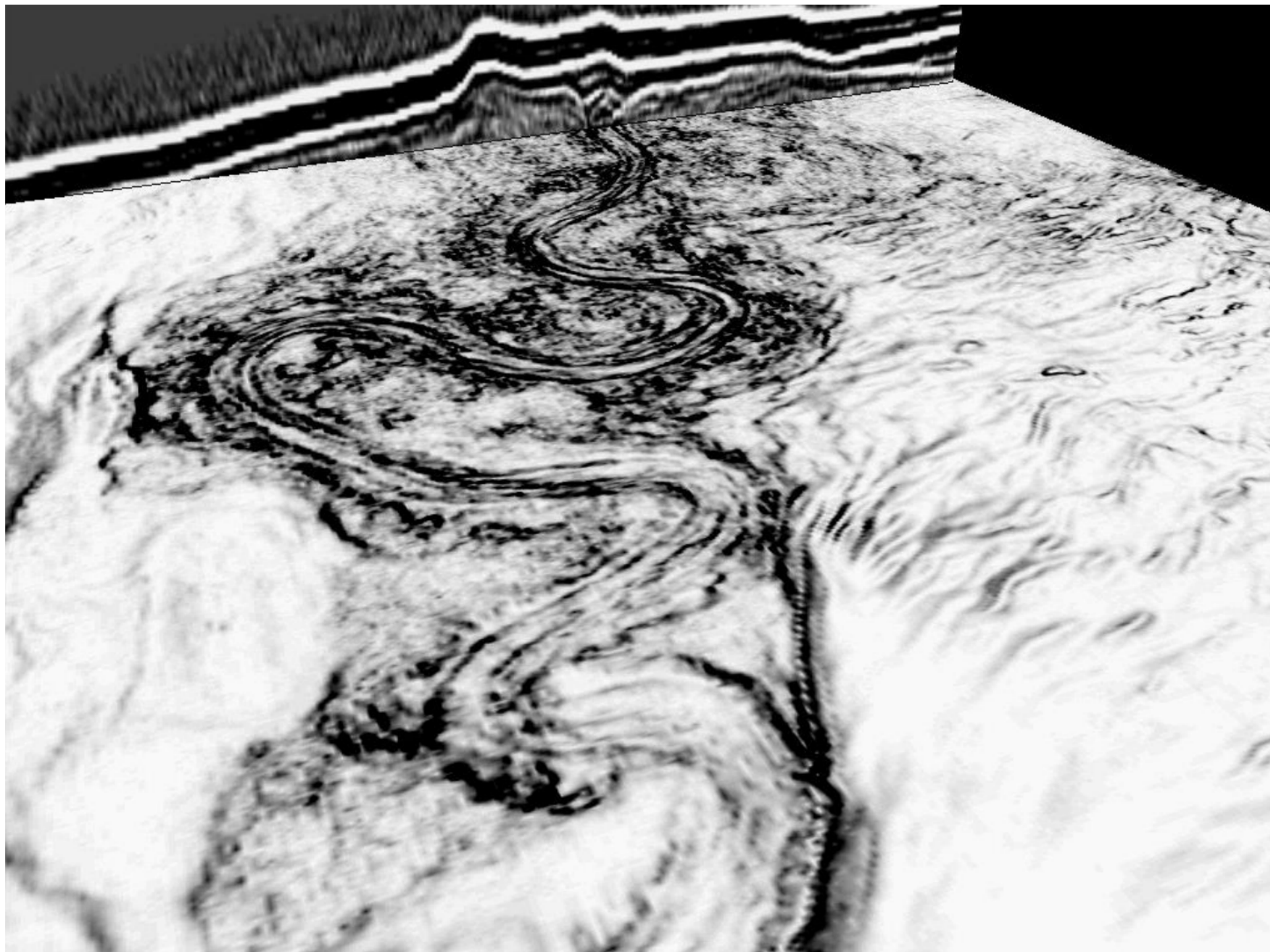


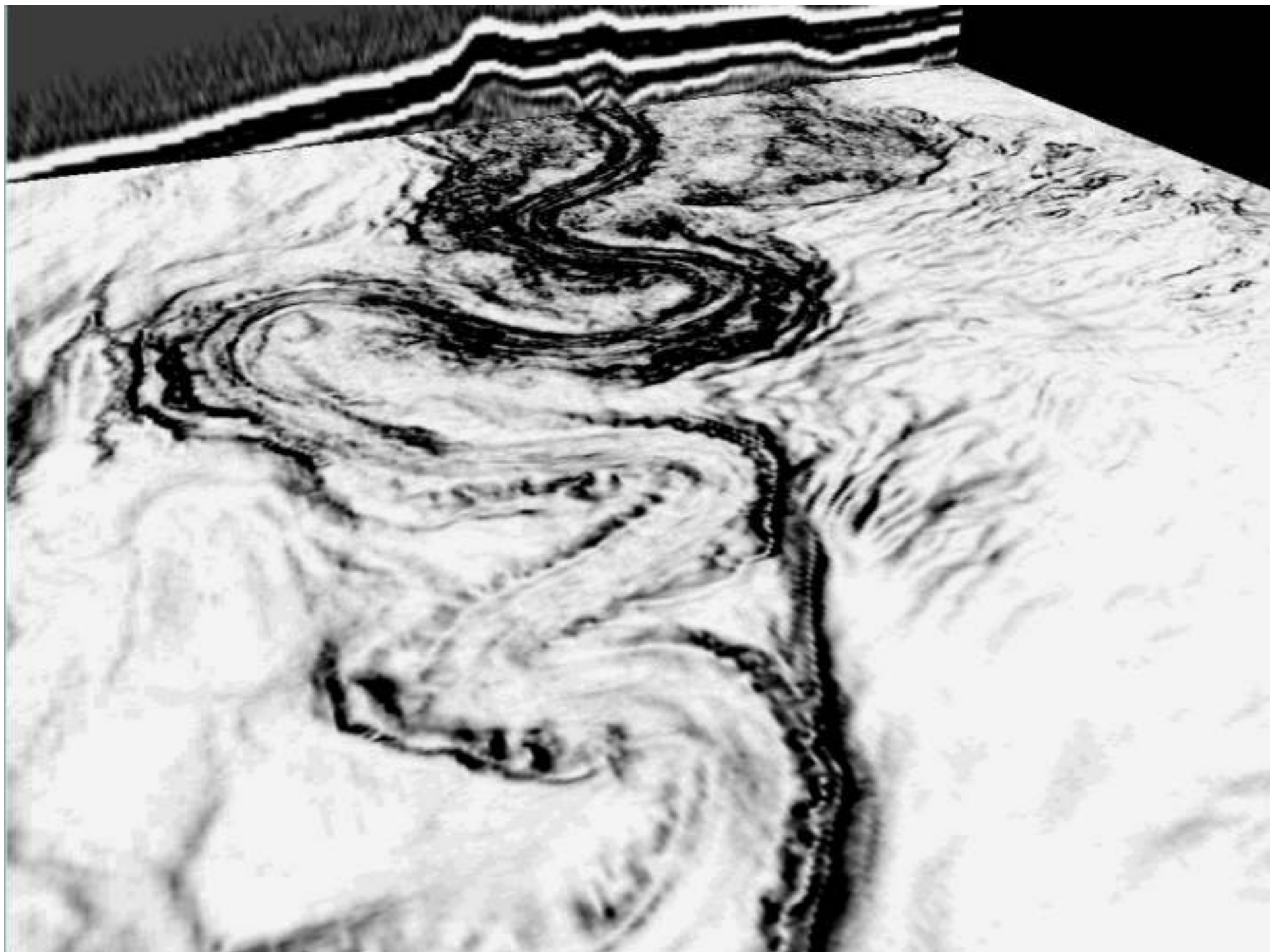




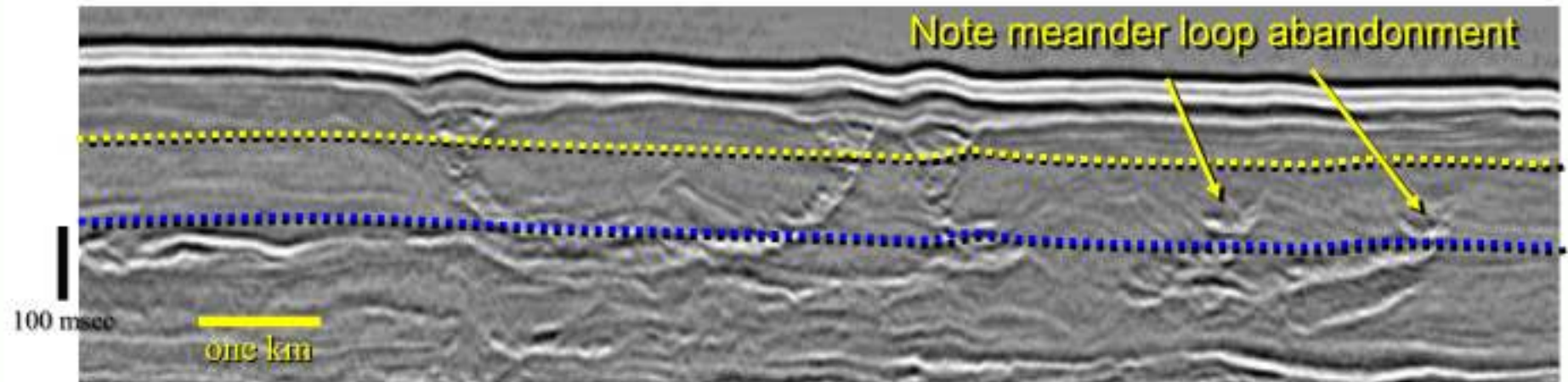




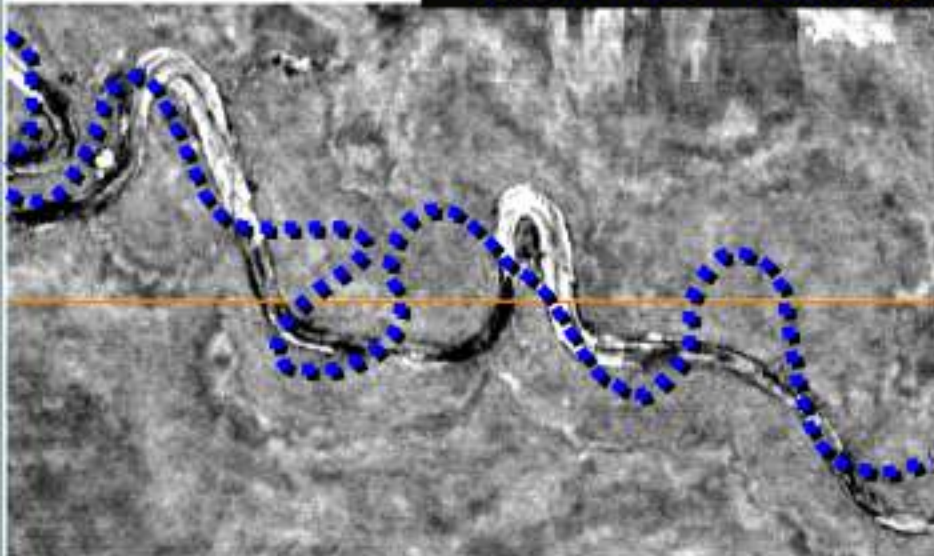




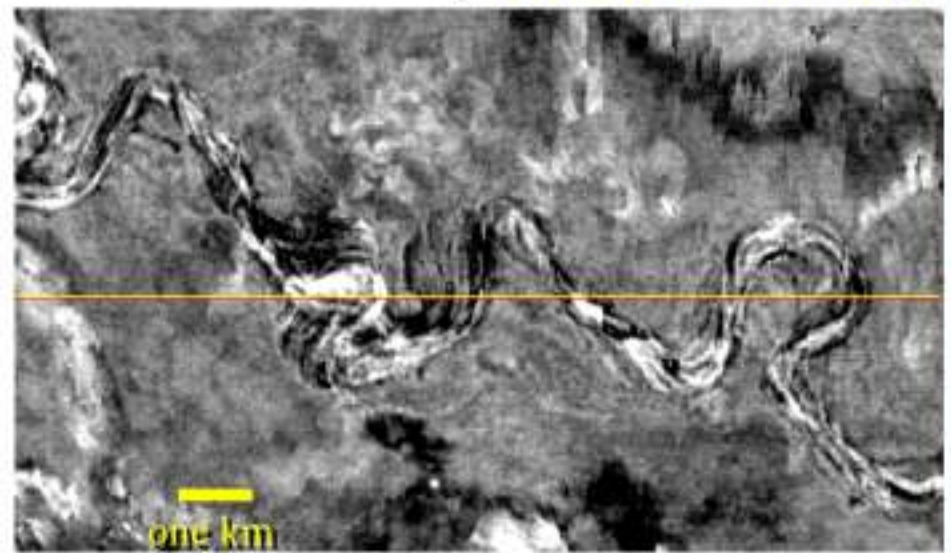
Leveed Channel Meander Loop Evolution



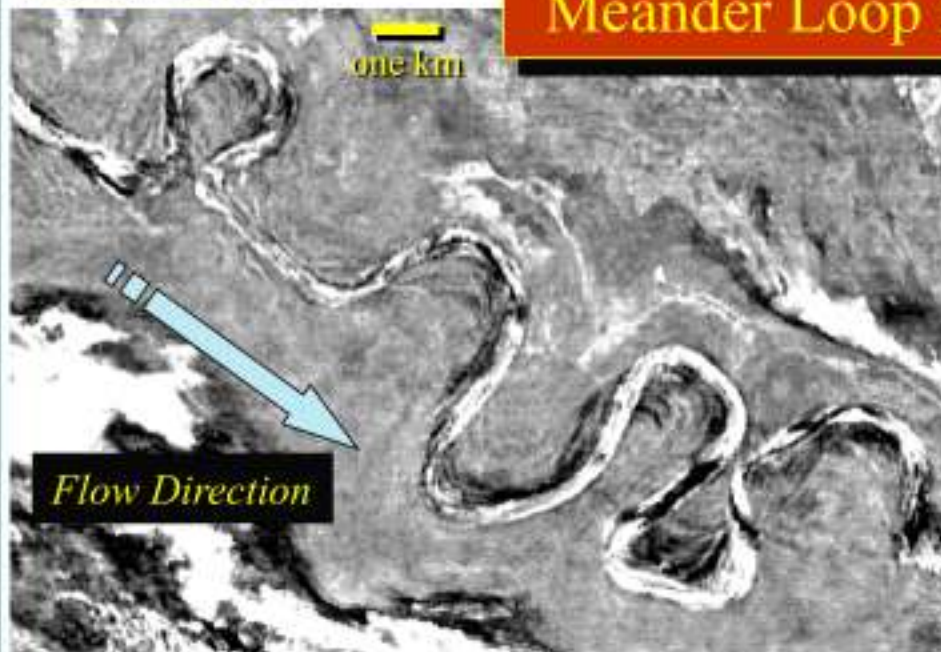
“Yellow Time” Thalweg



“Blue Time” Thalweg

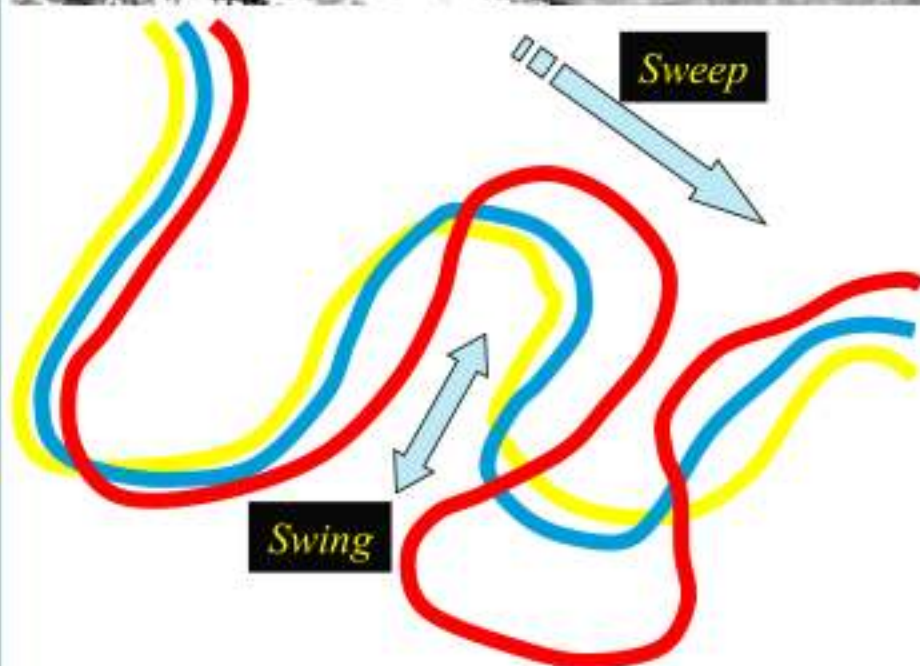
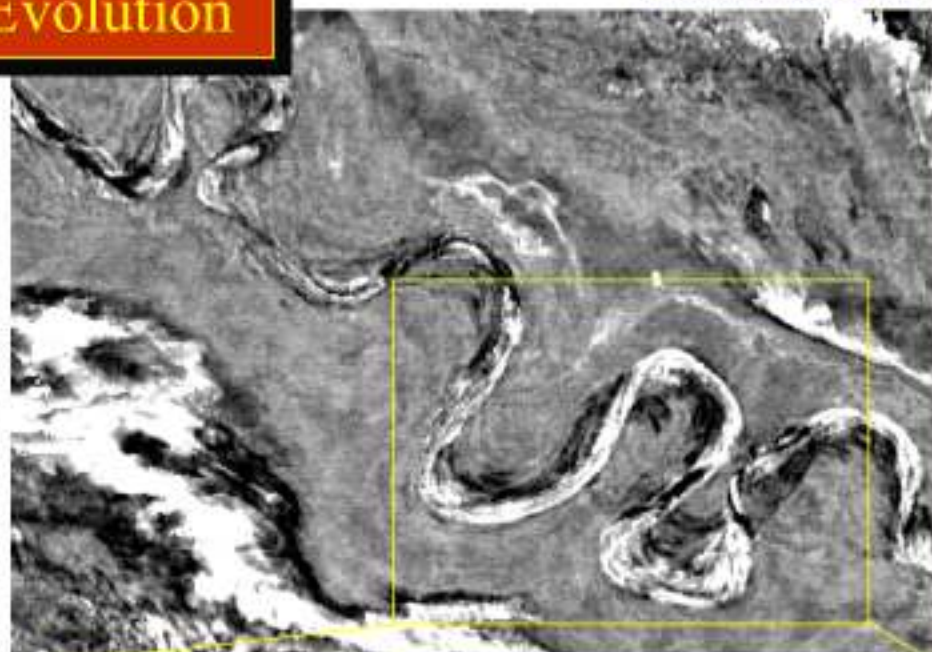


Horizon Slice 172



Meander Loop Evolution

Horizon Slice 176

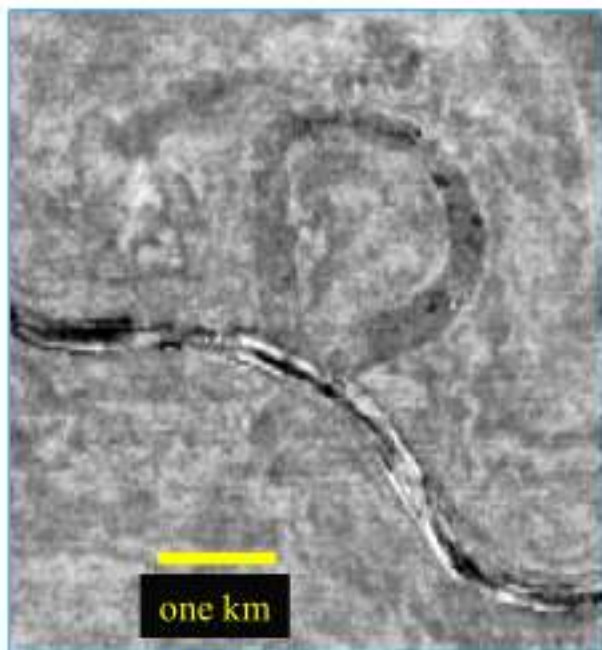
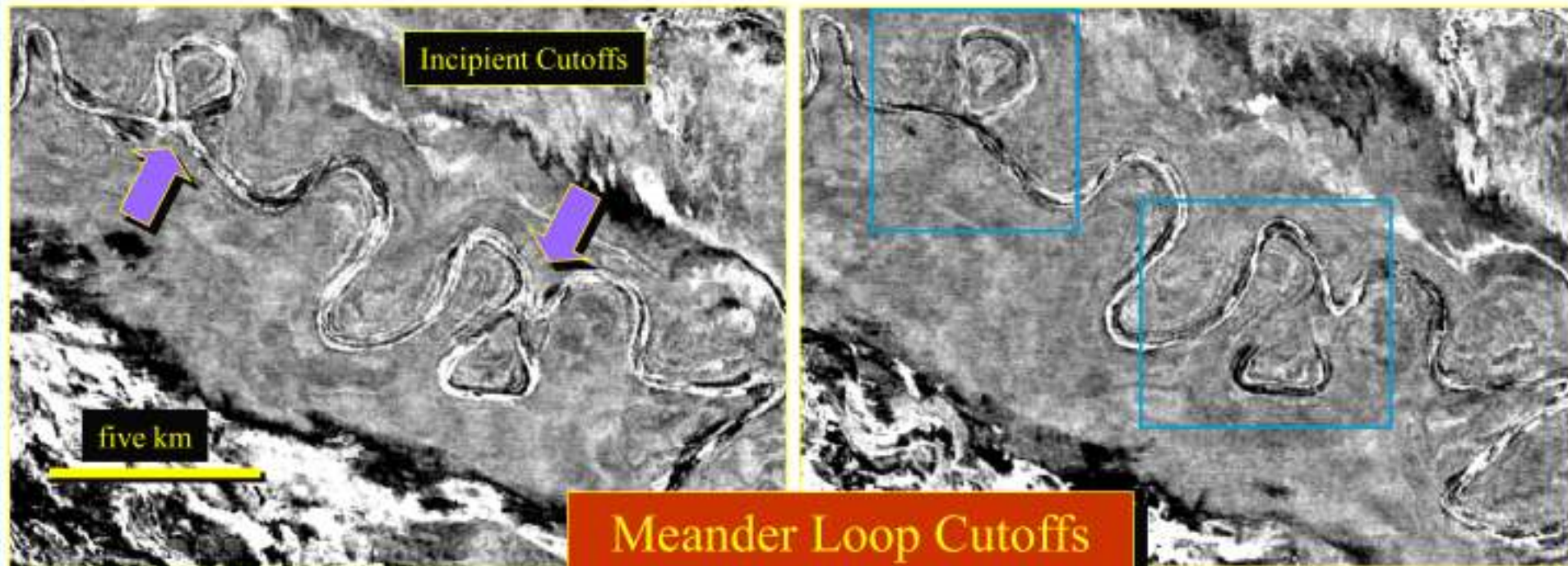


Deep-water



Fluvial

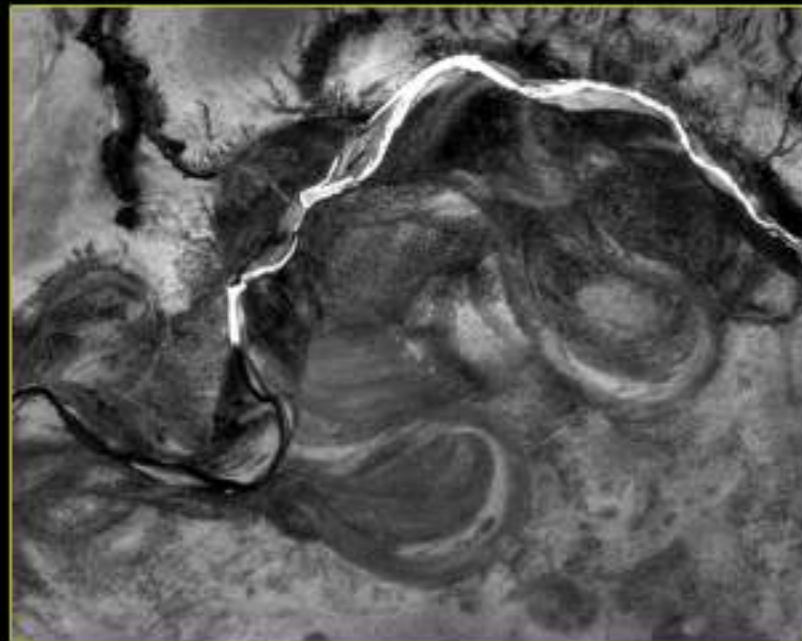




Deep-water

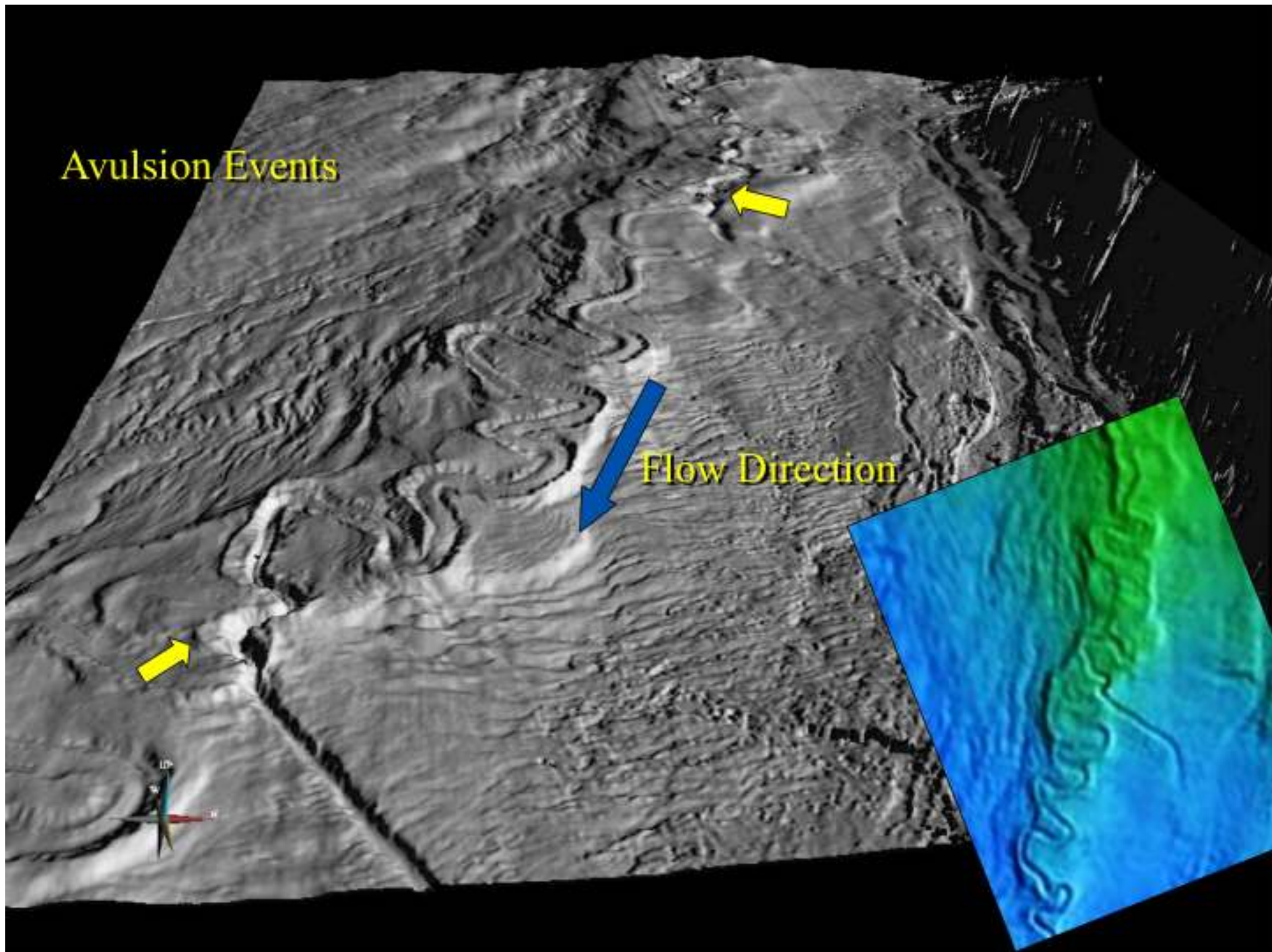


Fluvial

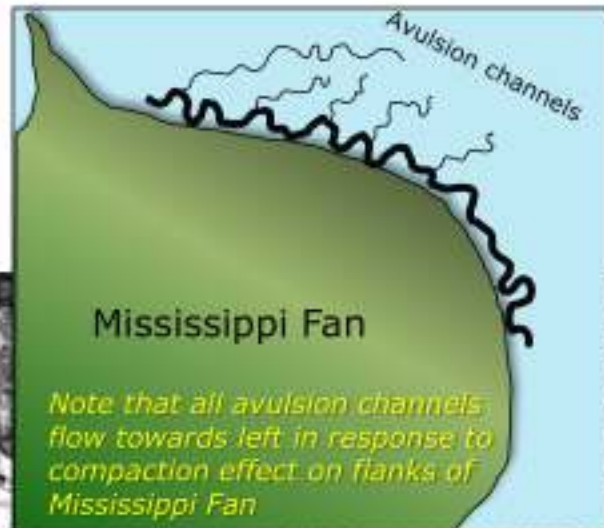


Avulsion Events

Flow Direction



Avulsion Channels



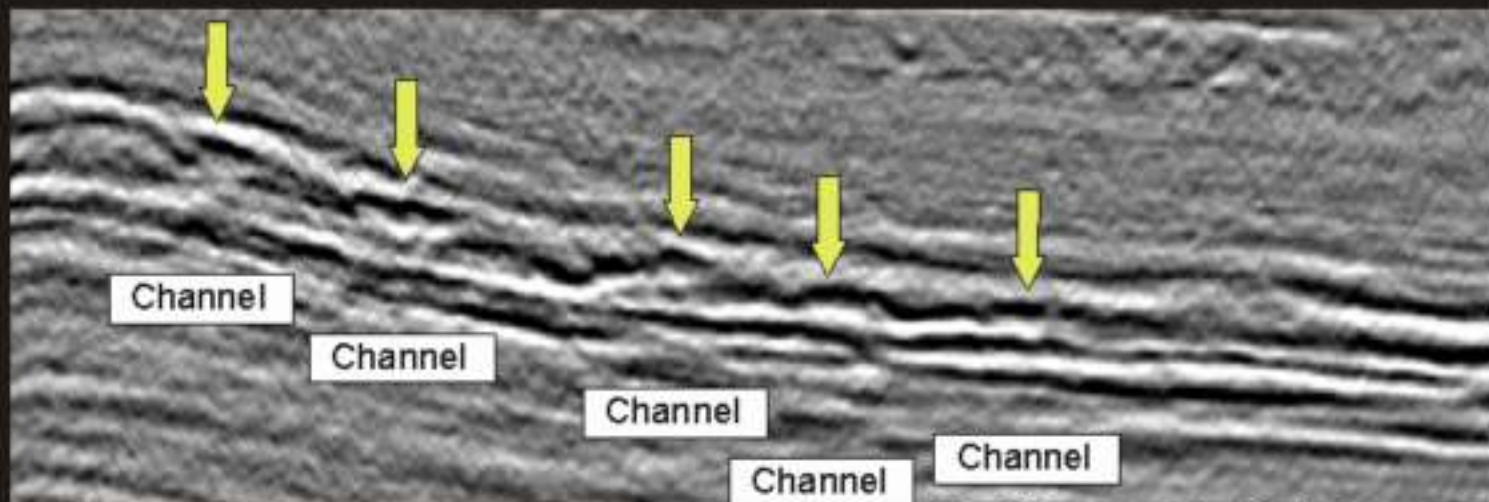
5 km

Avulsion Nodes

Late Miocene (?) Leveed Channel System

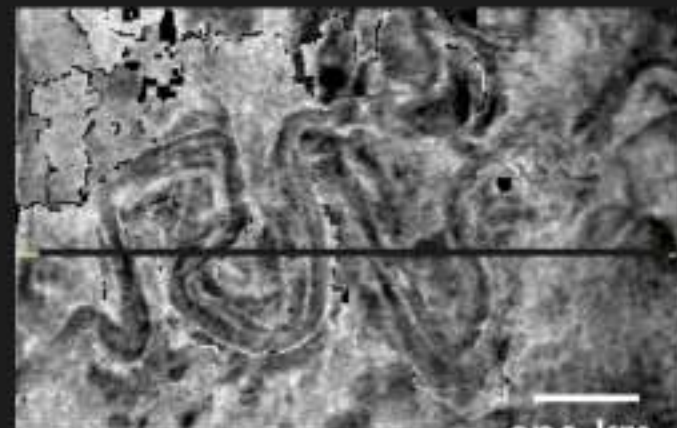
West

East



xline 5315

100 msec
one km

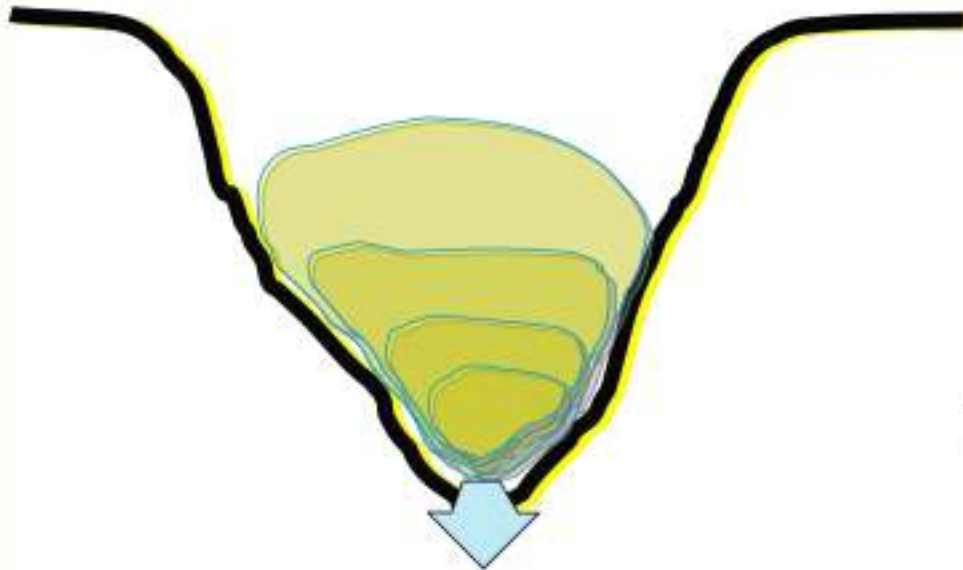


one km

Canyons and Slope Valleys

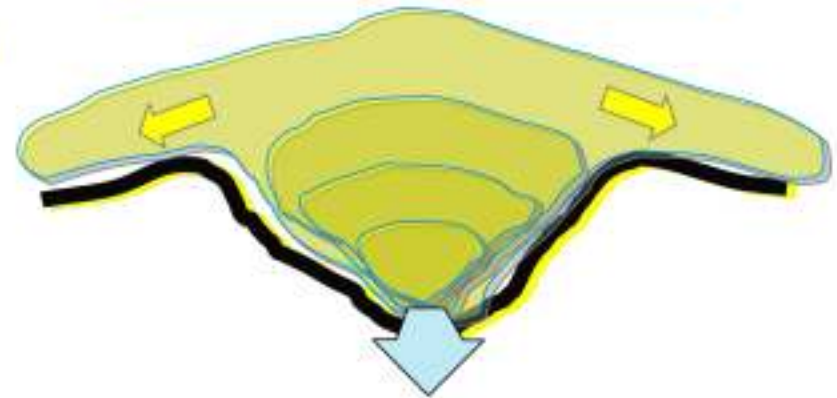
Terminology

Canyon/Slope Valley



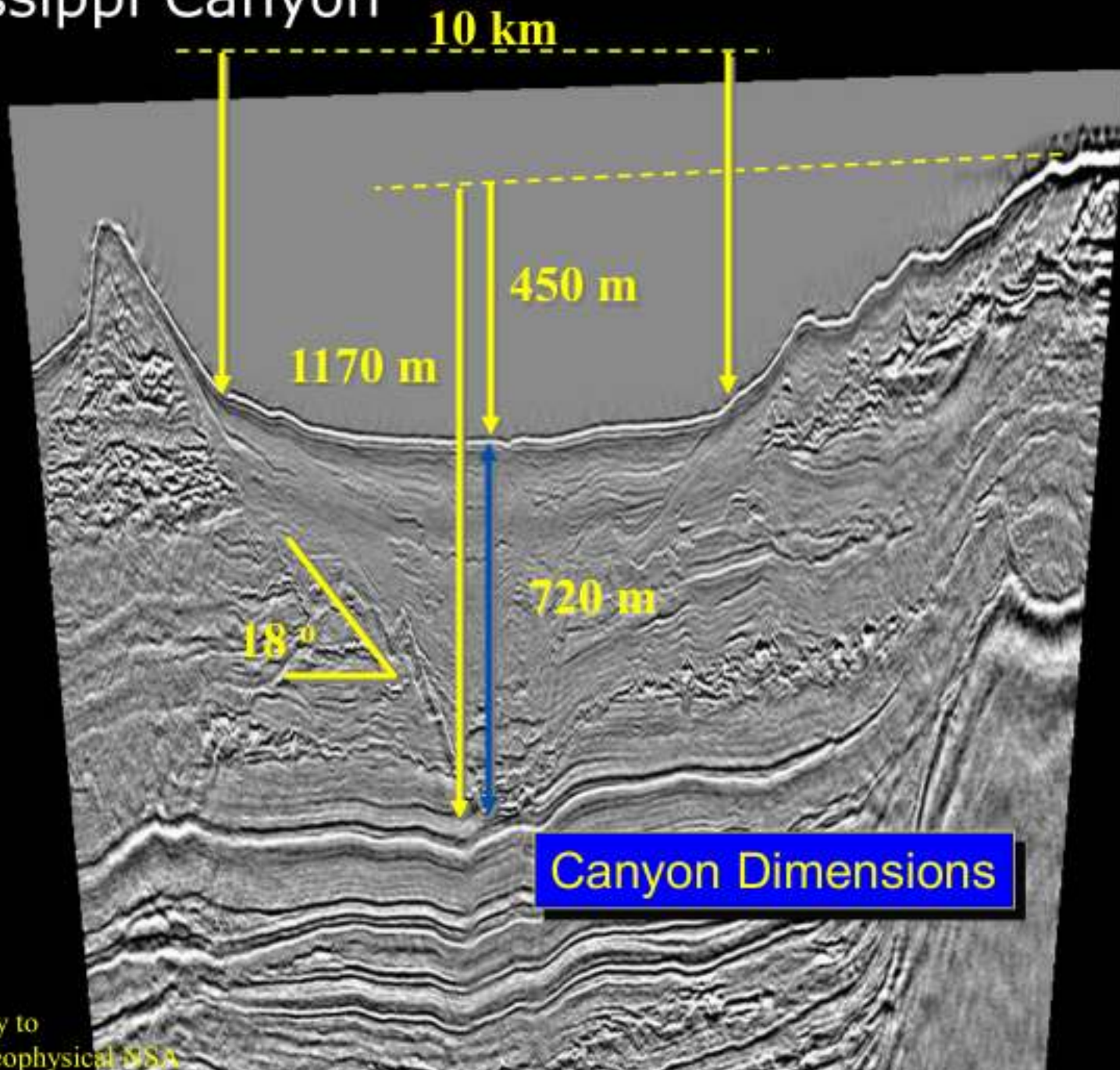
- Turbidity flows nearly full confined by walls
- External levees uncommon

Slope Channel/Gully



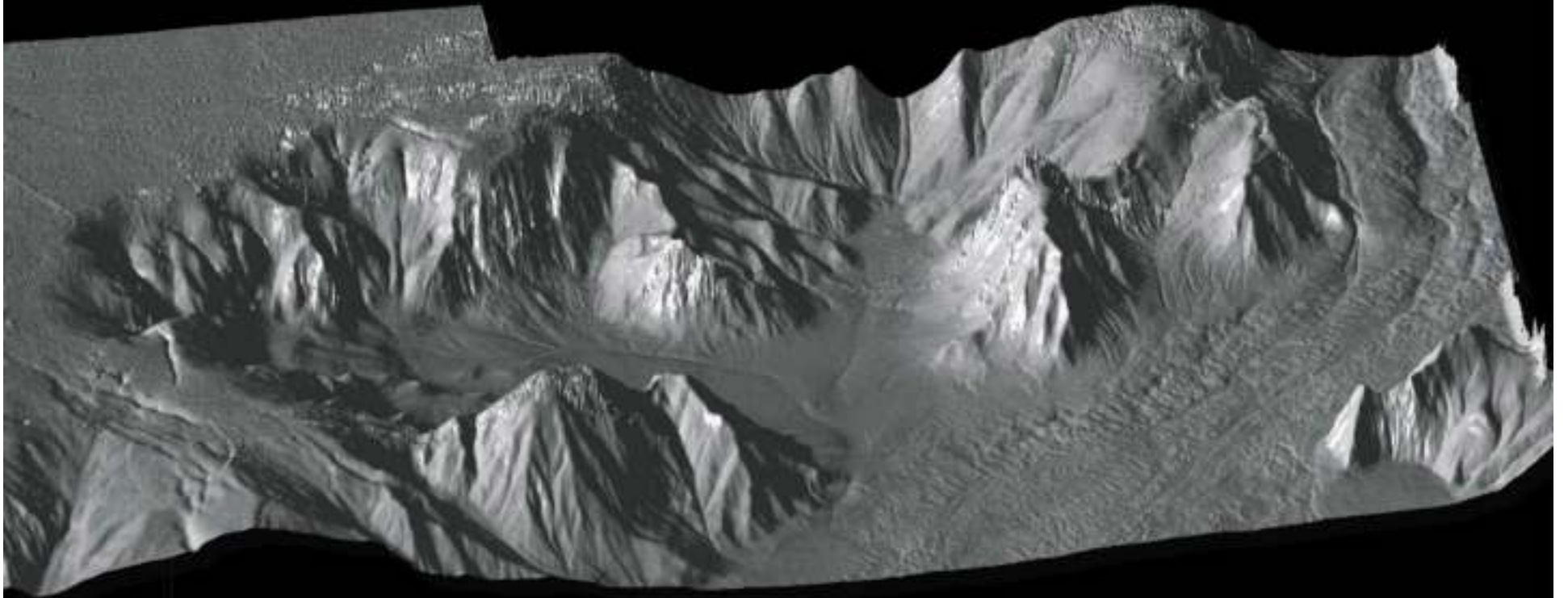
- Turbidity flows not fully confined by walls
- External levees common

Mississippi Canyon



Data proprietary to
PGS Marine Geophysical USA

Mississippi Canyon

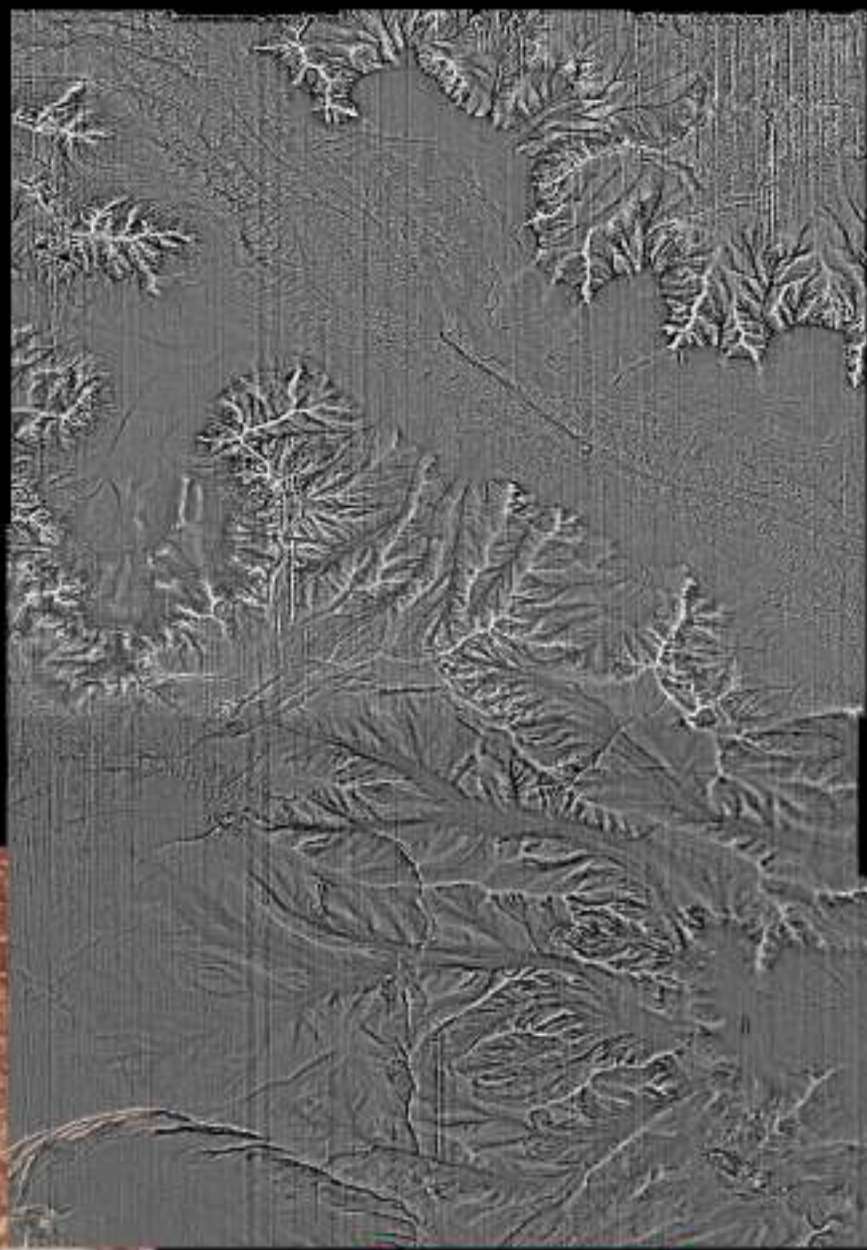


Mississippi Canyon Fly-over





Dip Azimuth



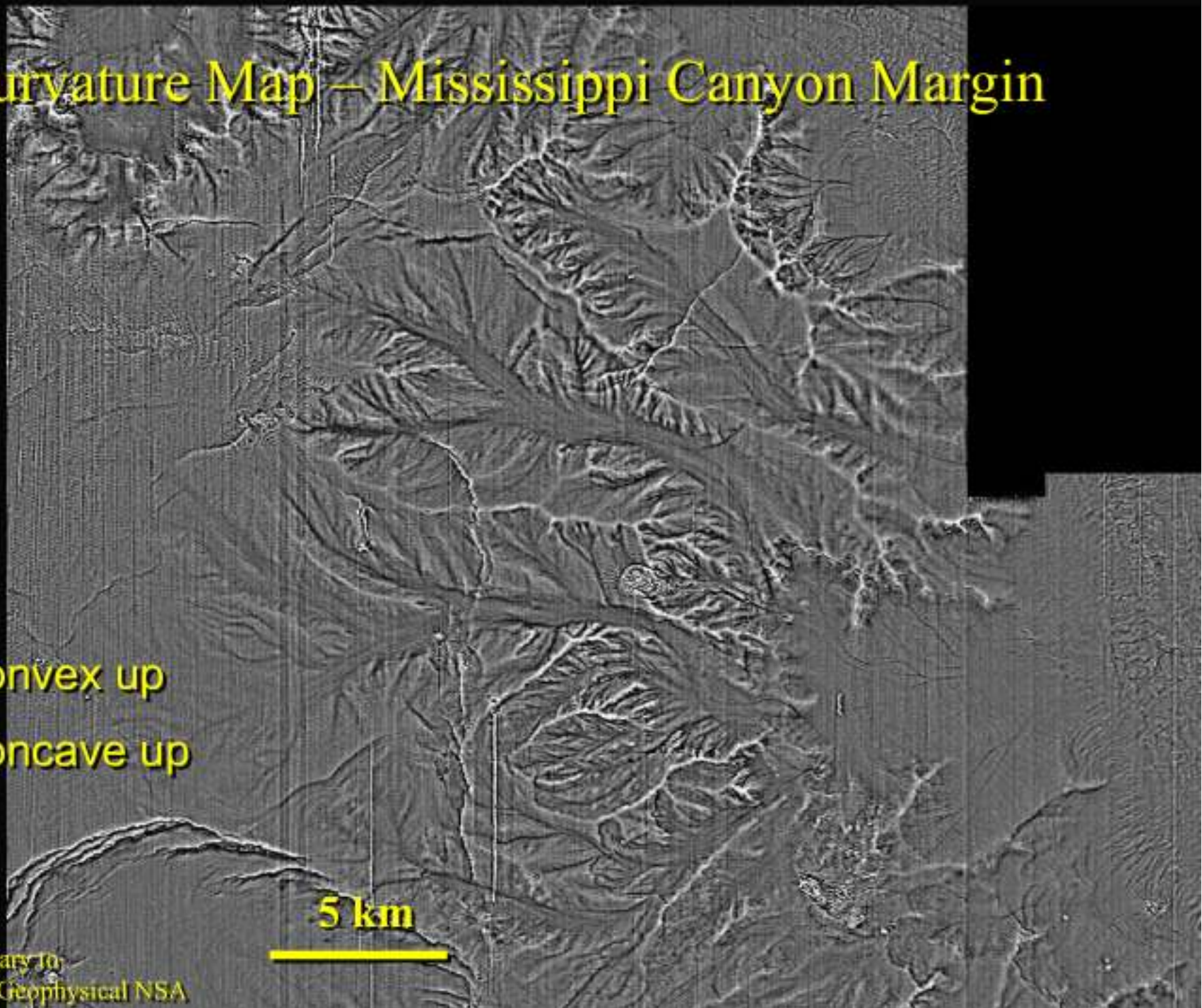
Curvature

Curvature Map – Mississippi Canyon Margin

- Convex up
- Concave up

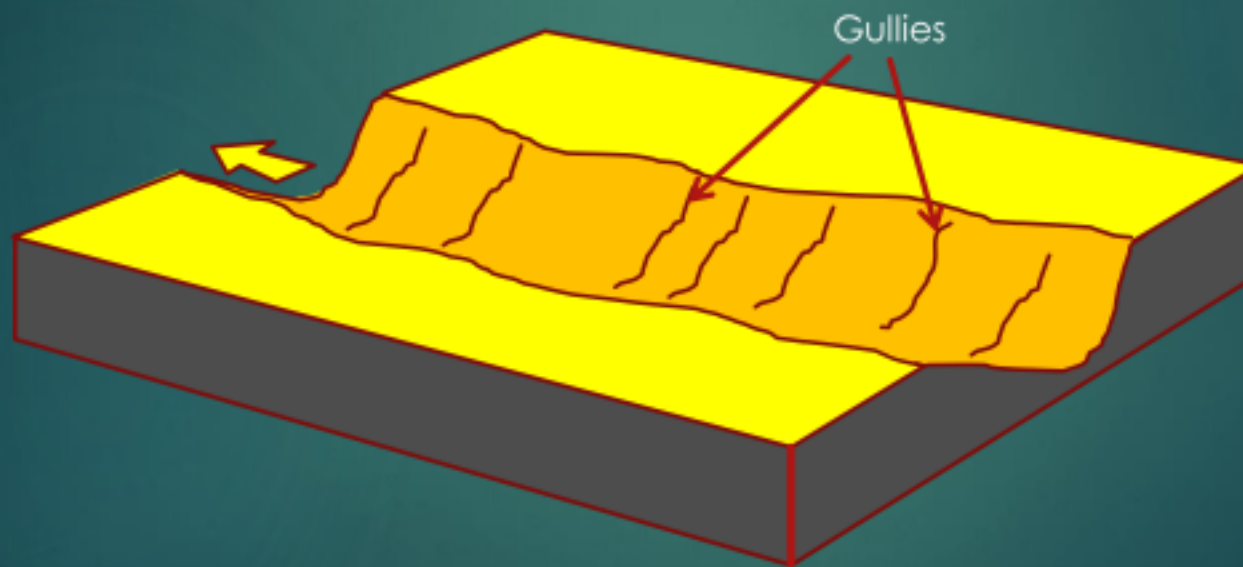
5 km

Data proprietary to
PGS Marine Geophysical NSA

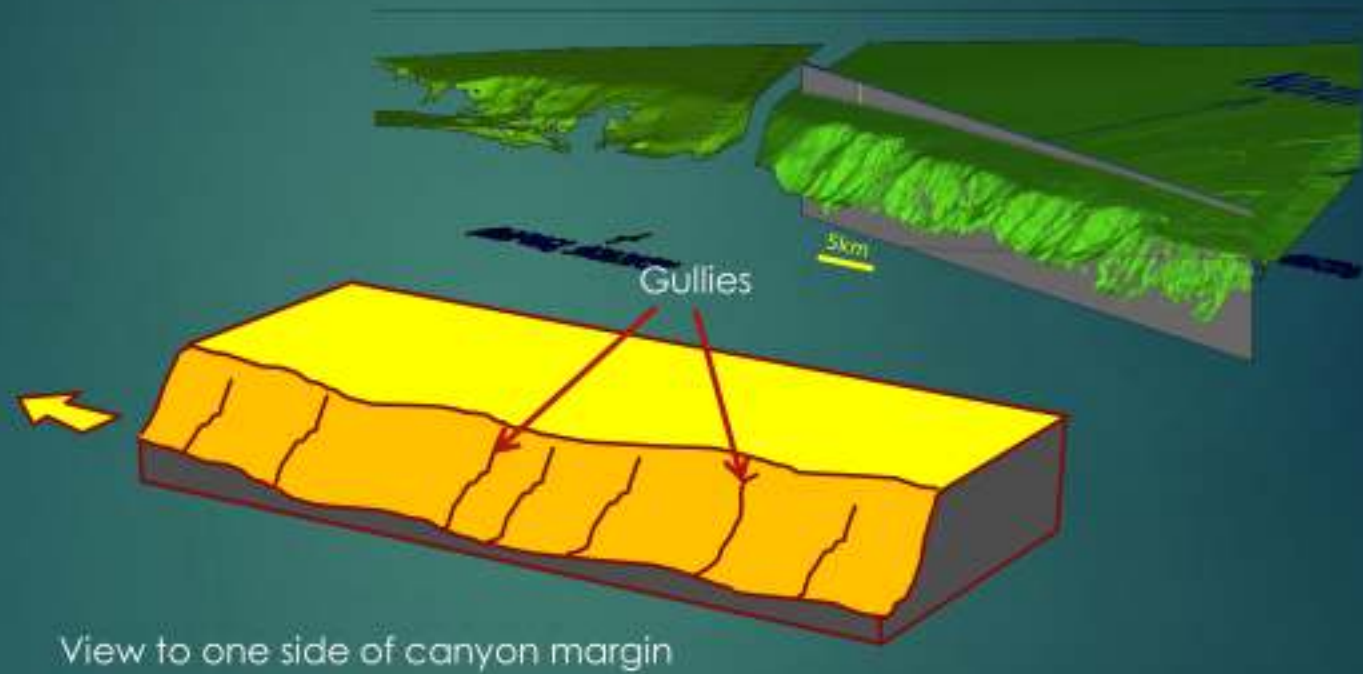


Canyon Morphology

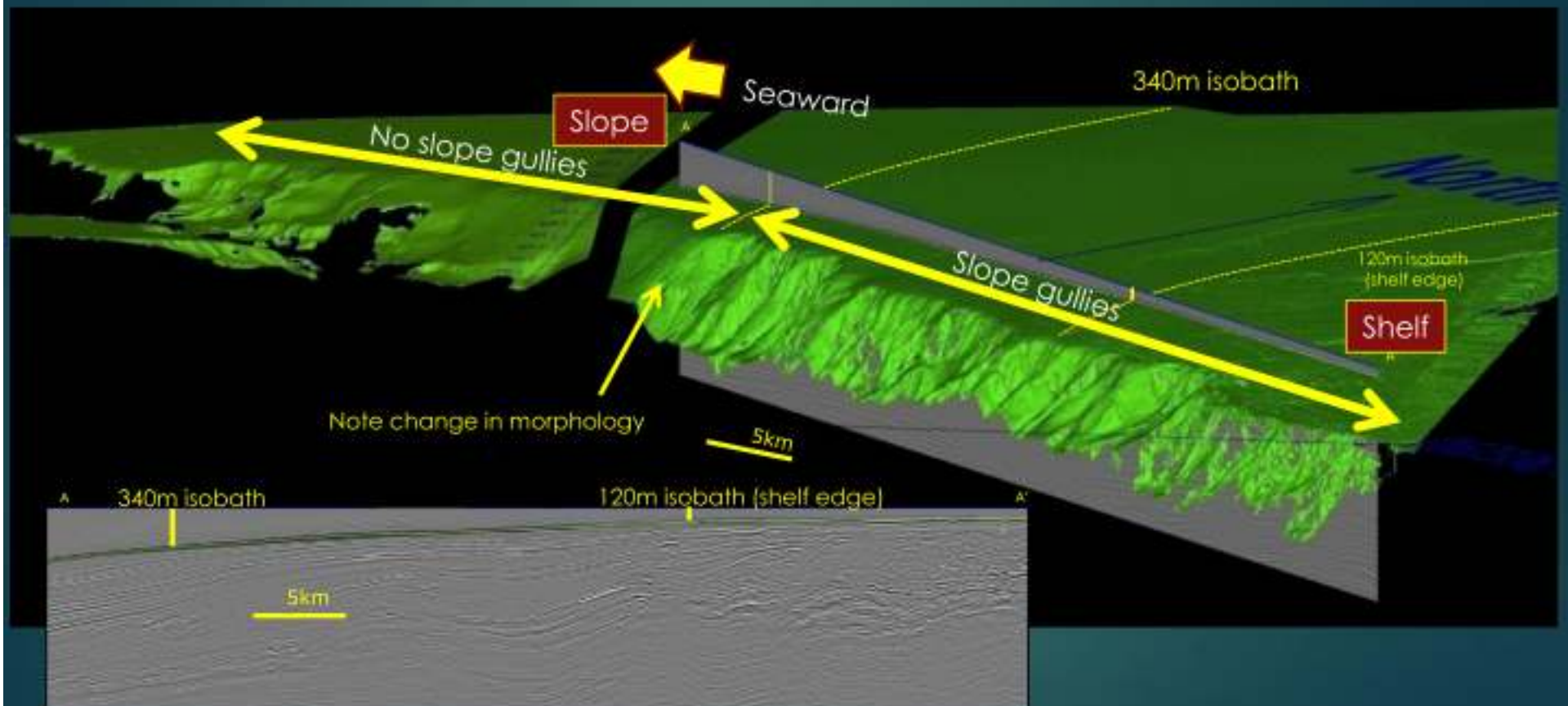
Case study: Gullies along canyon wall



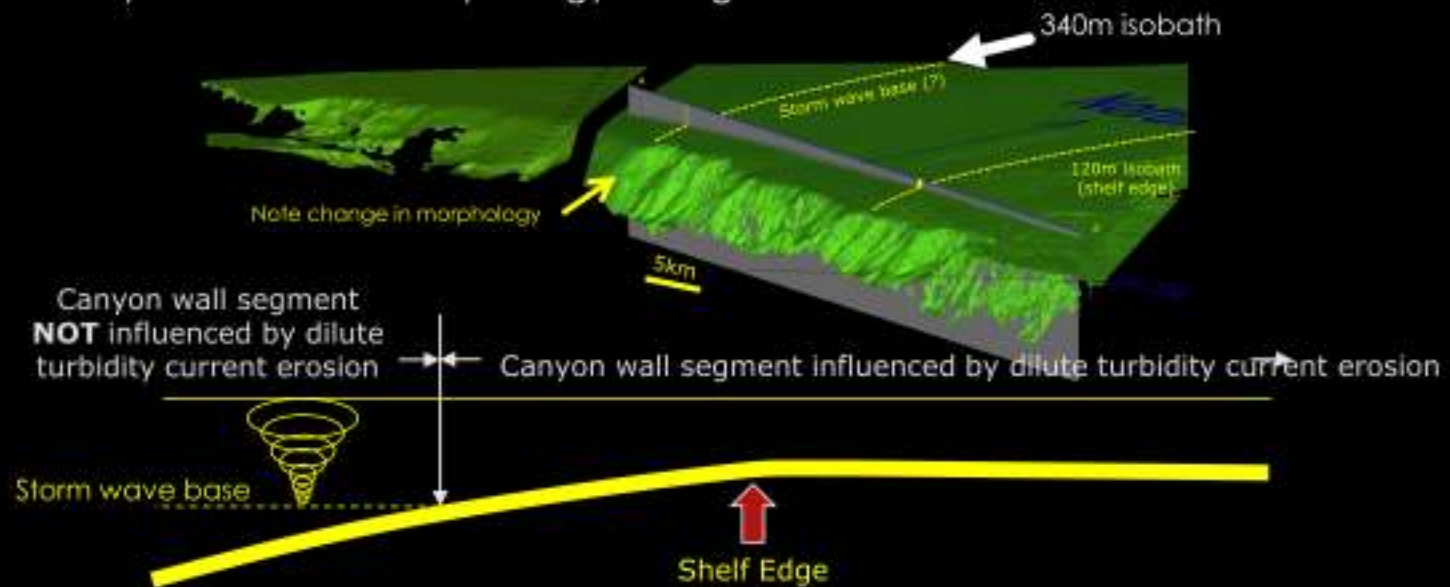
Canyon Morphology



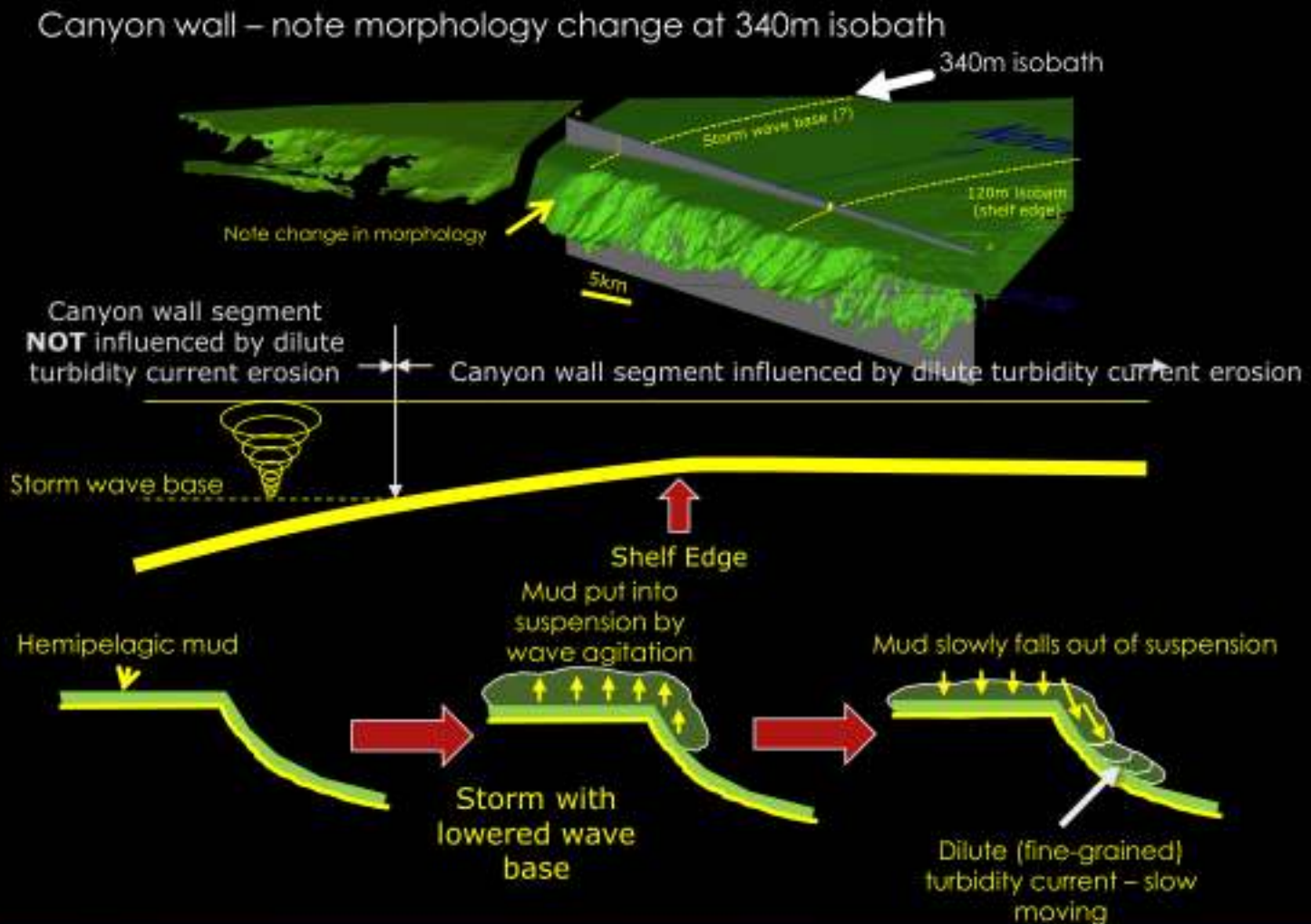
Canyon wall: Note morphology change at slope 340m isobath



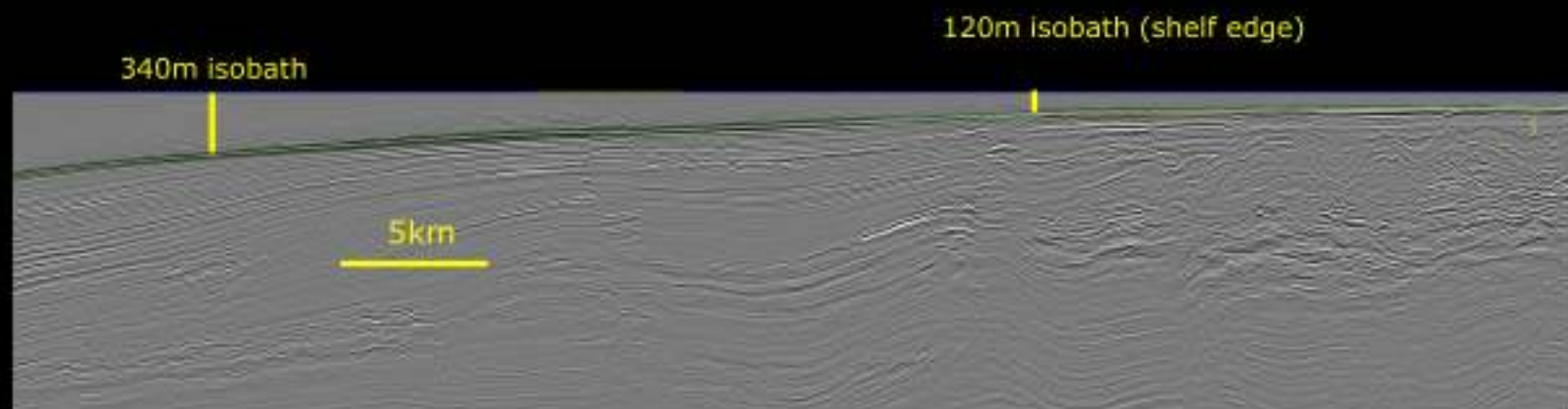
Canyon wall – note morphology change at 340m isobath



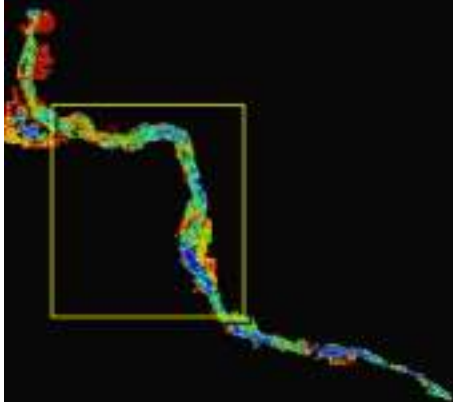
Canyon Wall Processes



Dip Profile



Axial Channel Detail (Discontinuity)



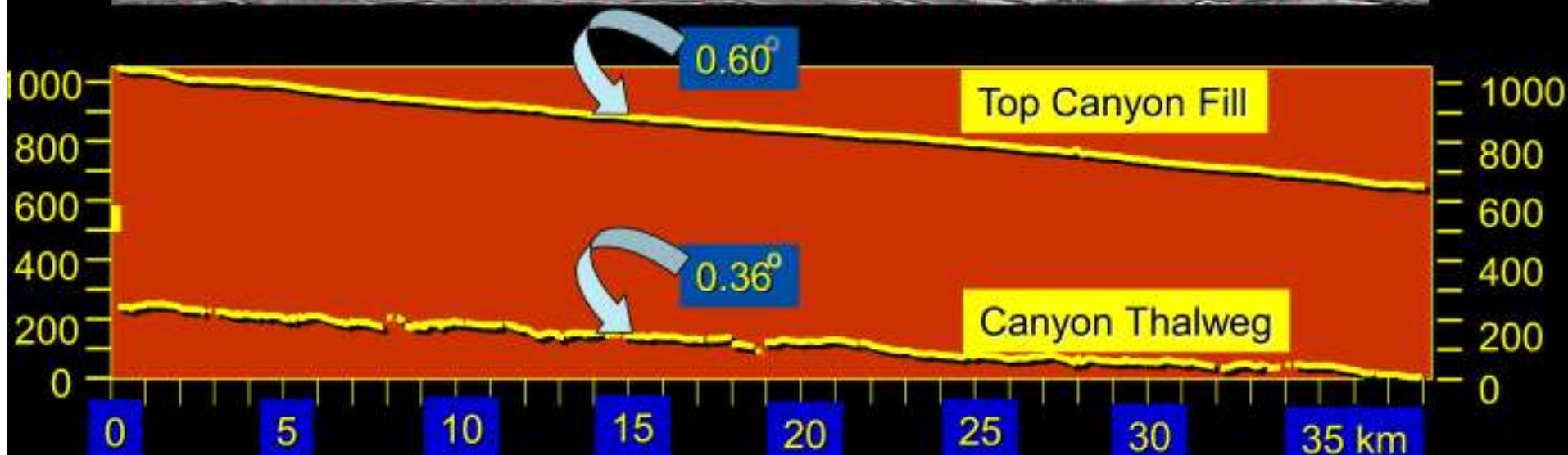
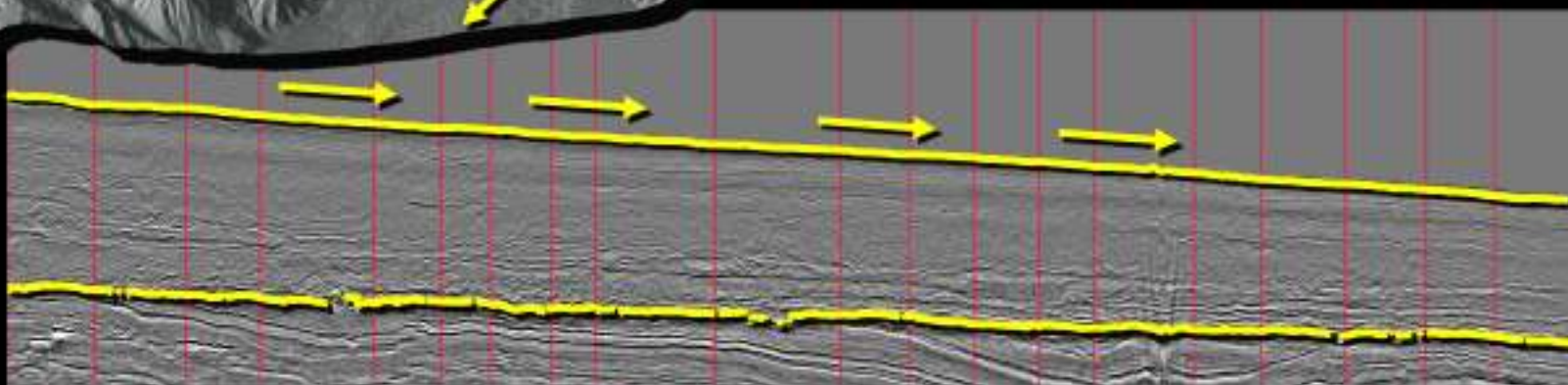
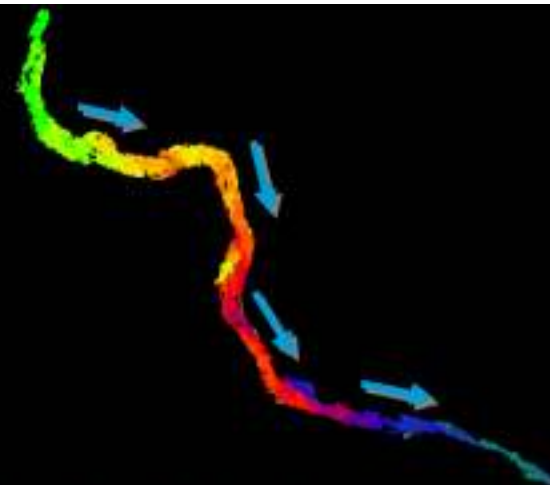
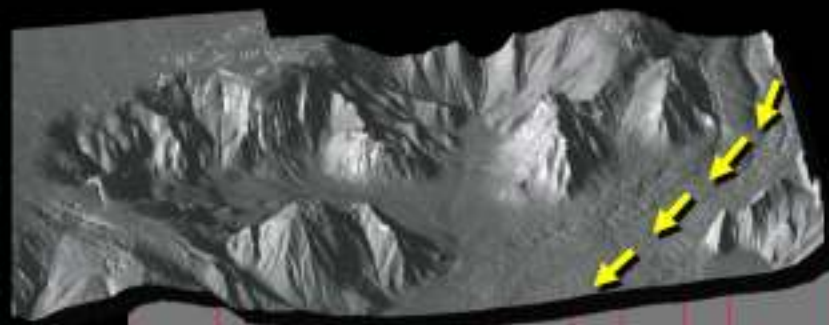
Data proprietary to
PGS Marine Geophysical NSA



time = 1360

Mississippi Canyon Gradients

Fill Top vs. Thalweg



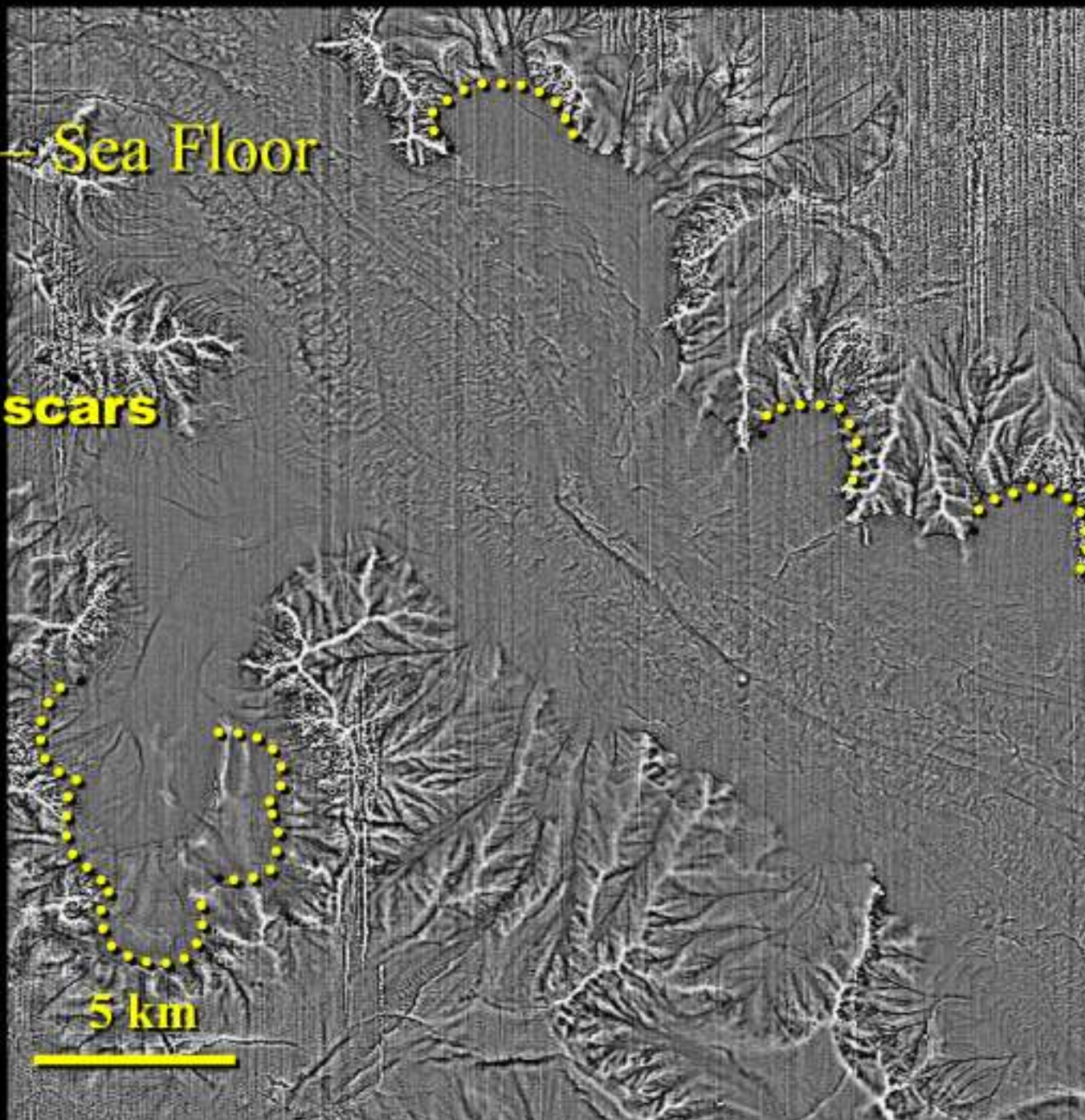
Curvature Map – Sea Floor

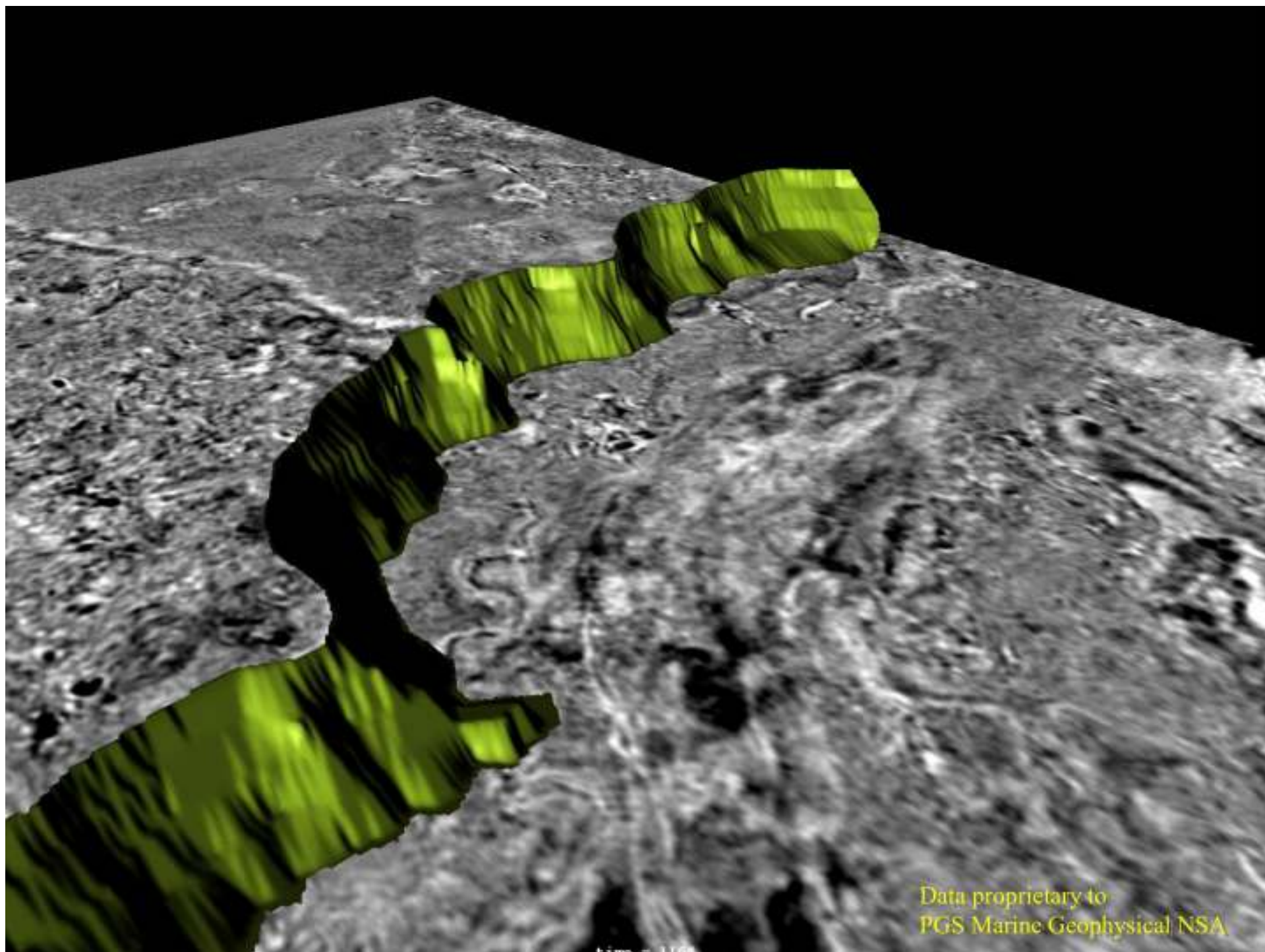
Note arcuate scars

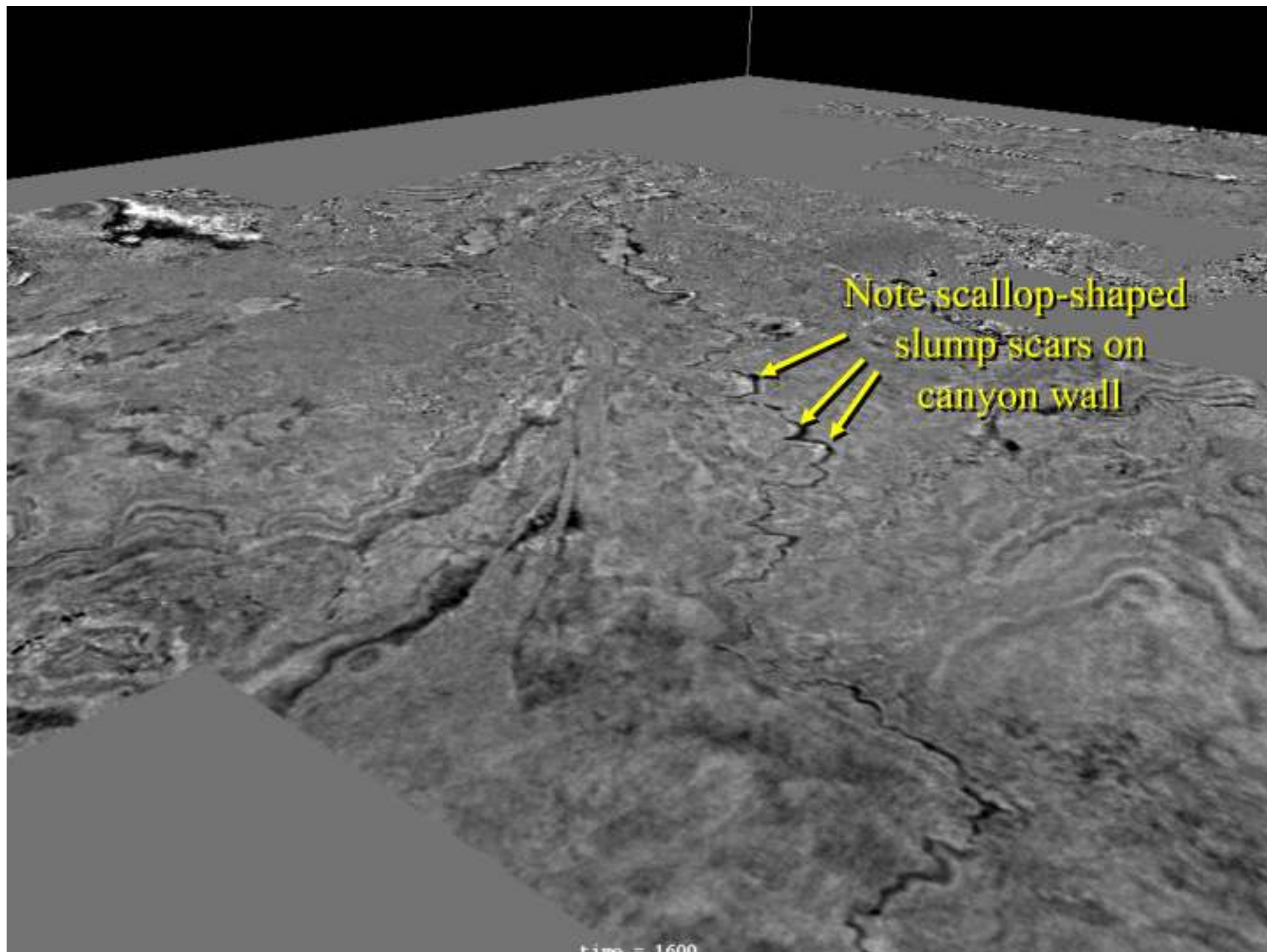
- Convex up
- Concave up

5 km

Data proprietary to
PGS Marine Geophysical NSA

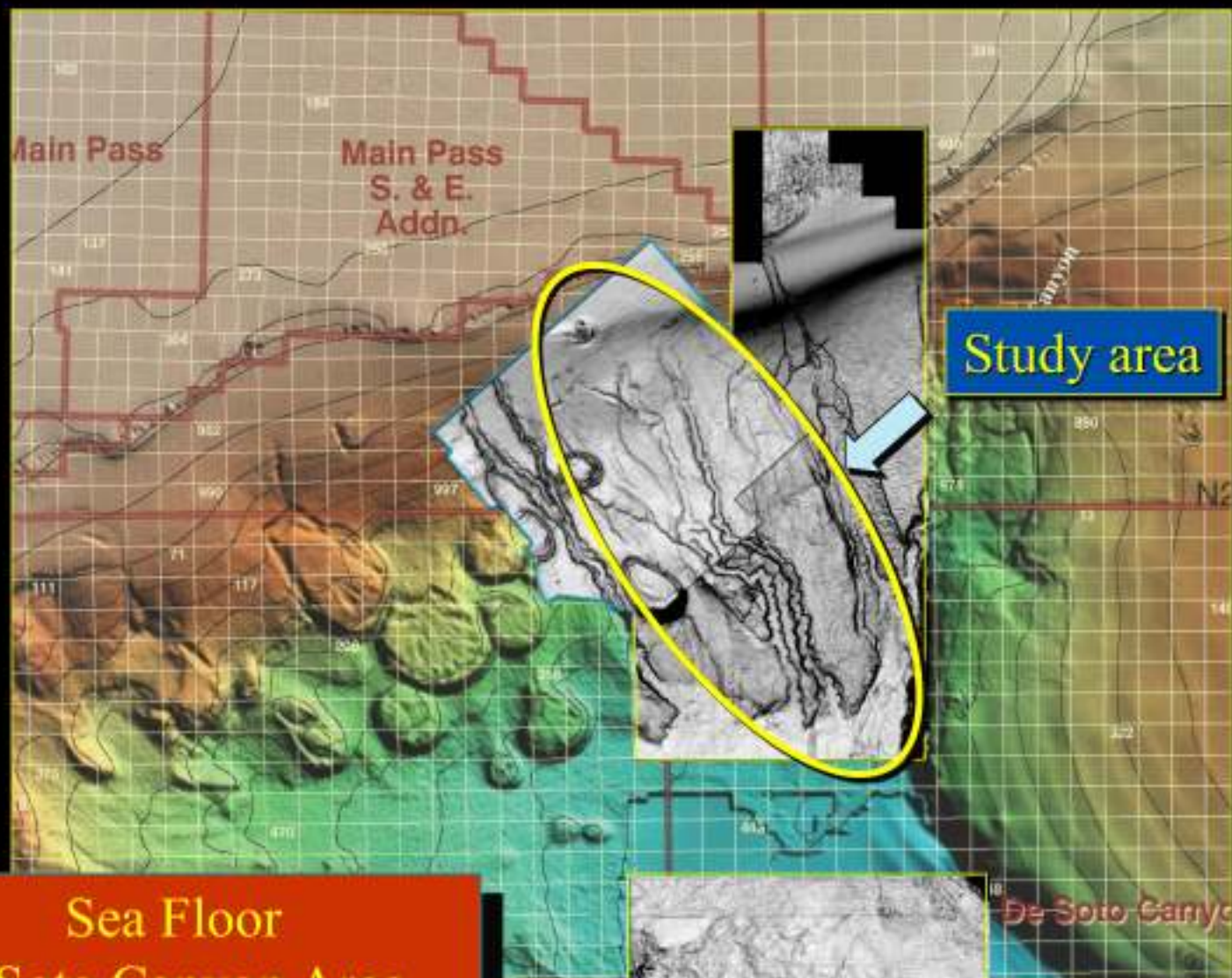






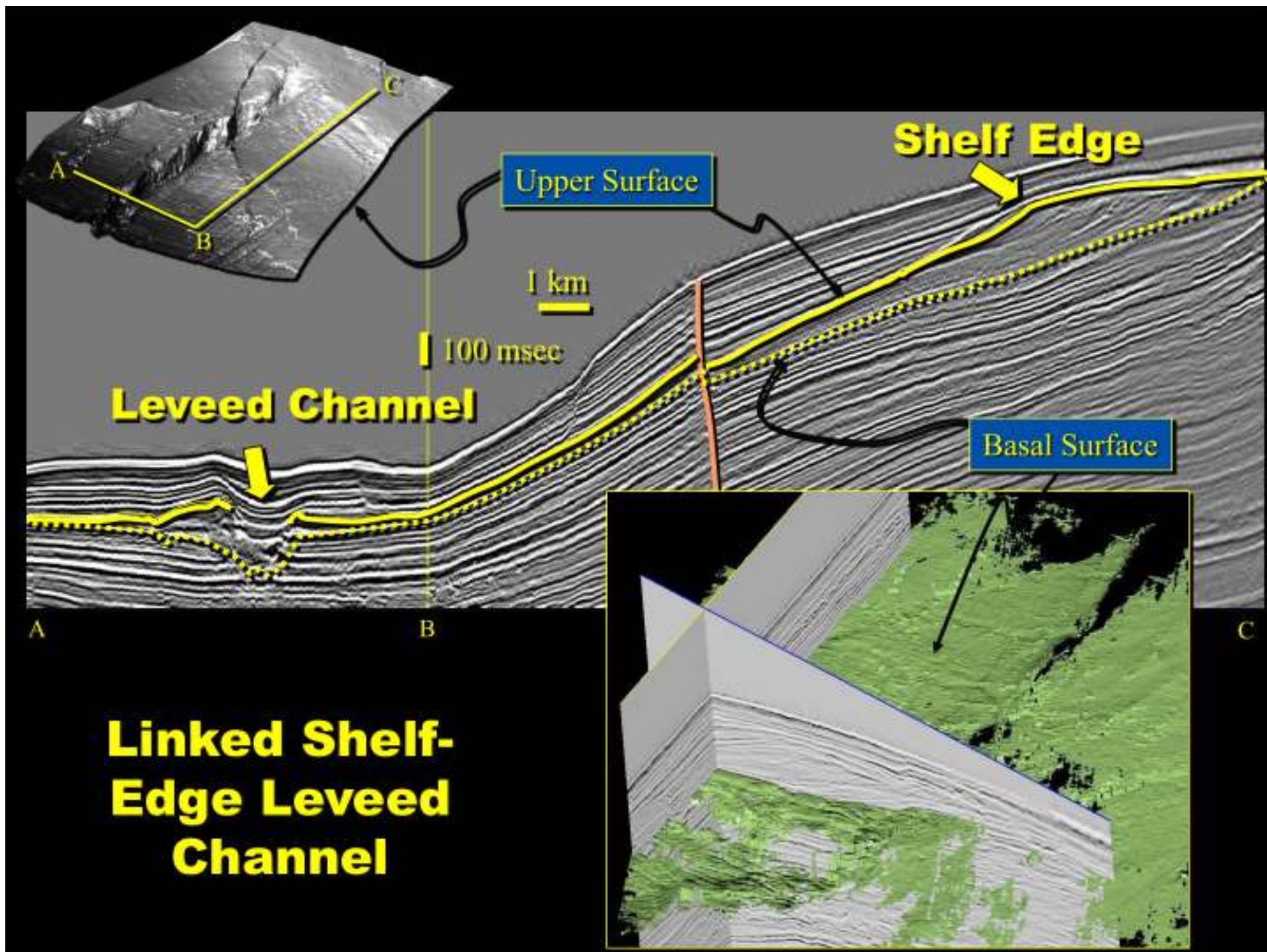
time = 1600

Slope Channels

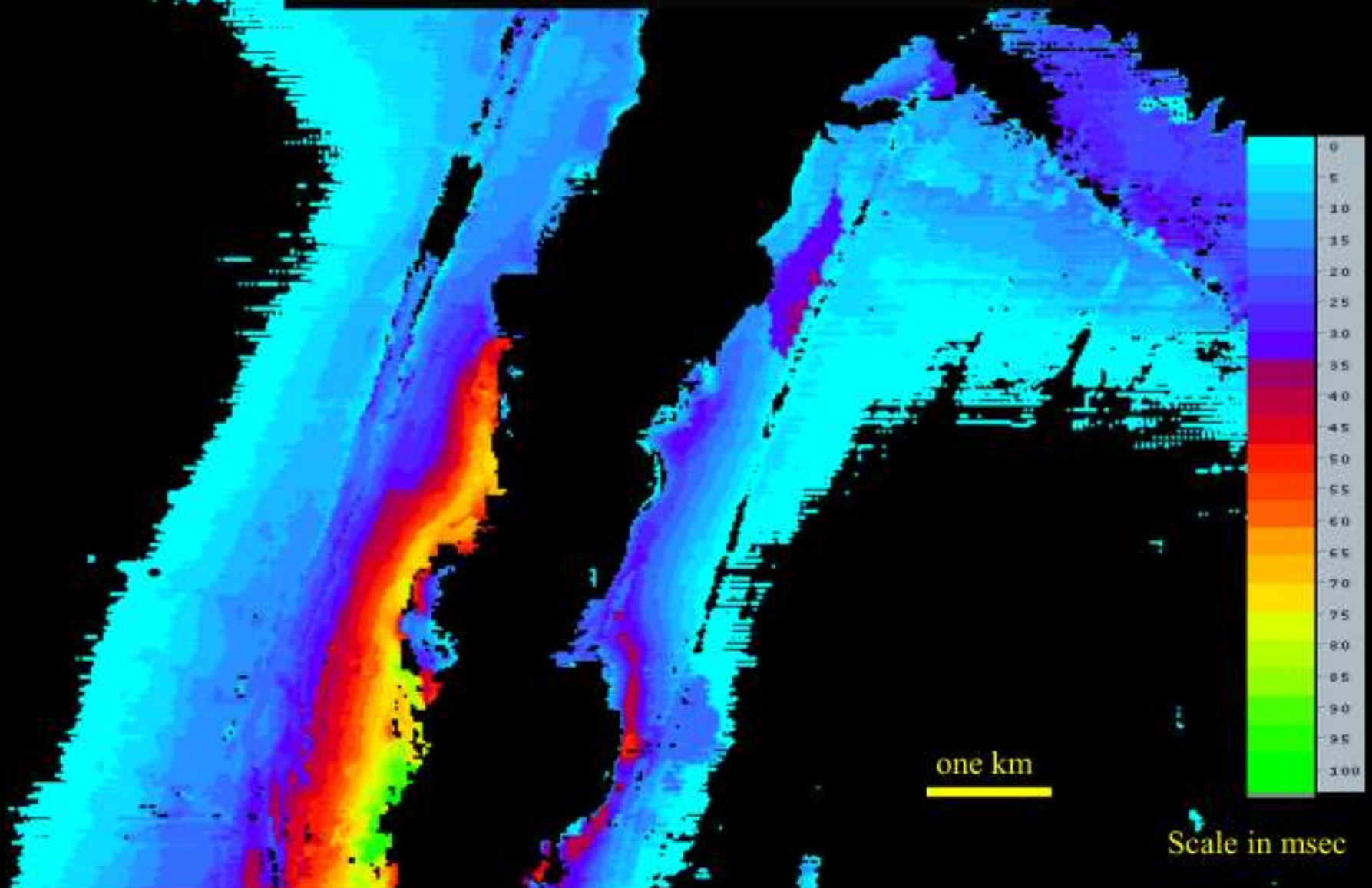


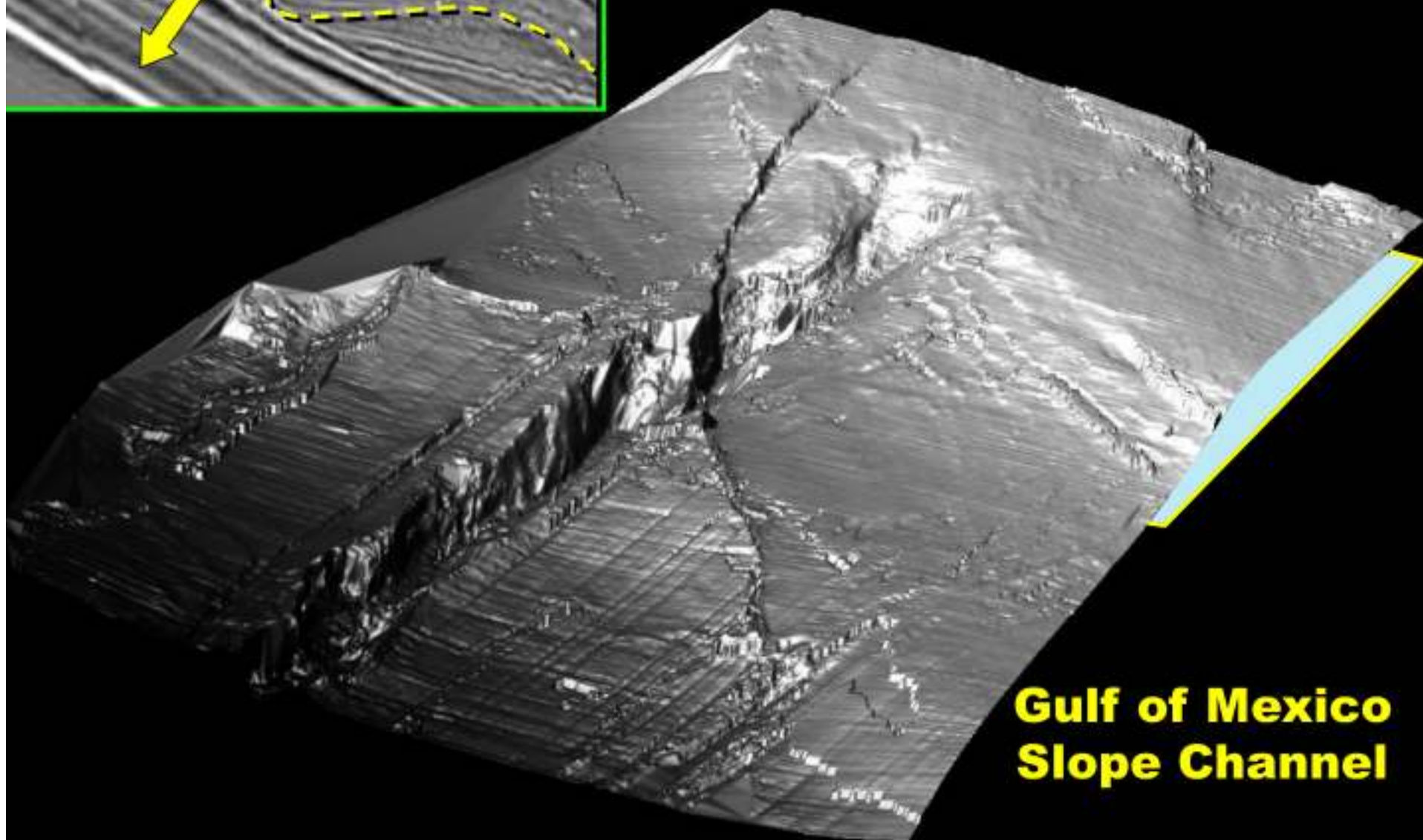
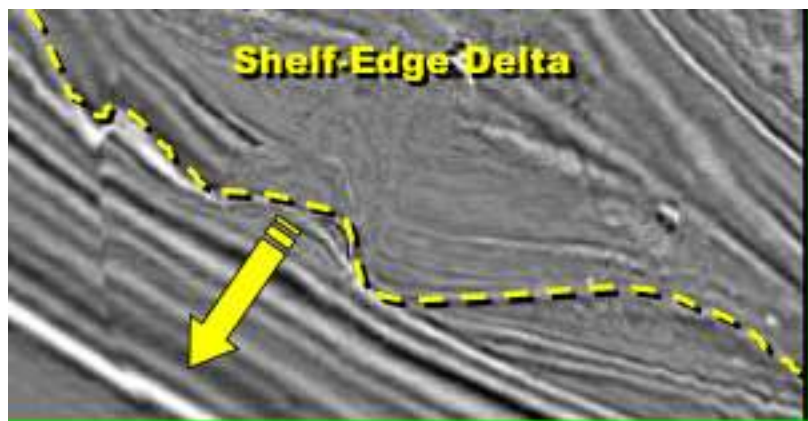
**Sea Floor
DeSoto Canyon Area,
Gulf of Mexico**

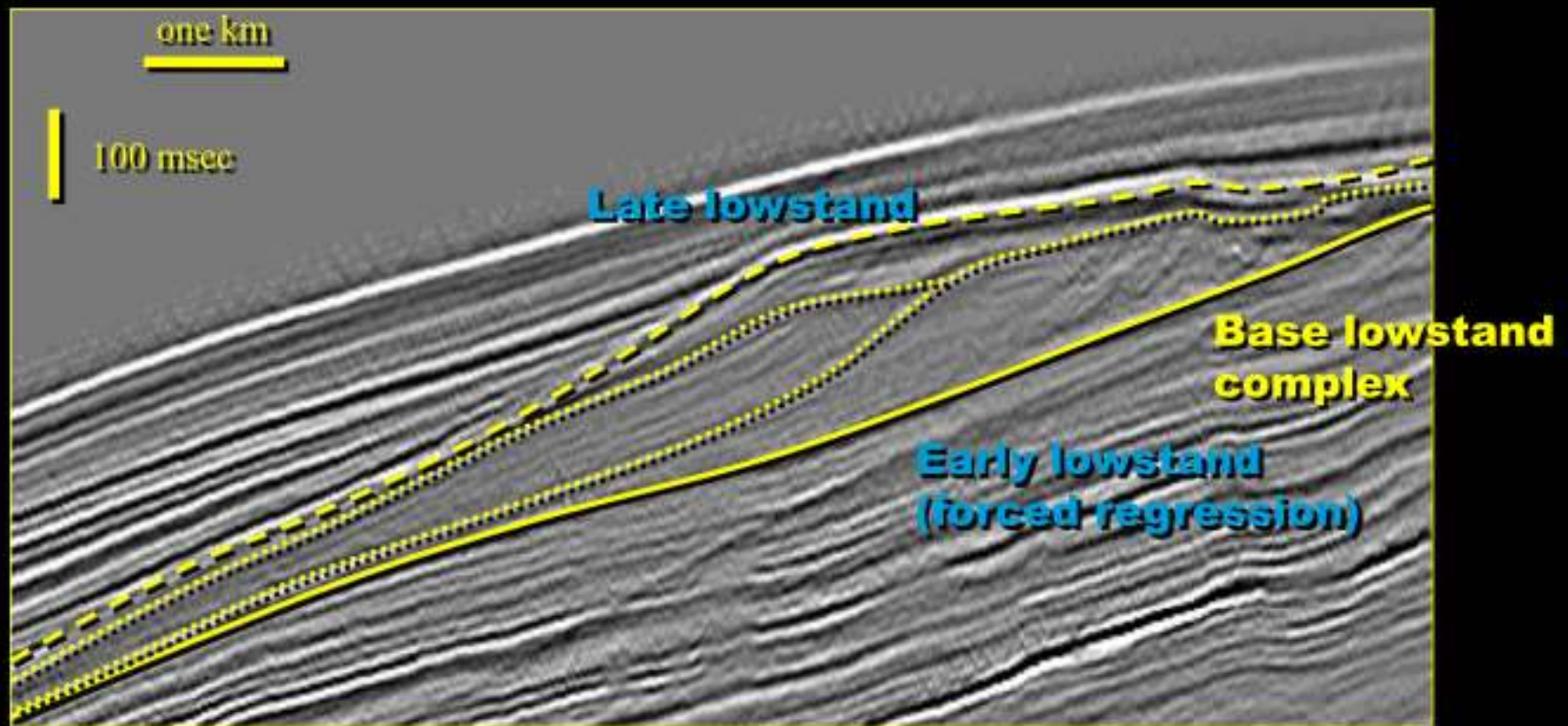
Base map courtesy of TGS Nopec



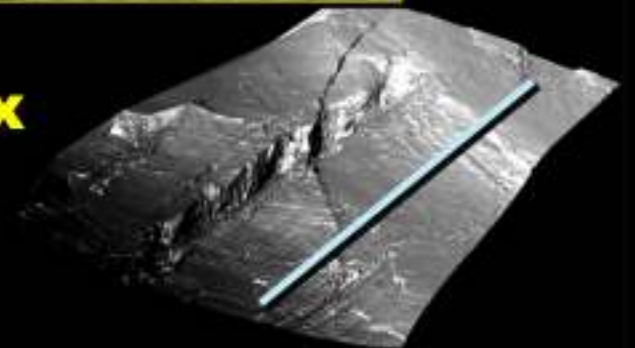
Levee Isochron







Lowstand Shelf-Edge Delta Complex (Away from slope channel)

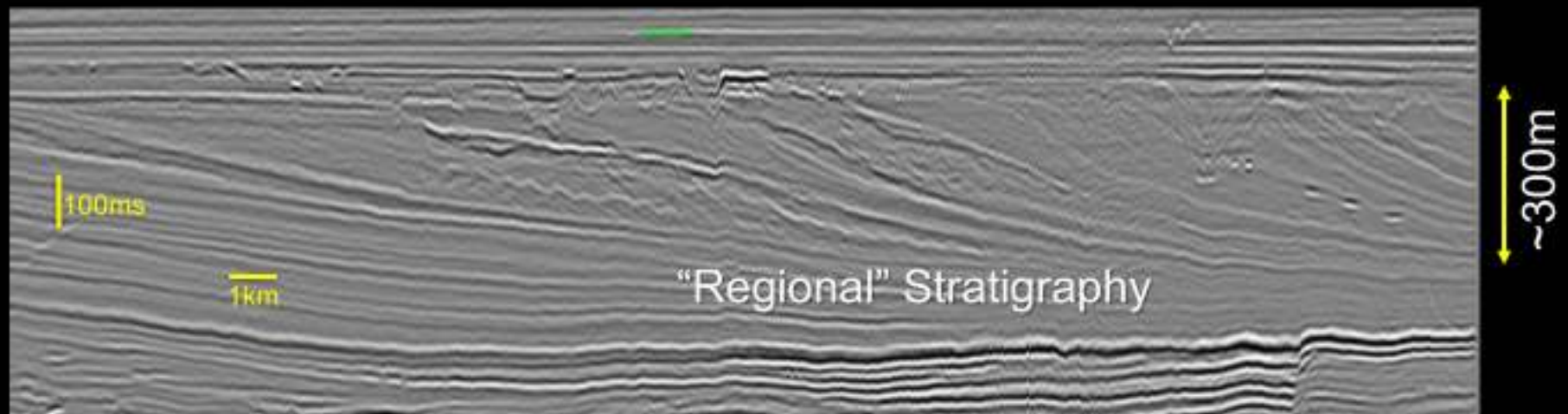
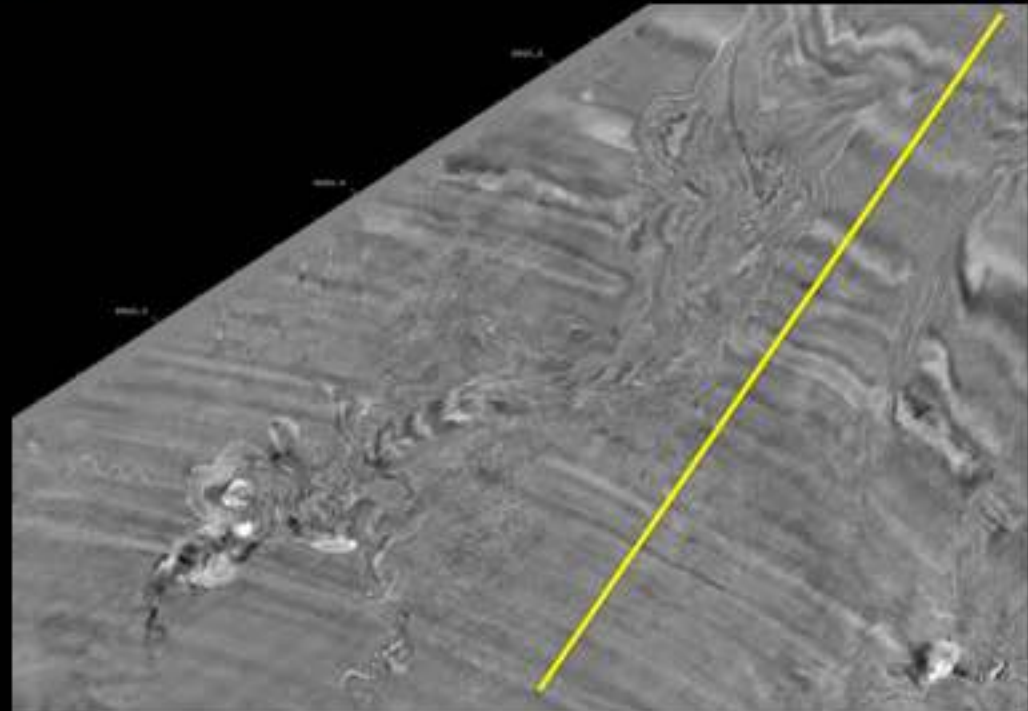


Deep-water canyon

Key issues:

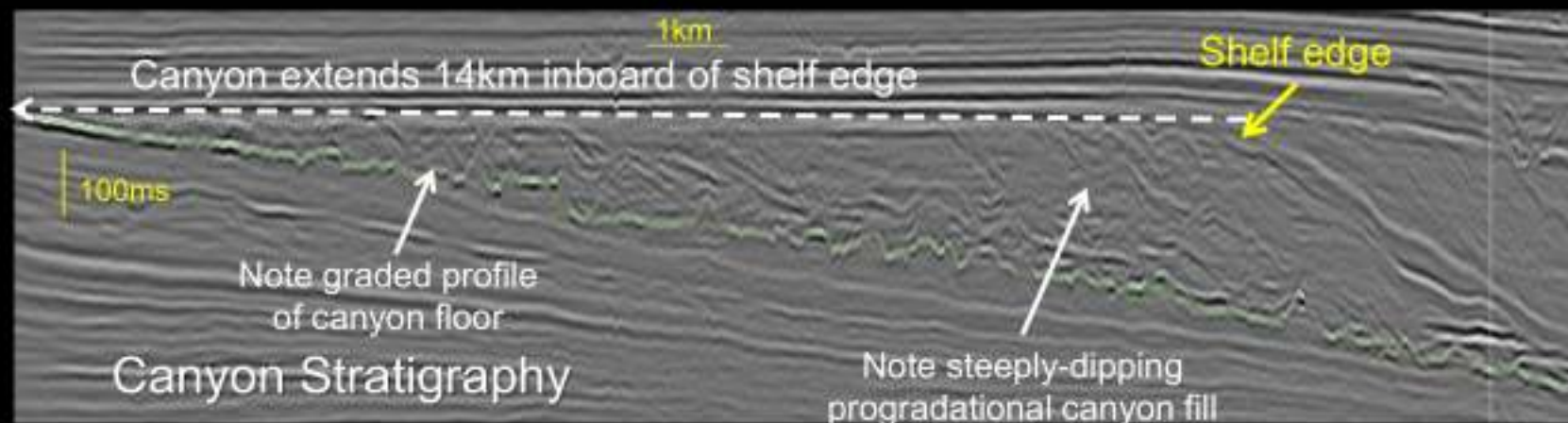
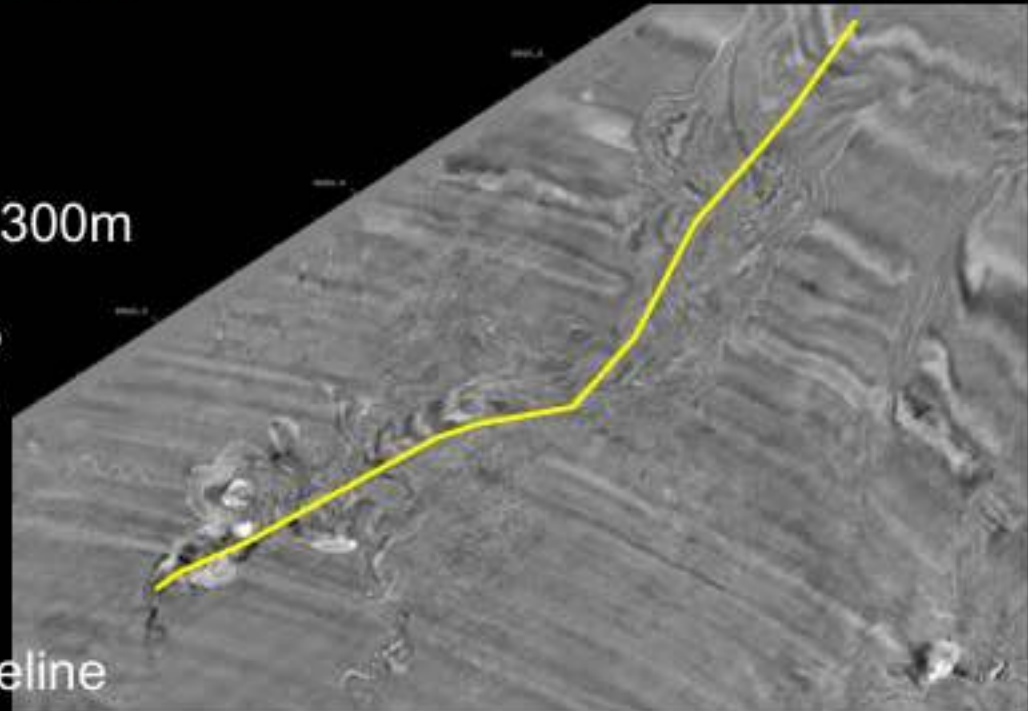
- Fill process
- Fill lithology
- Stratigraphic trap mechanism

Aspect ratio = ~8:1



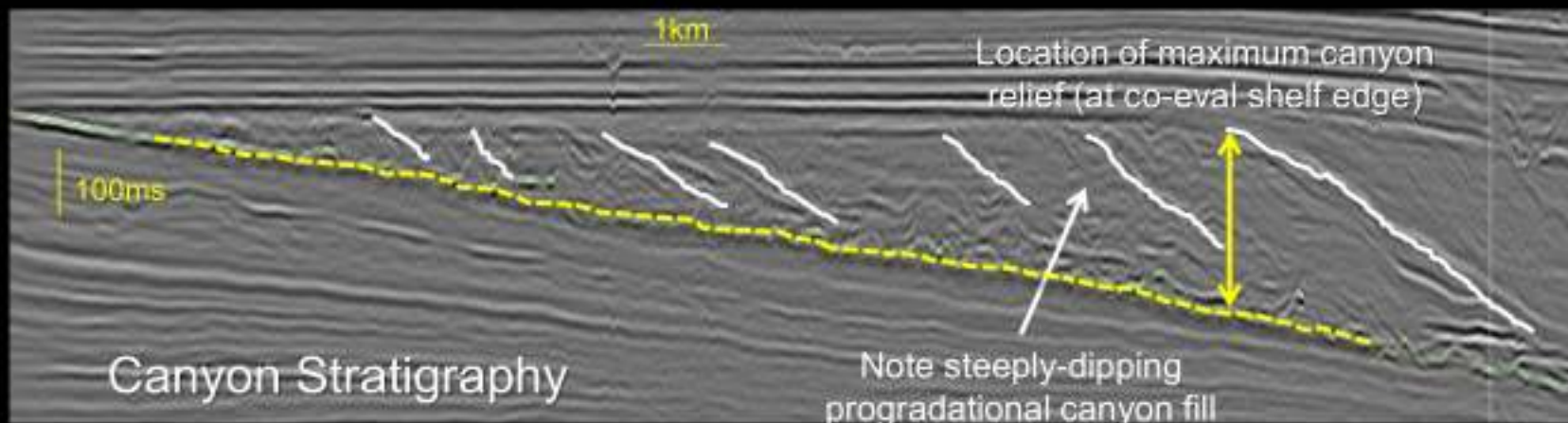
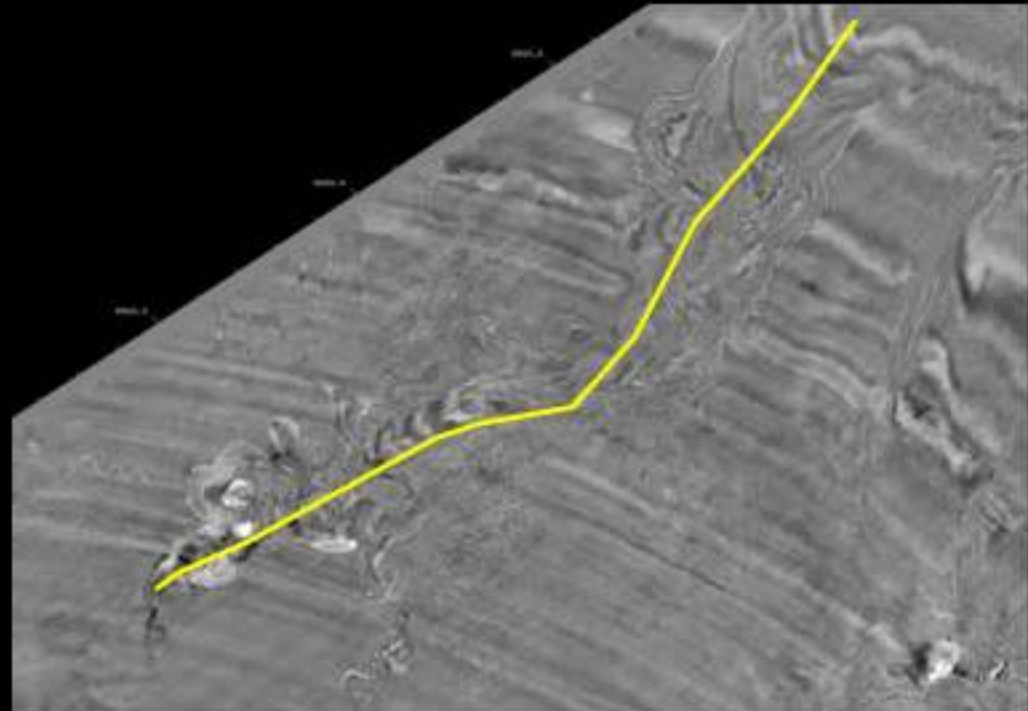
Deep-water canyon fill

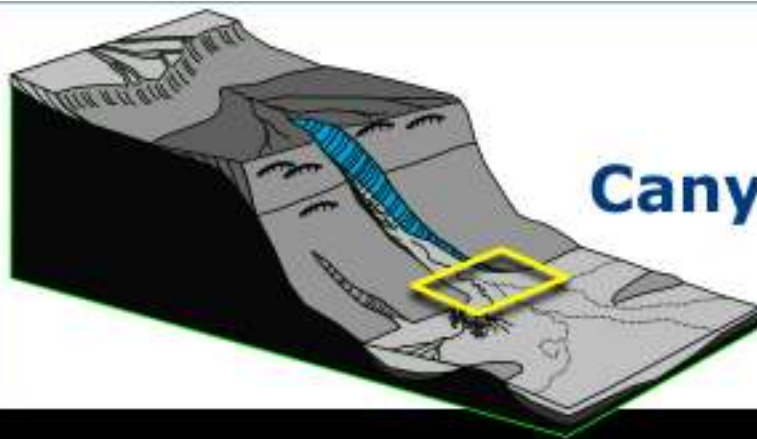
- Maximum canyon relief = $\sim 300\text{m}$
- Canyon width = $\sim 2\text{km}$
- Slope of canyon floor = $\sim 1^\circ$
- Slope of canyon fill = $\sim 4.2^\circ$
- Slope of adjacent shelf clinoforms = $\sim 3.5^\circ$
- Canyon oriented nearly orthogonal to regional shoreline



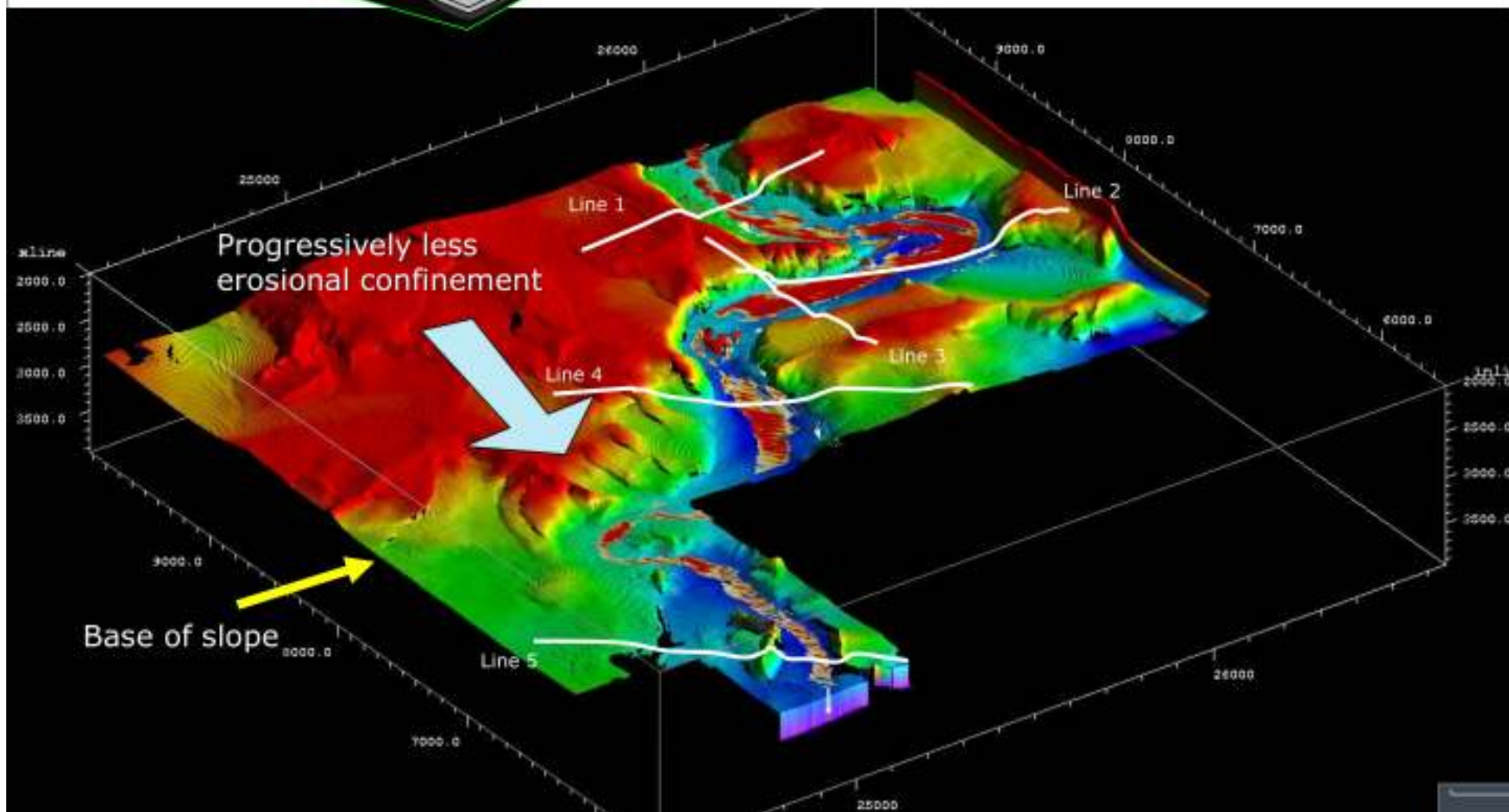
Deep-water canyon fill

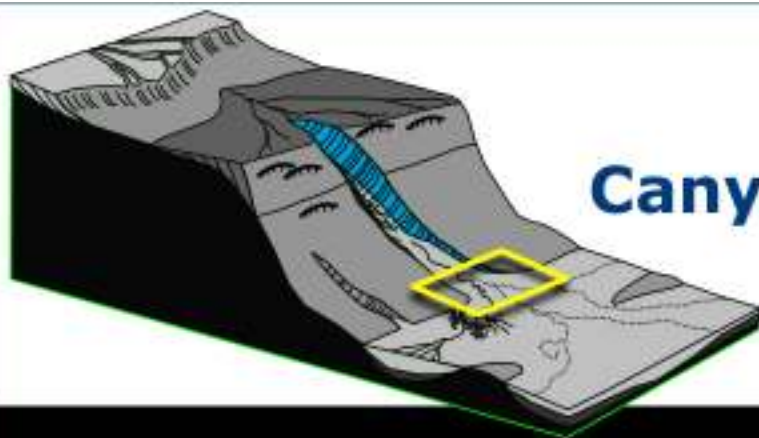
- Maximum canyon relief occurs at shelf edge
- Equilibrium gradient associated with turbulent flow is less than that associated with mass transport or plume sedimentation
- Seaward progradation characterizes canyon fill architecture



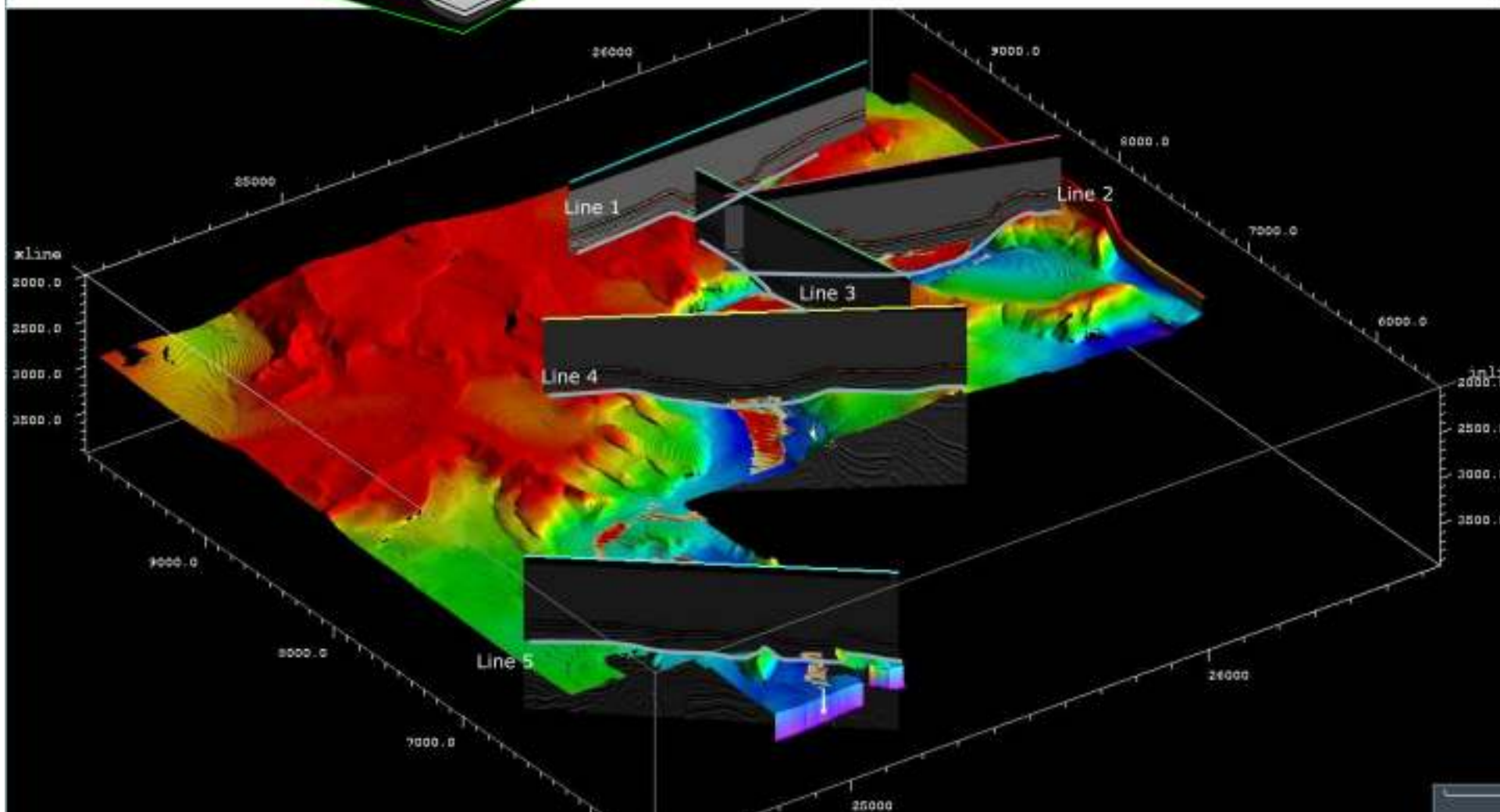


Canyon to Basin Floor Transition

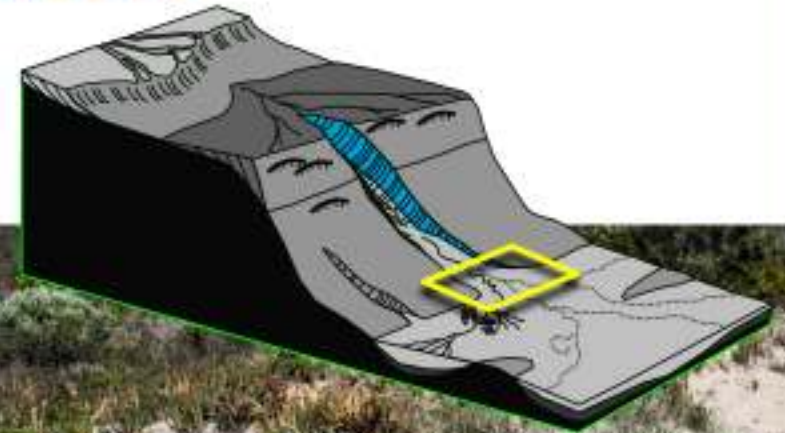
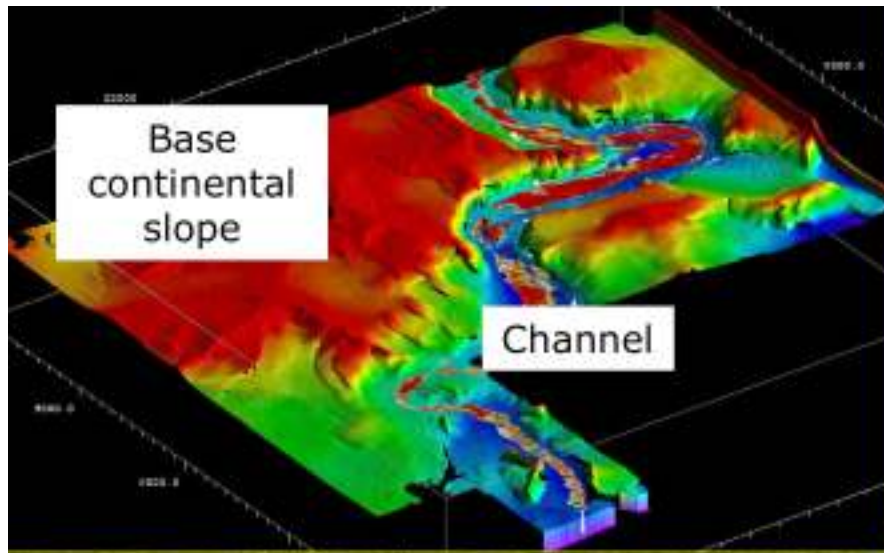




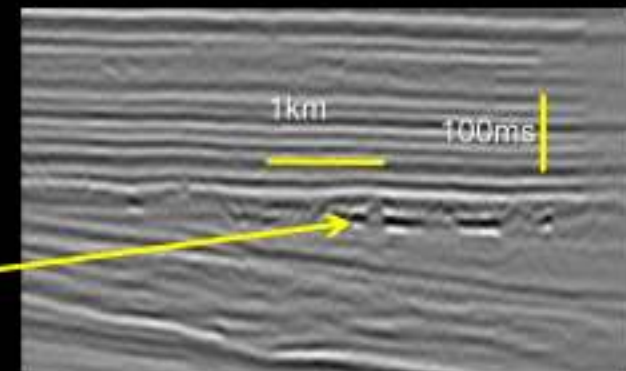
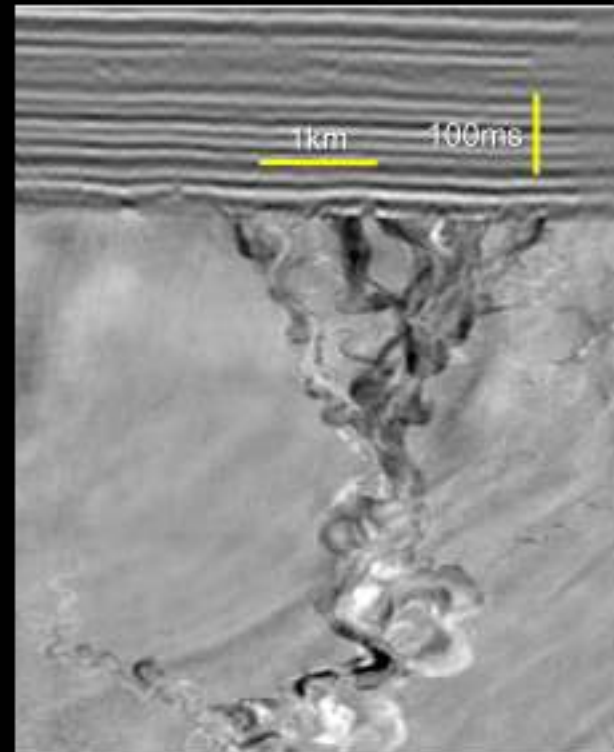
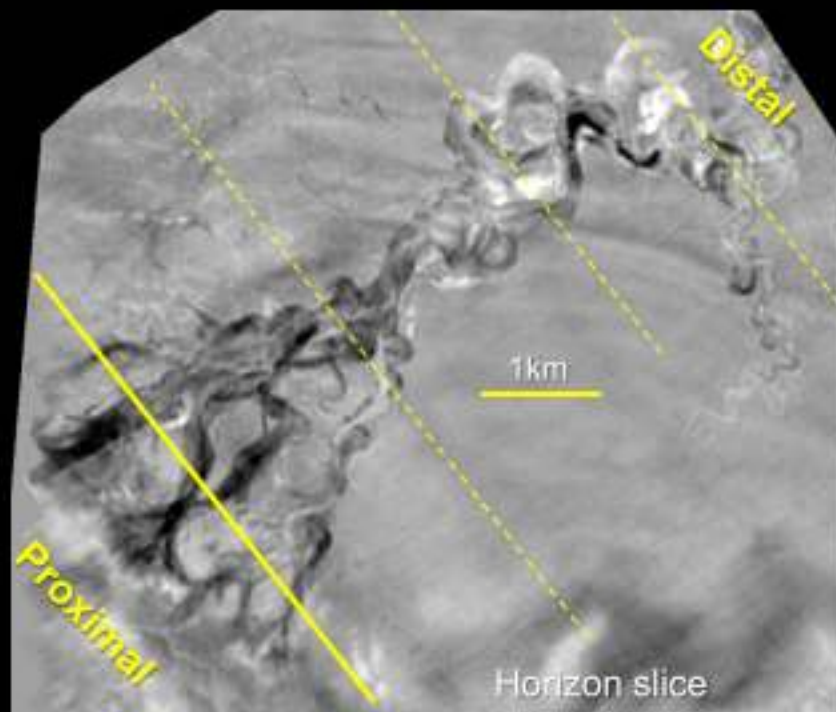
Canyon to Basin Floor Transition



Equilibrium Gradients Associated with Different Processes

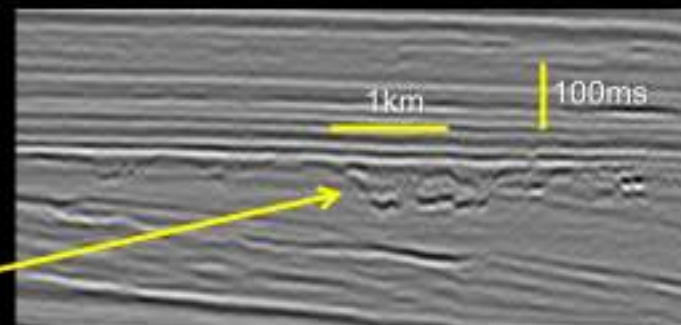
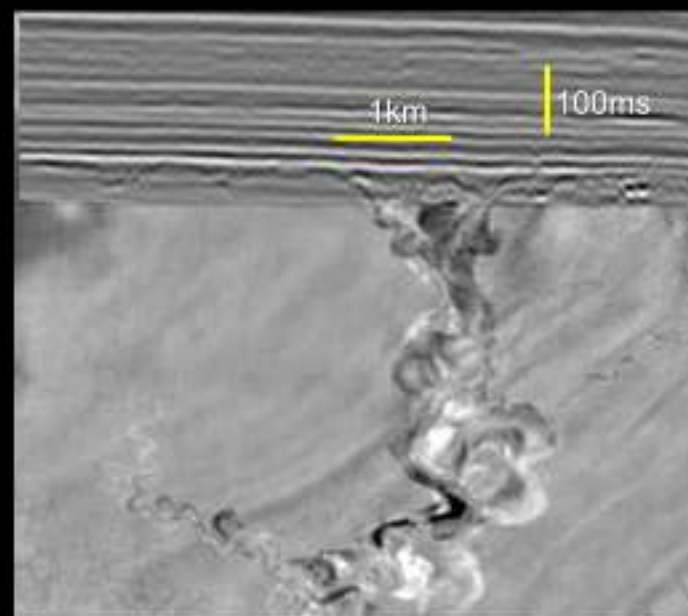
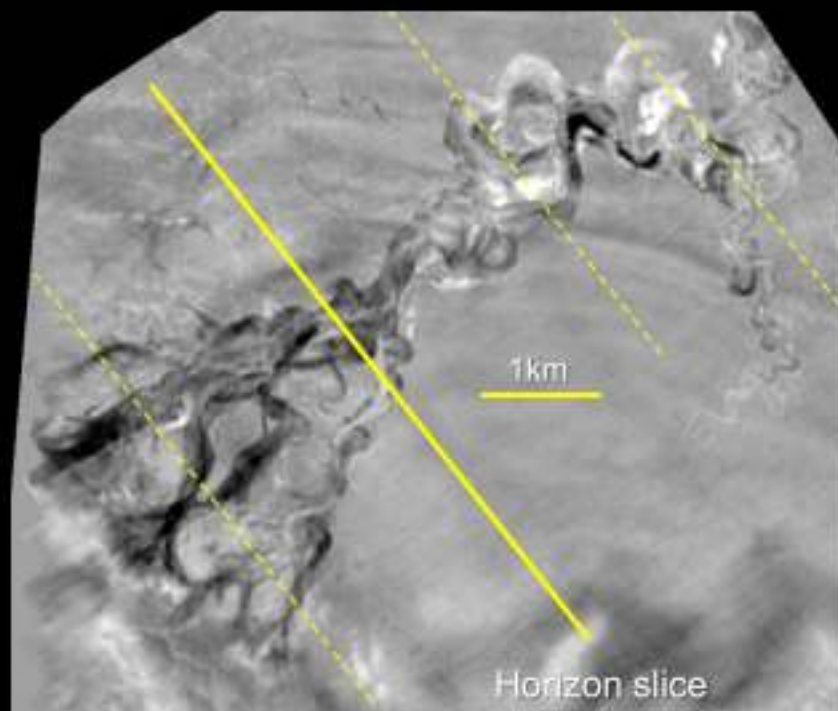


Submarine canyon architecture



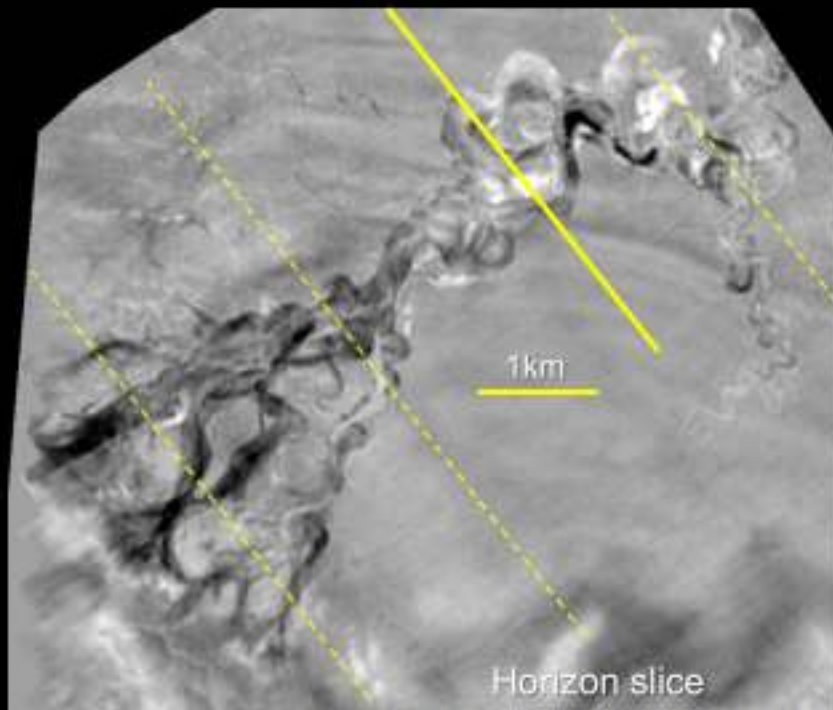
Canyon depth = ~20m

Submarine canyon architecture



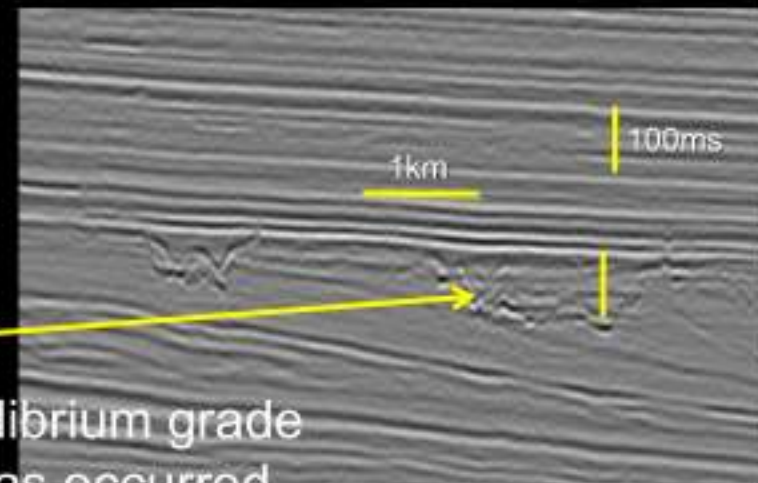
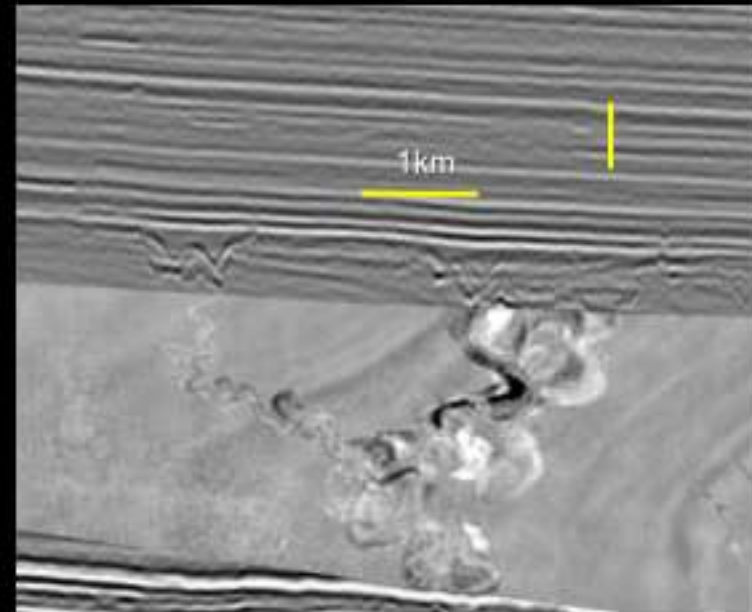
Canyon depth = ~60m

Submarine canyon architecture

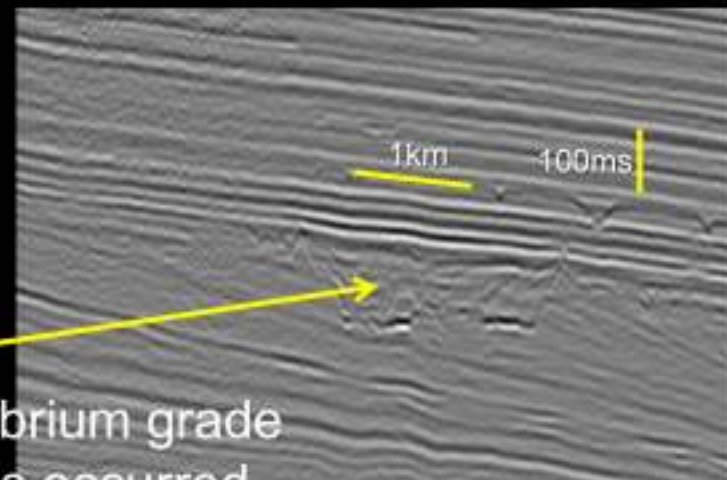
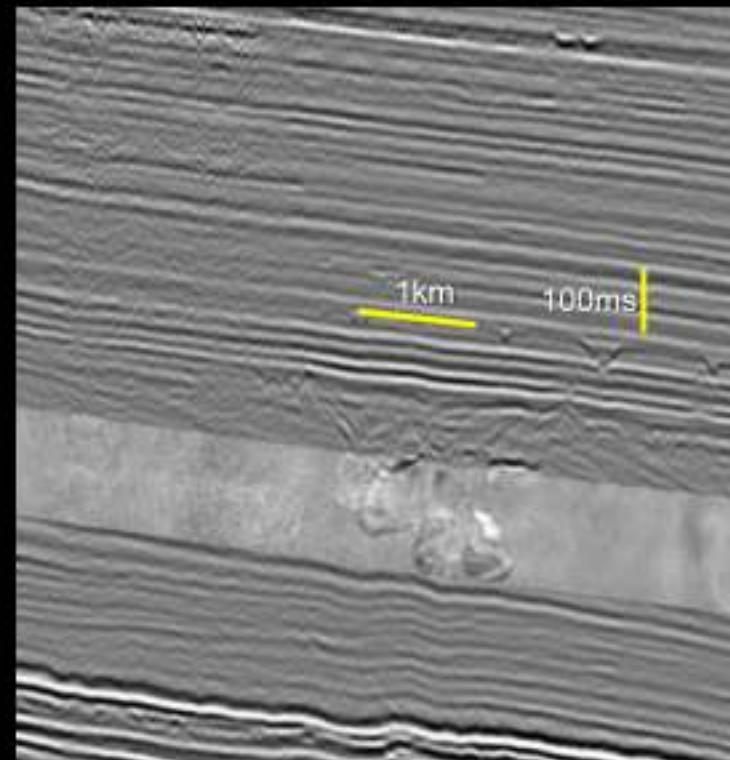
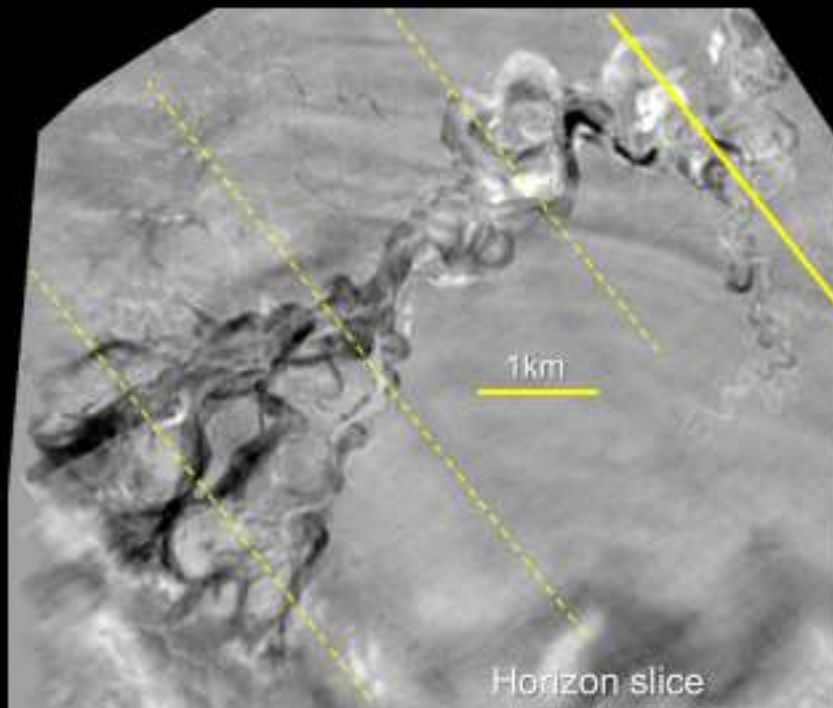


Canyon depth = ~110m

Canyon is flat-floored indicating that equilibrium grade has been achieved and lateral cutting has occurred



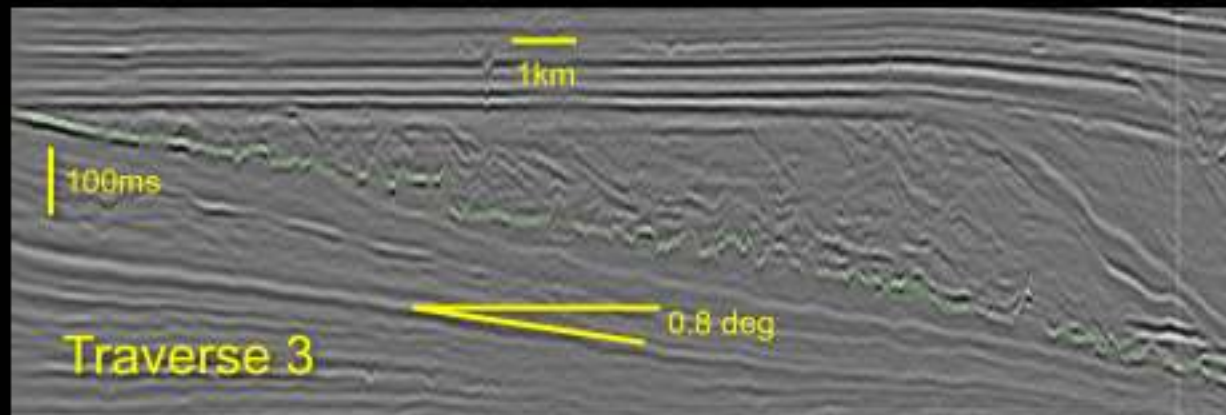
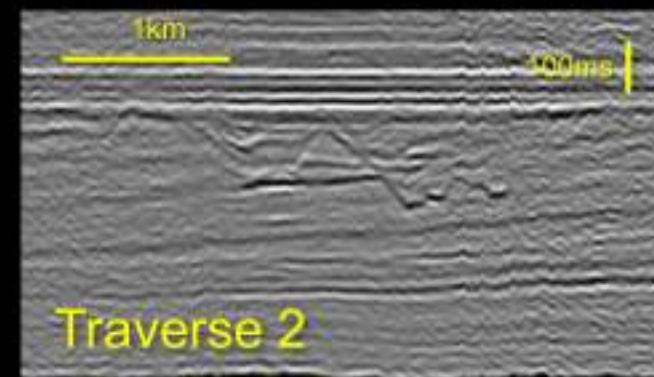
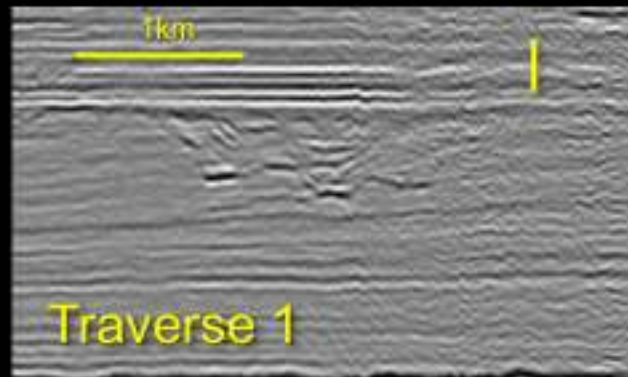
Submarine canyon architecture



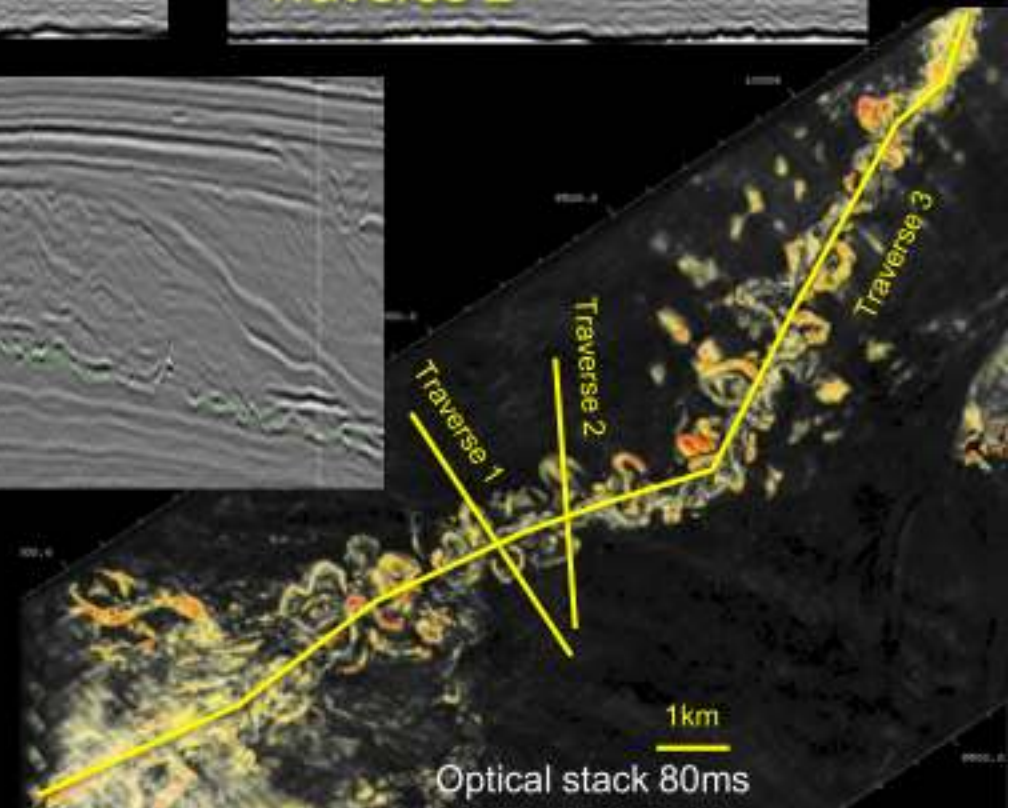
Canyon depth = ~145m

Canyon is flat-floored indicating that equilibrium grade has been achieved and lateral cutting has occurred

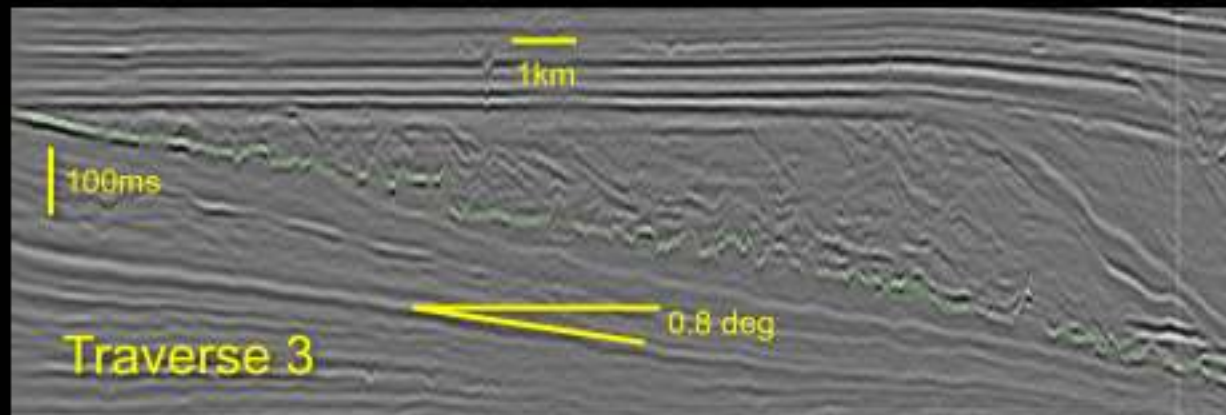
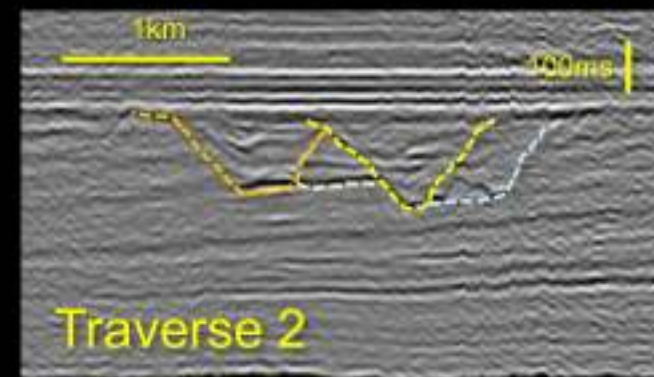
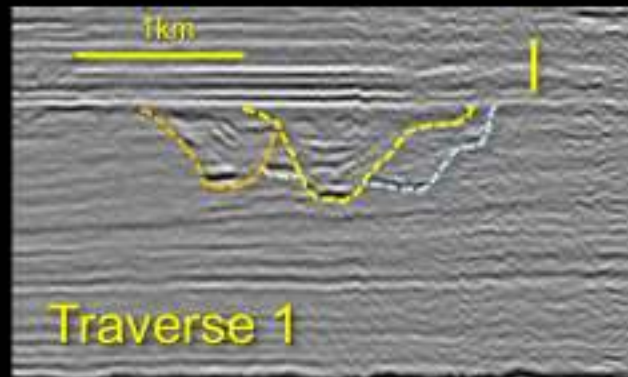
Canyon fill lithology



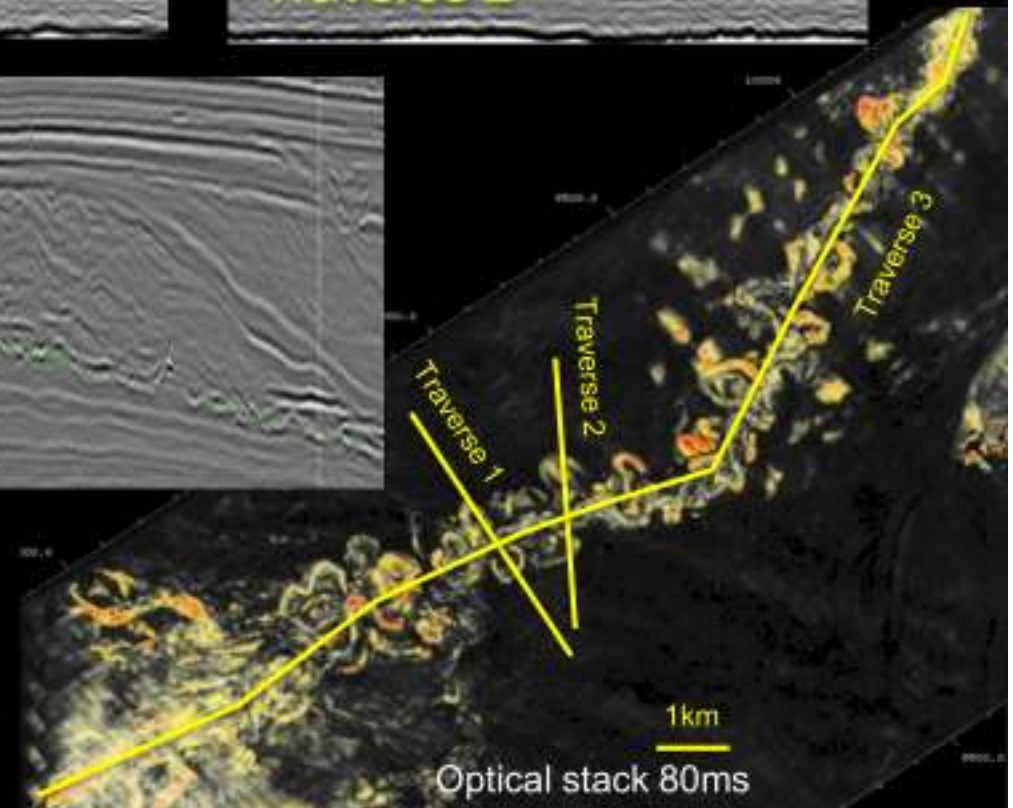
- Turbidite deposits at canyon base
- Most of canyon mud-filled
- Canyon fill characterized by multiple cut and fill



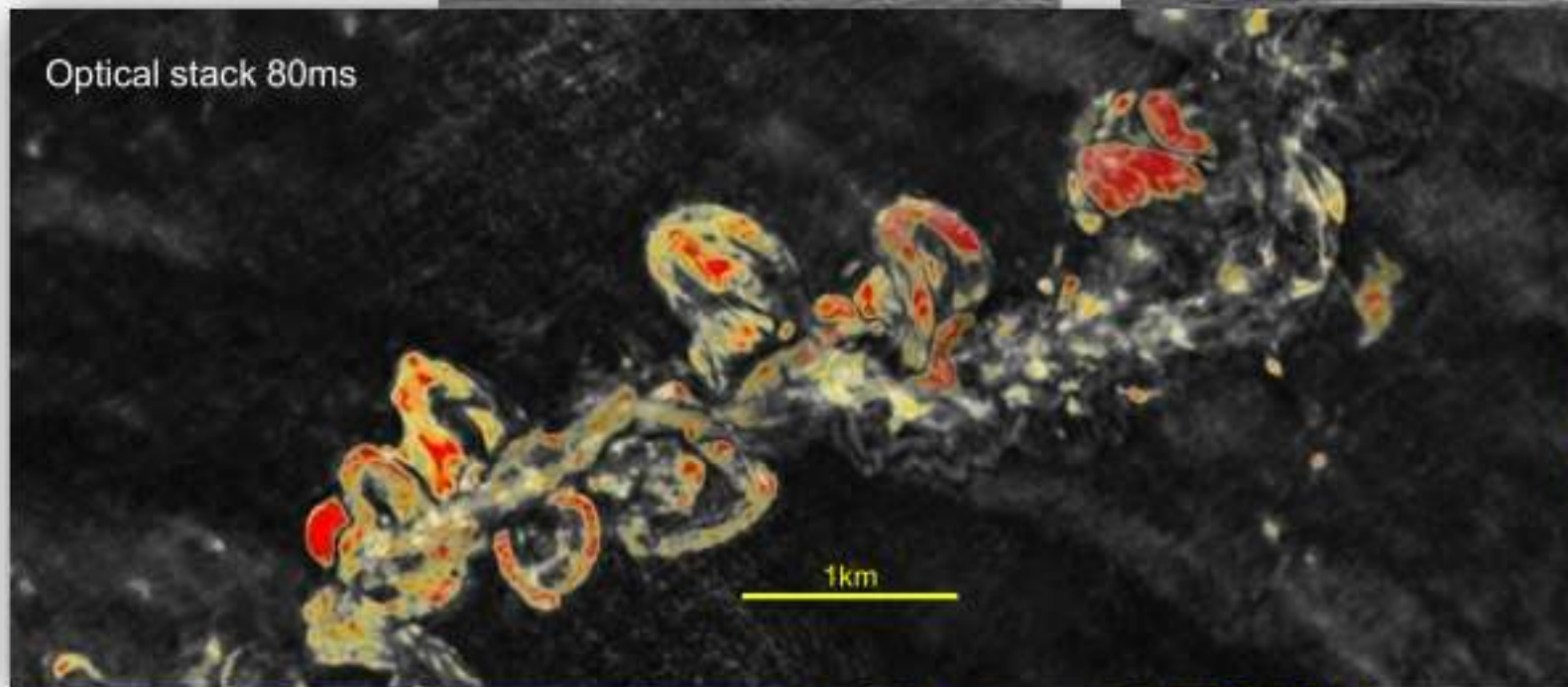
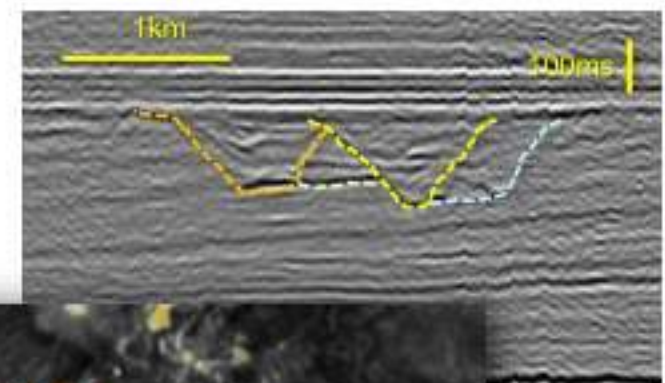
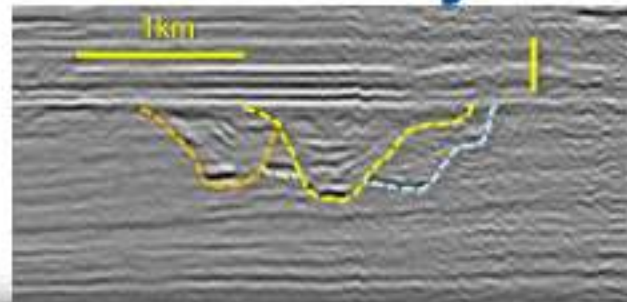
Canyon fill lithology



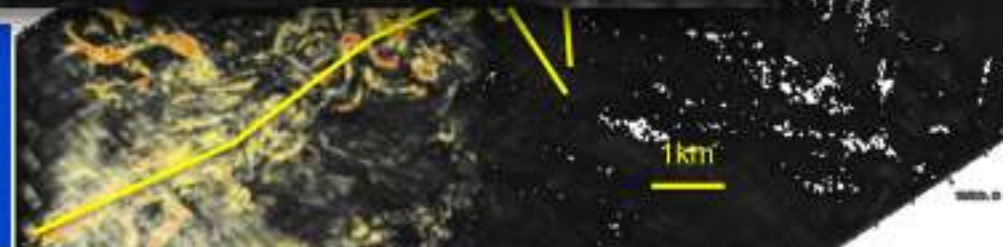
- Turbidite deposits at canyon base
- Most of canyon mud-filled
- Canyon fill characterized by multiple cut and fill



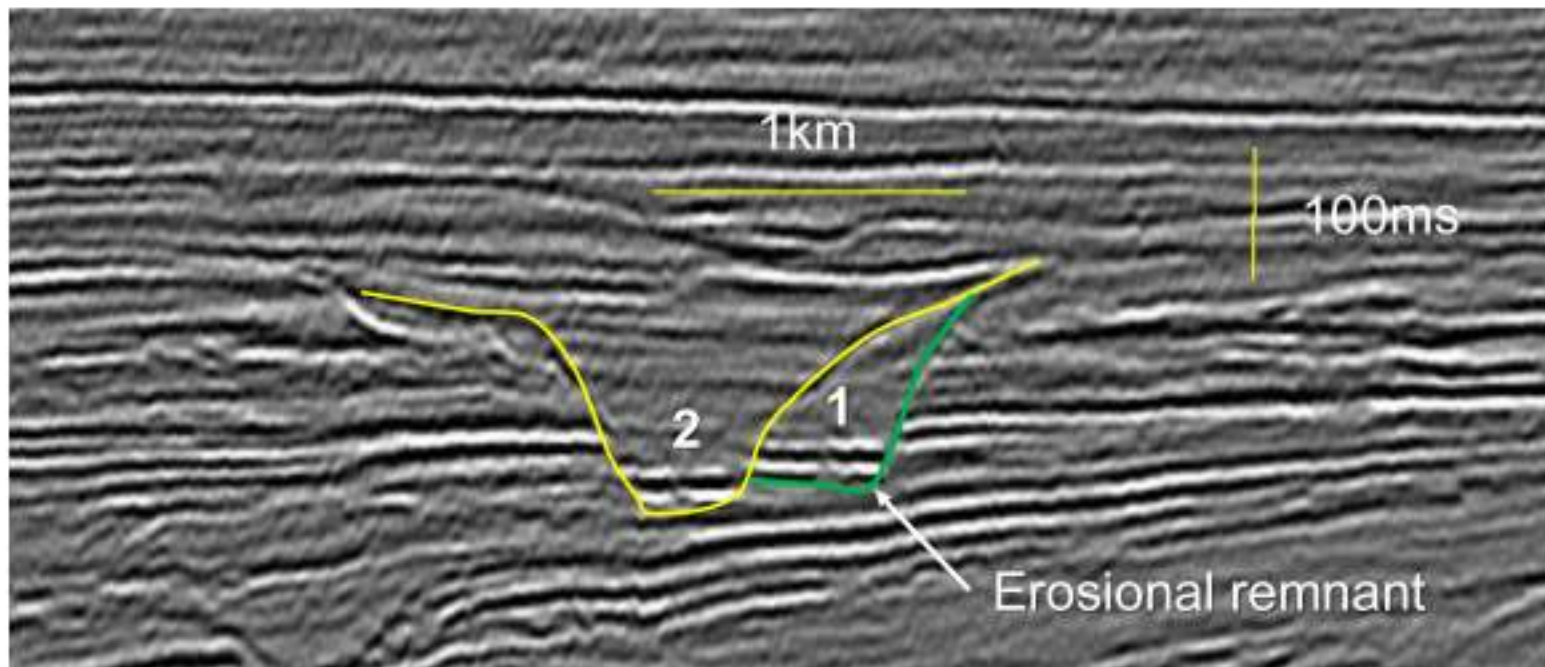
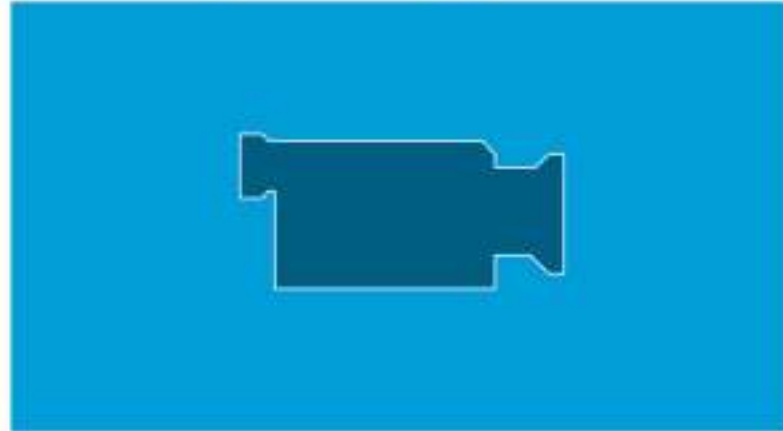
Turbidites at base of canyon



- Turbidite deposits at canyon base
- Most of canyon mud-filled
- Canyon fill characterized by multiple cut and fill



Canyon fill in multiple stages



Canyon fill processes

Canyon head

Straight channel elements

Sinuuous channel elements

Sinuosity = 1.10

3.0km

Sinuosity = 2.19

Upper canyon fill
dominated by mass
transport processes

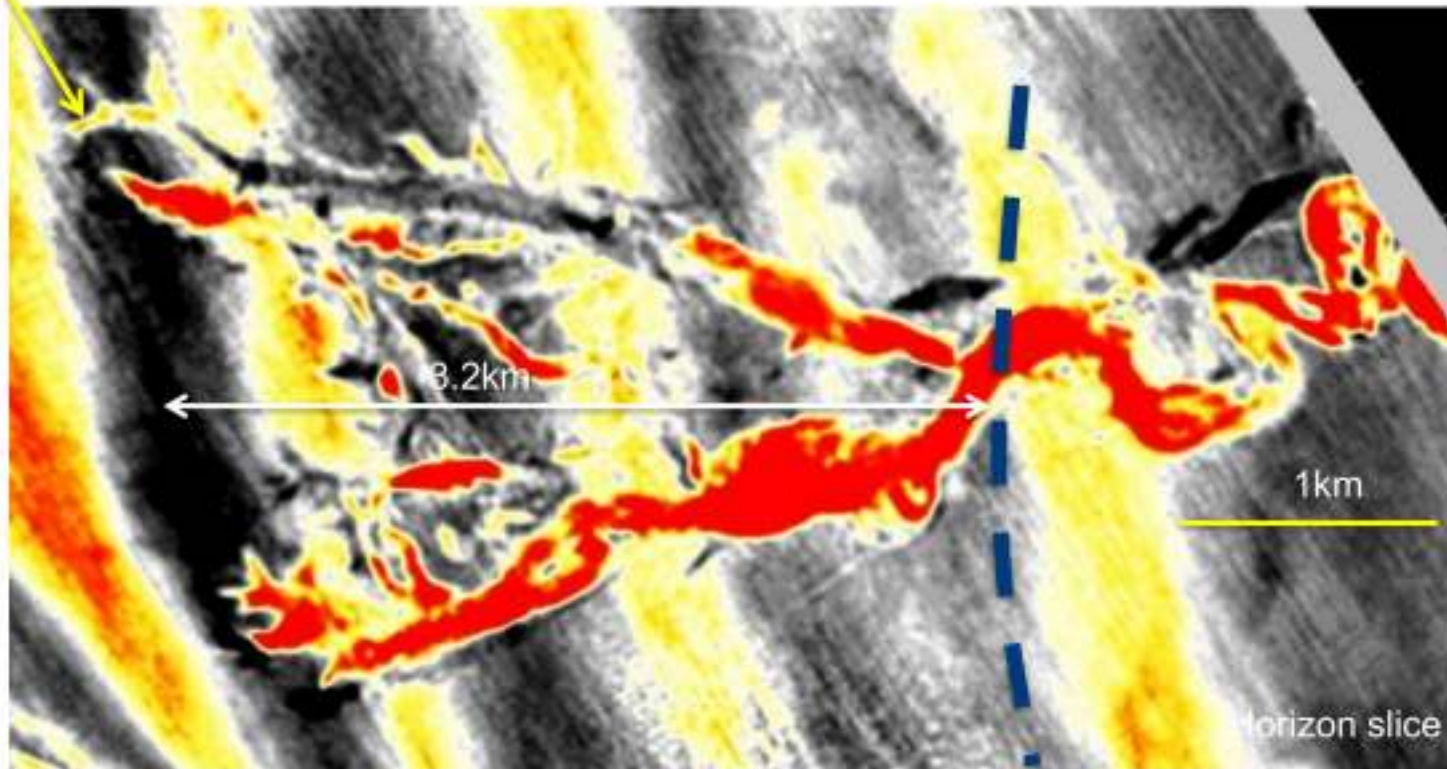
Middle and distal basal
canyon fill dominated by
turbidity current processes

- slump/slide/debris flow deposits
- relatively poor reservoir facies

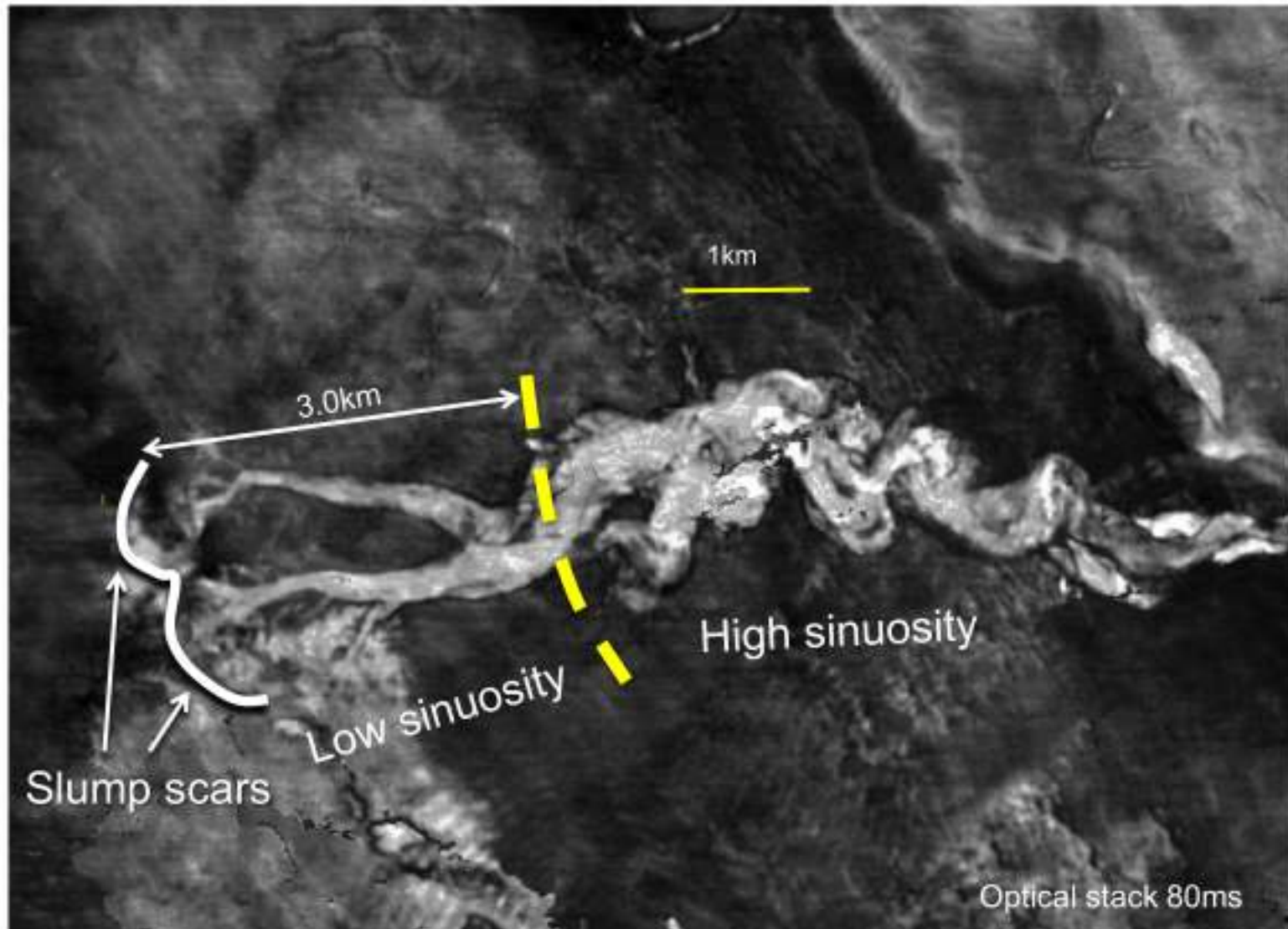
- turbidite deposits
- good reservoir facies

Canyon fill processes

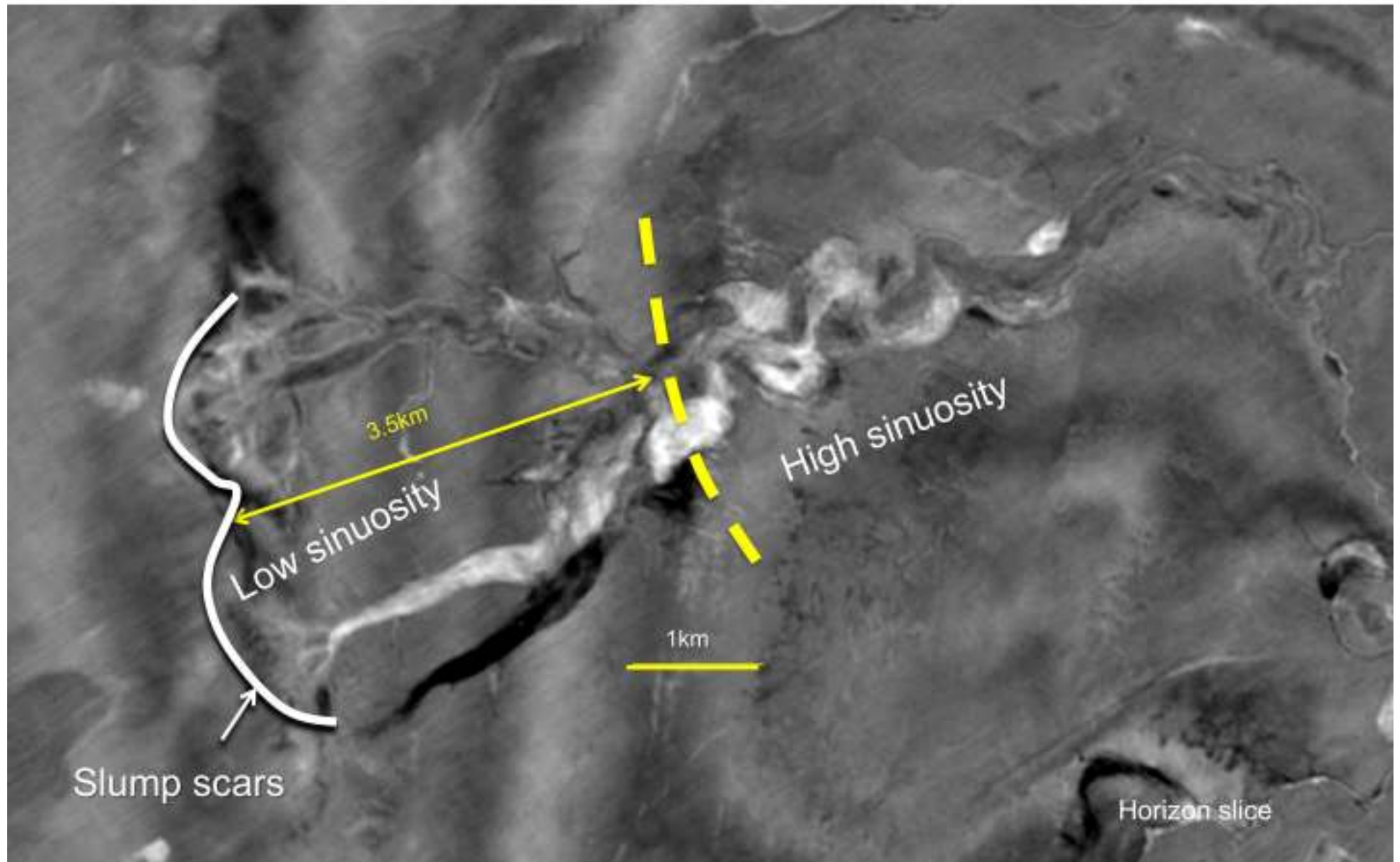
Canyon head



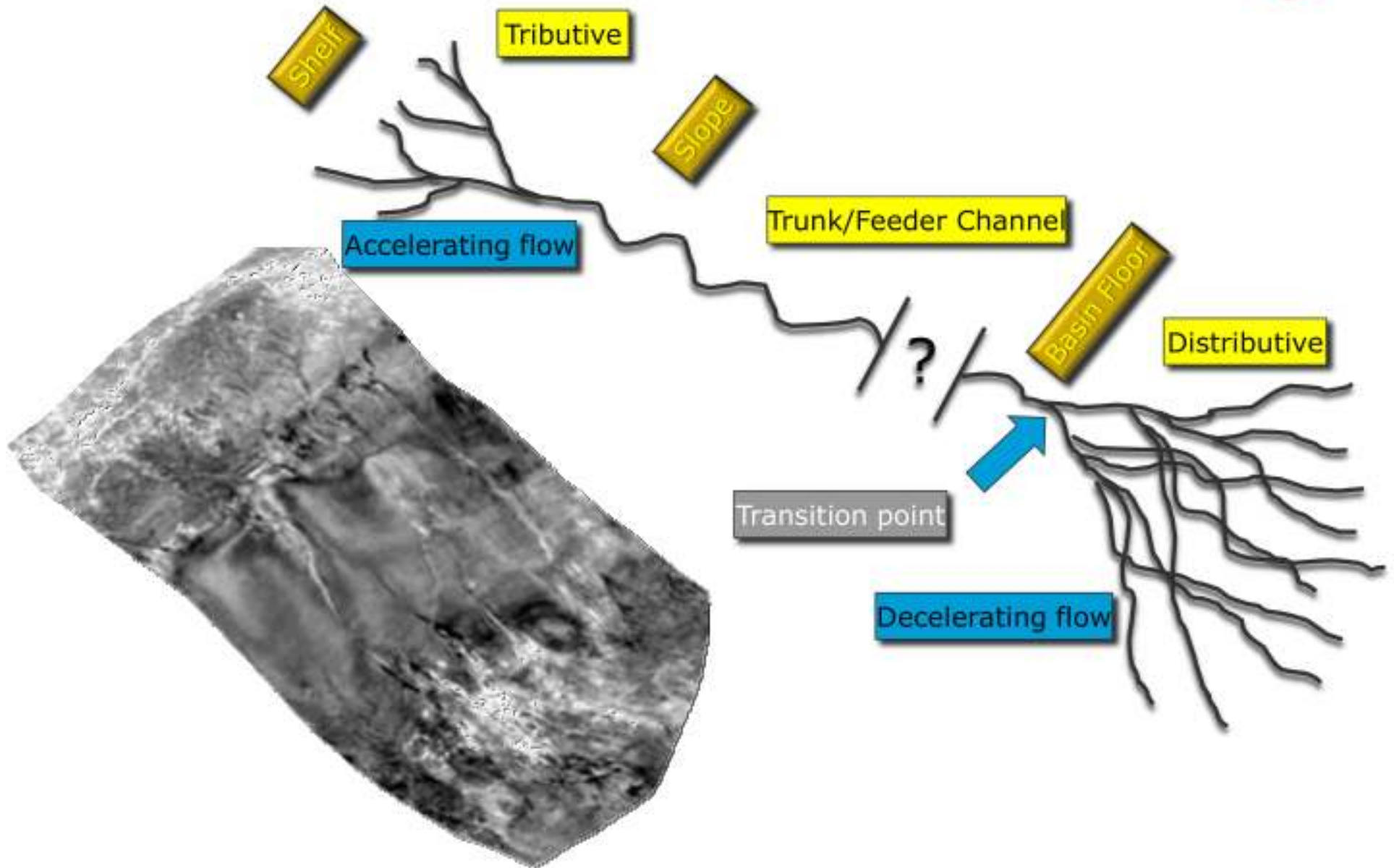
Canyon fill processes



Canyon fill processes



Turbidite Geomorphology Summary



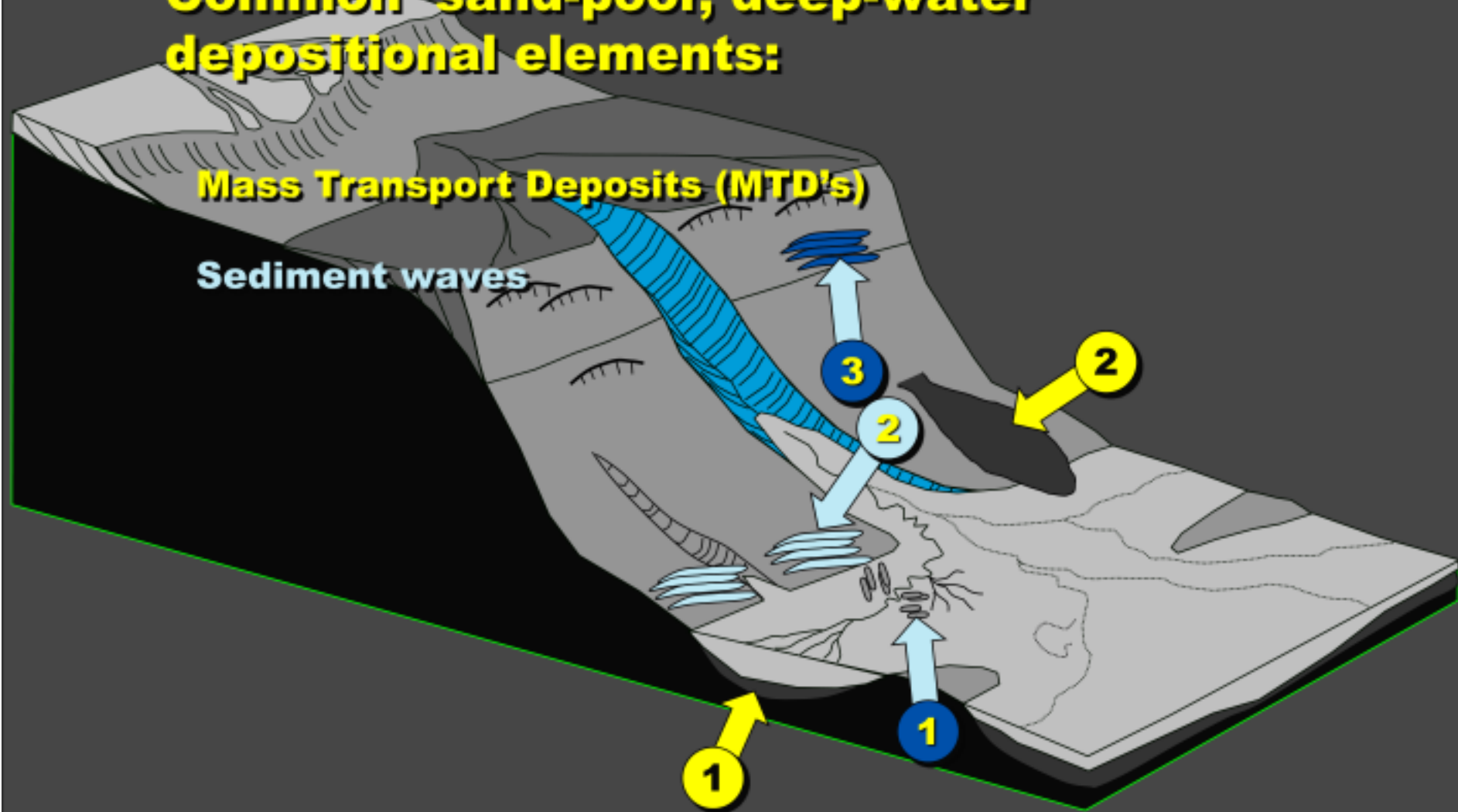
Overbank Deposits

- **Sediment waves**
- **Crevasse splays**

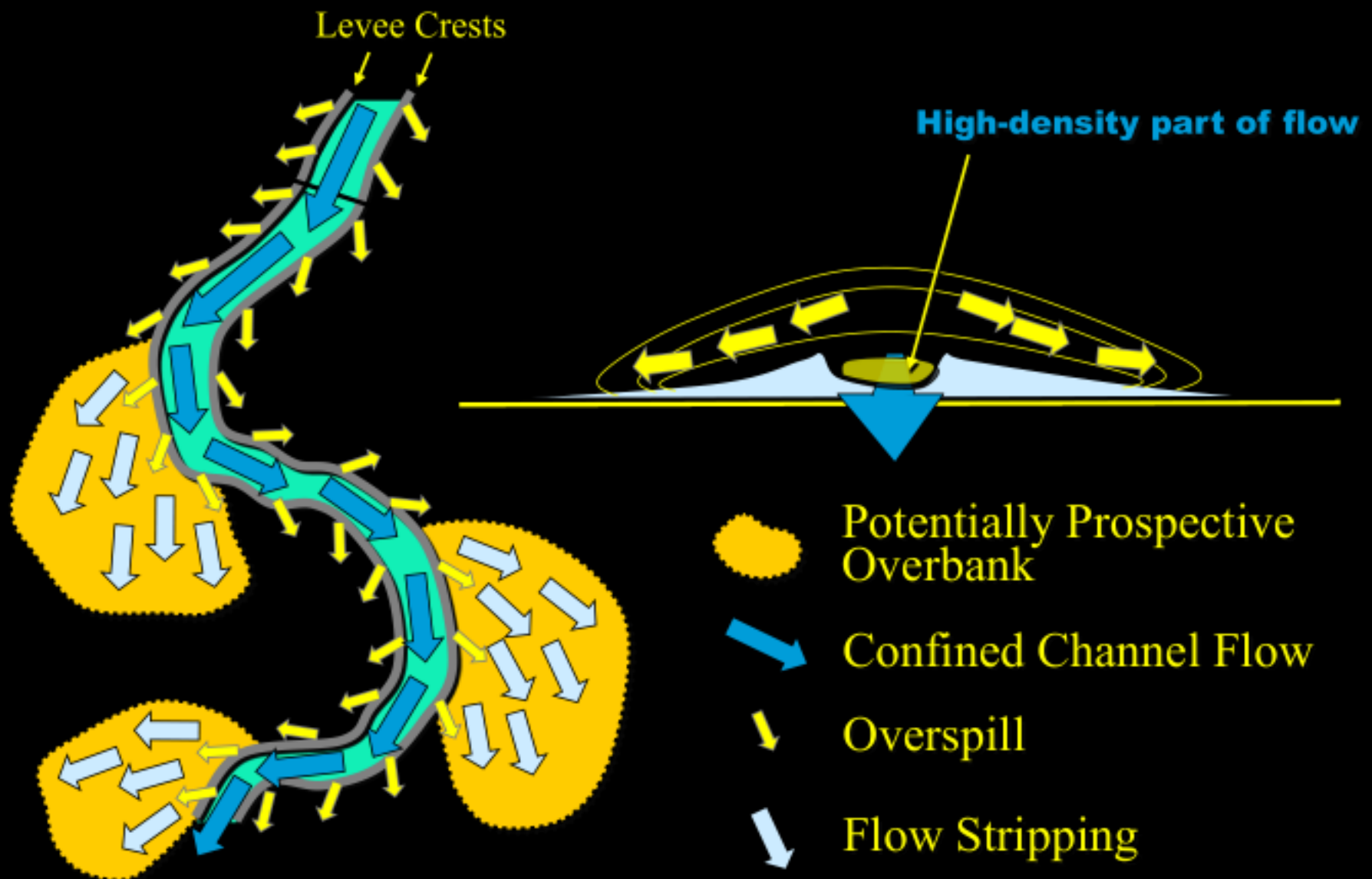
Common sand-poor, deep-water depositional elements:

Mass Transport Deposits (MTD's)

Sediment waves

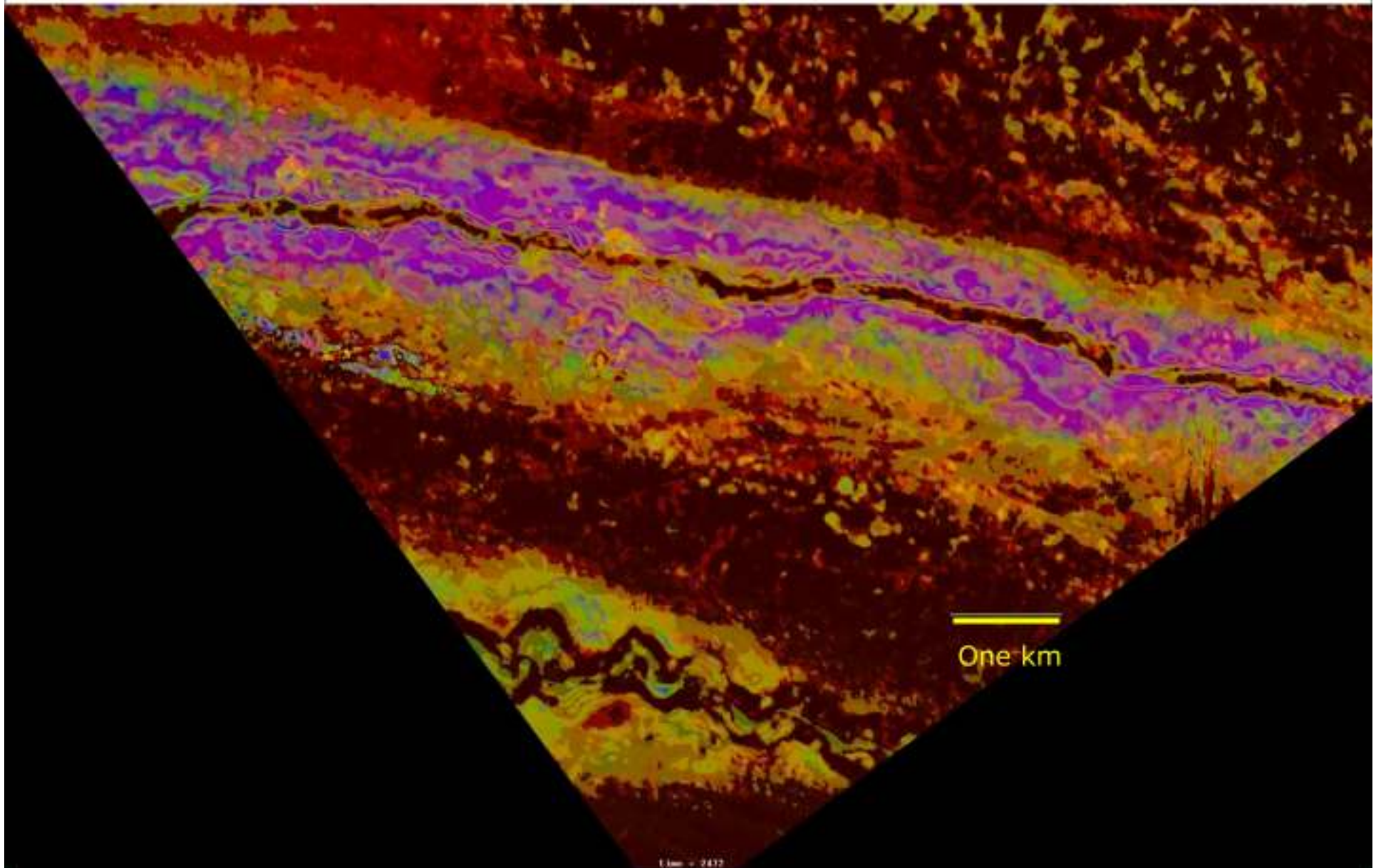


Overspill and Flow Stripping

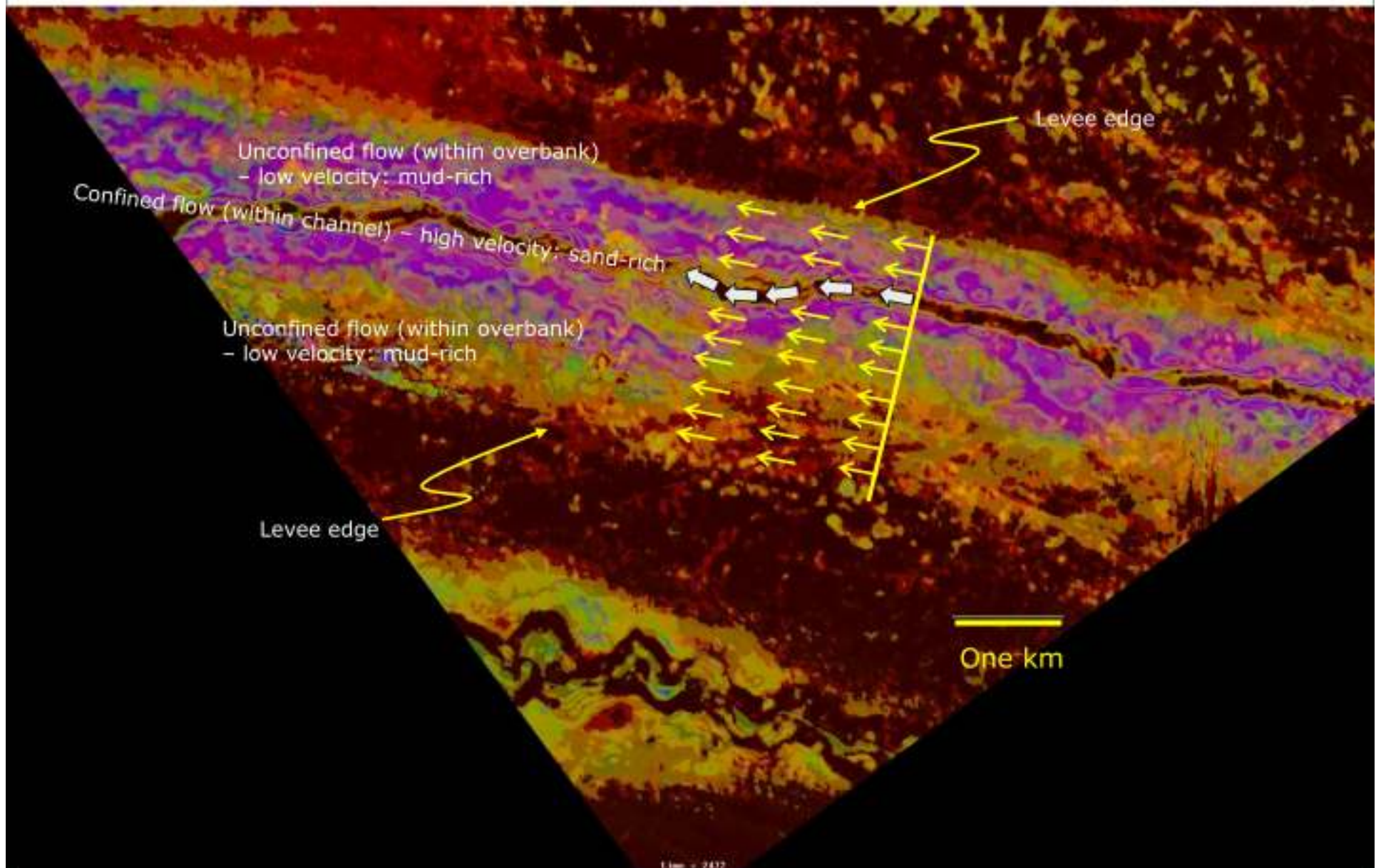




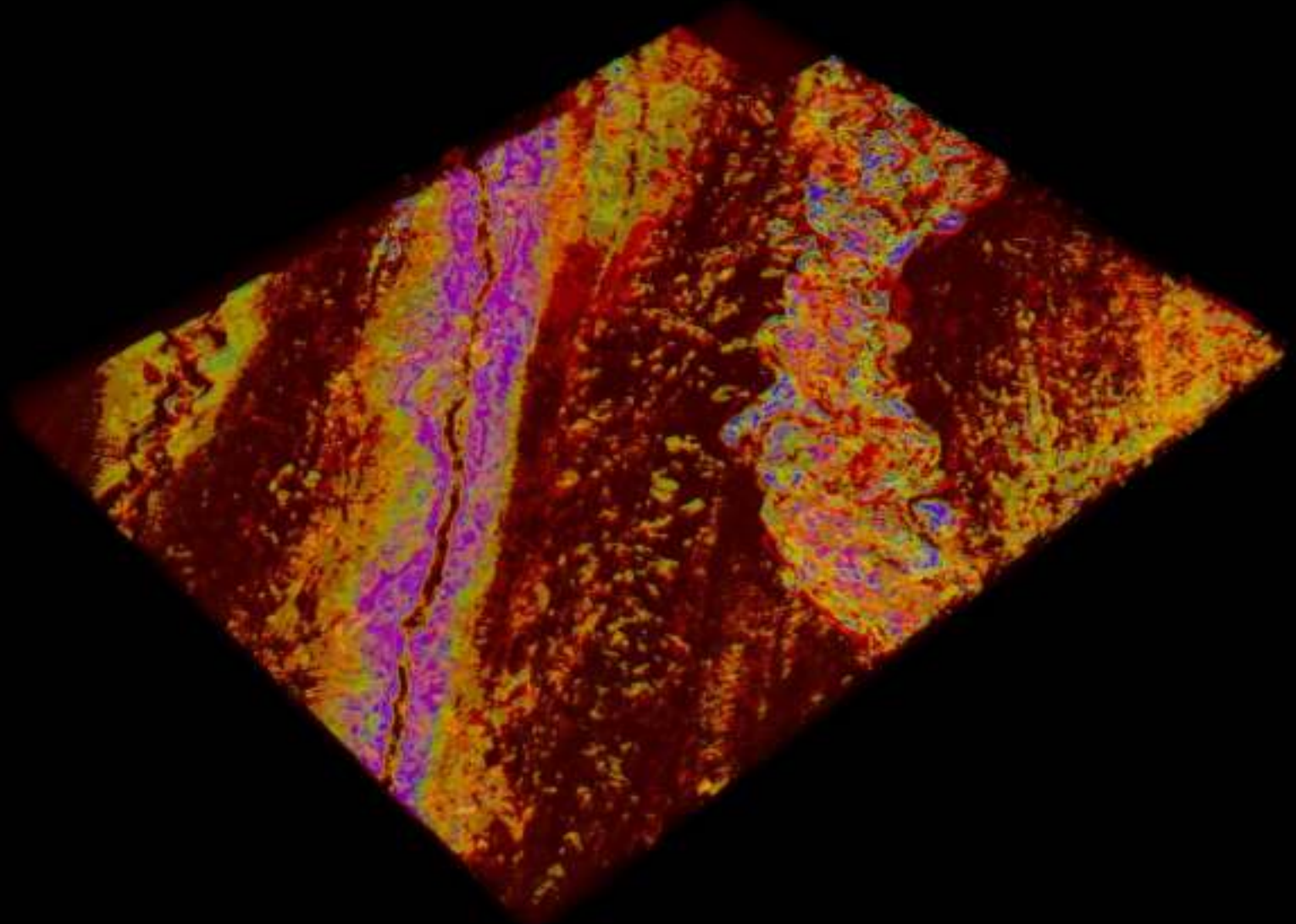
Turbidite Channels and Associated Levees



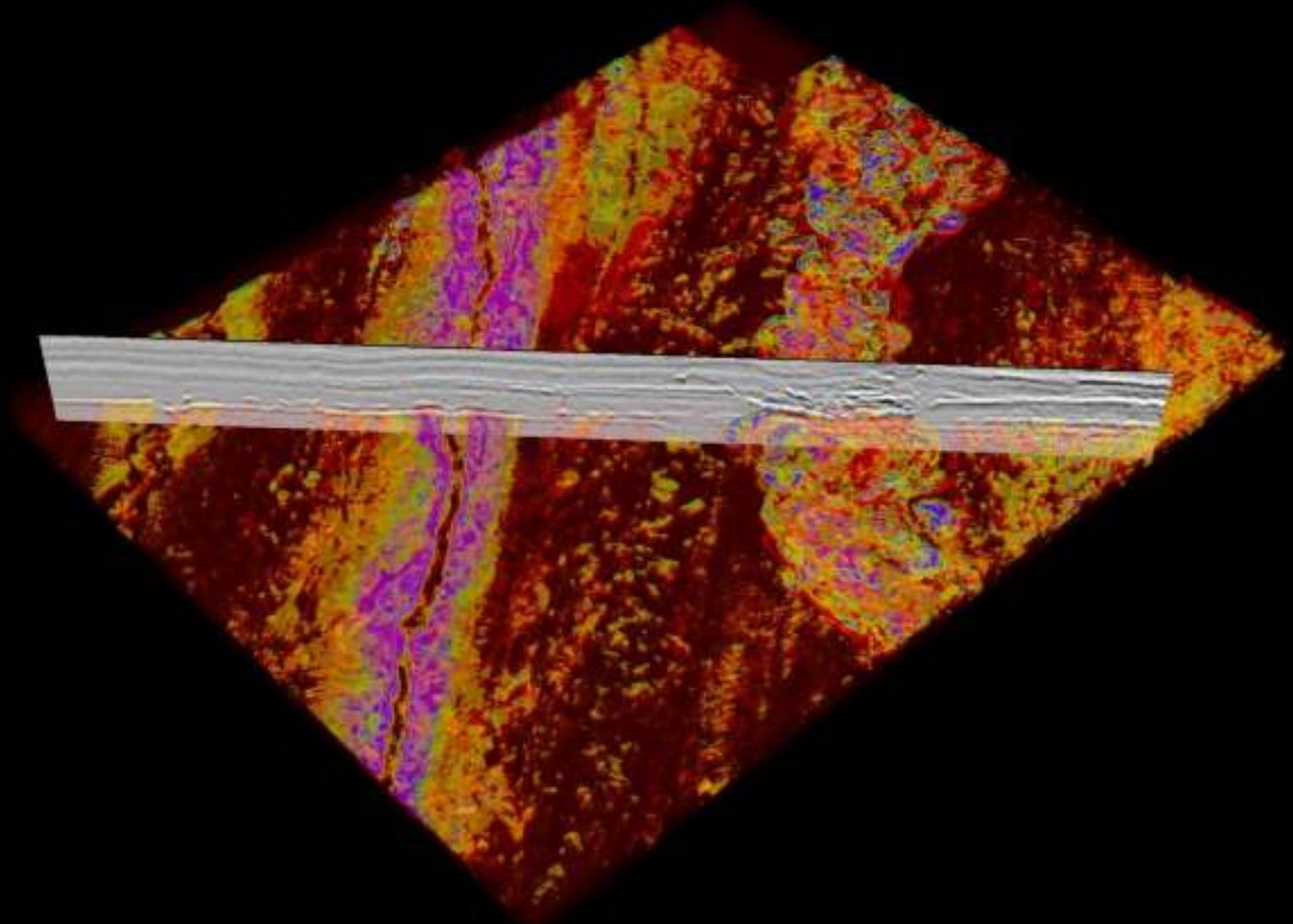
Turbidite Channels and Associated Levees



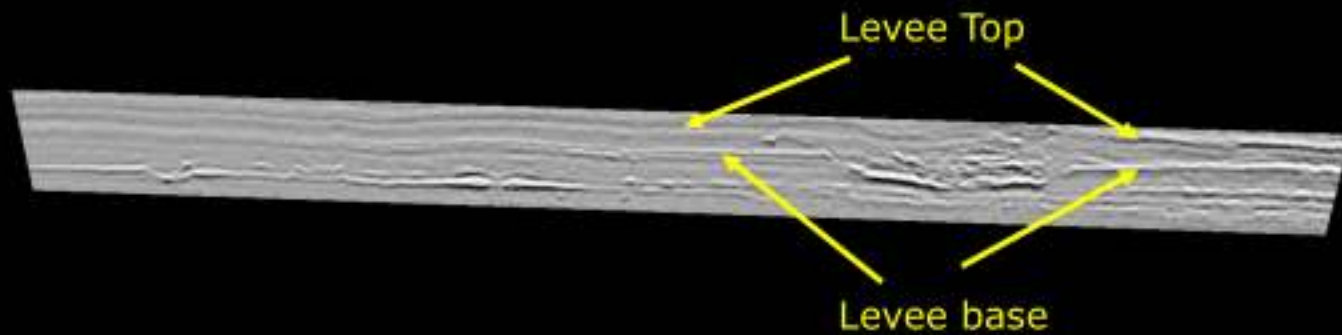
Turbidite Channels and Associated Levees



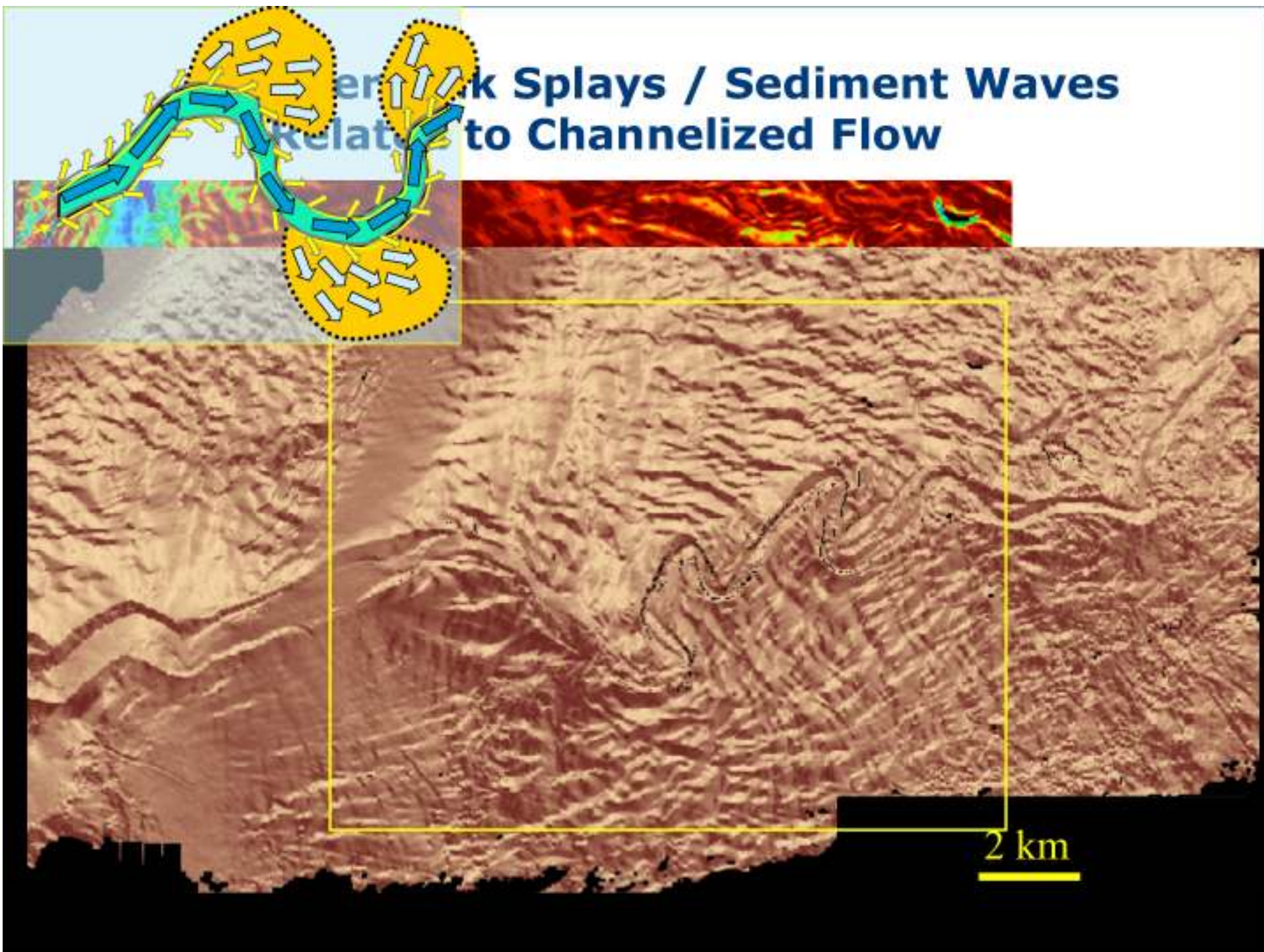
Turbidite Channels and Associated Levees



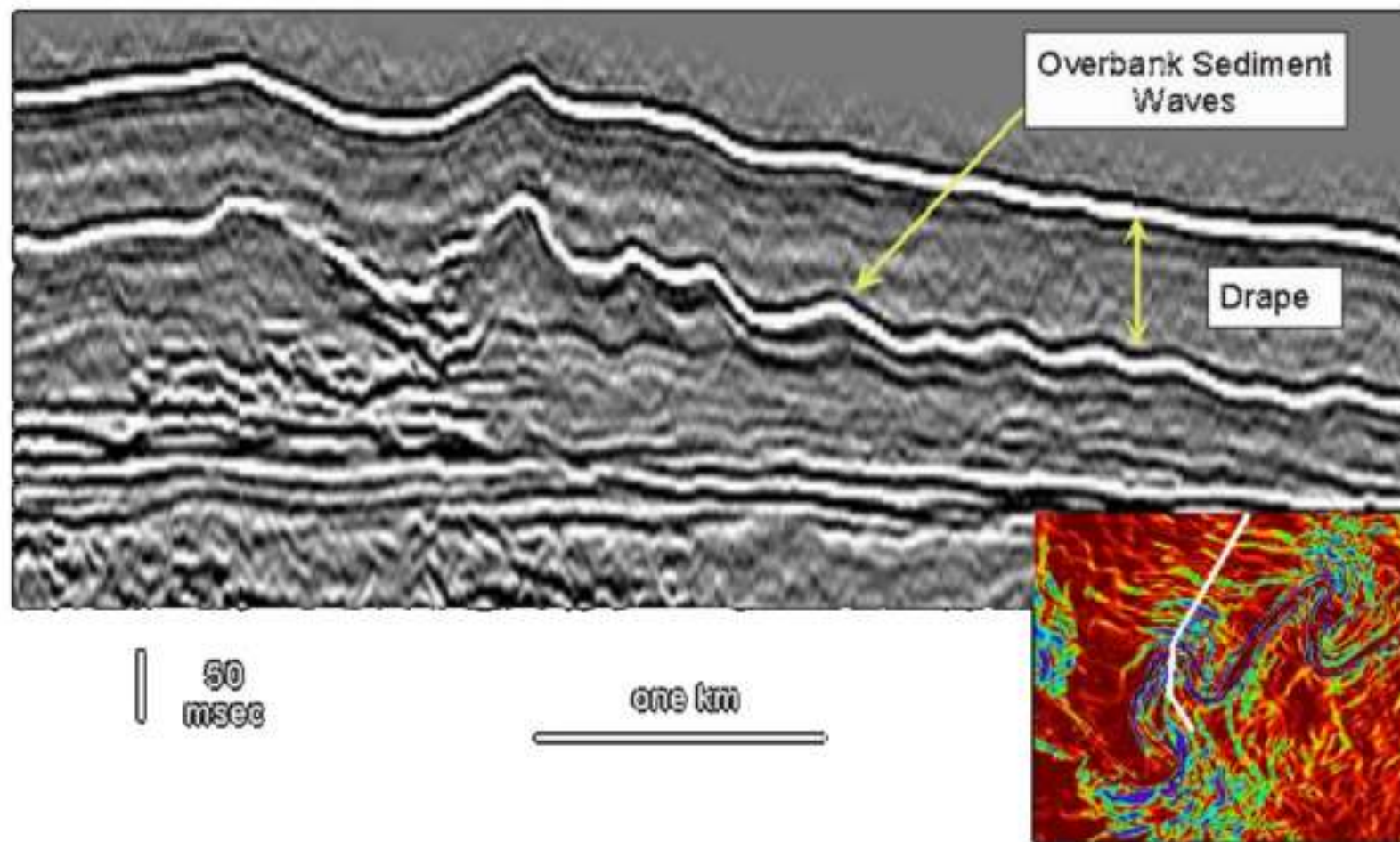
Turbidite Channels and Associated Levees



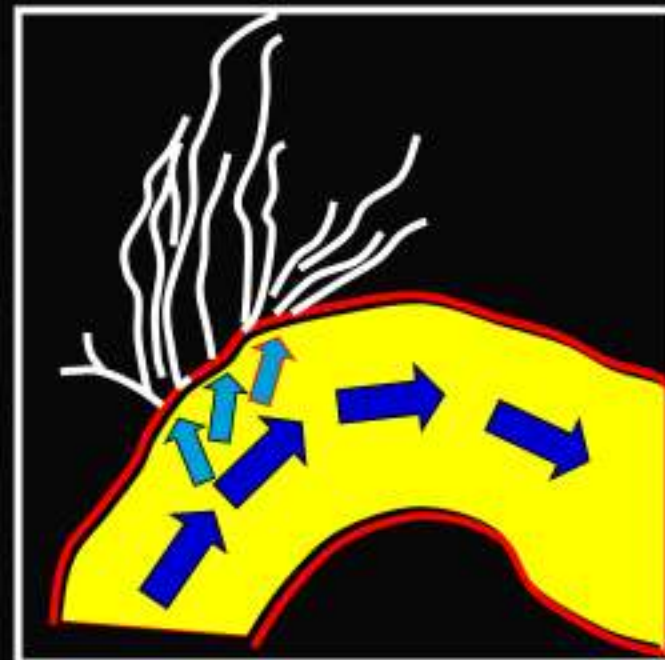
Interfingering Splays / Sediment Waves Related to Channelized Flow



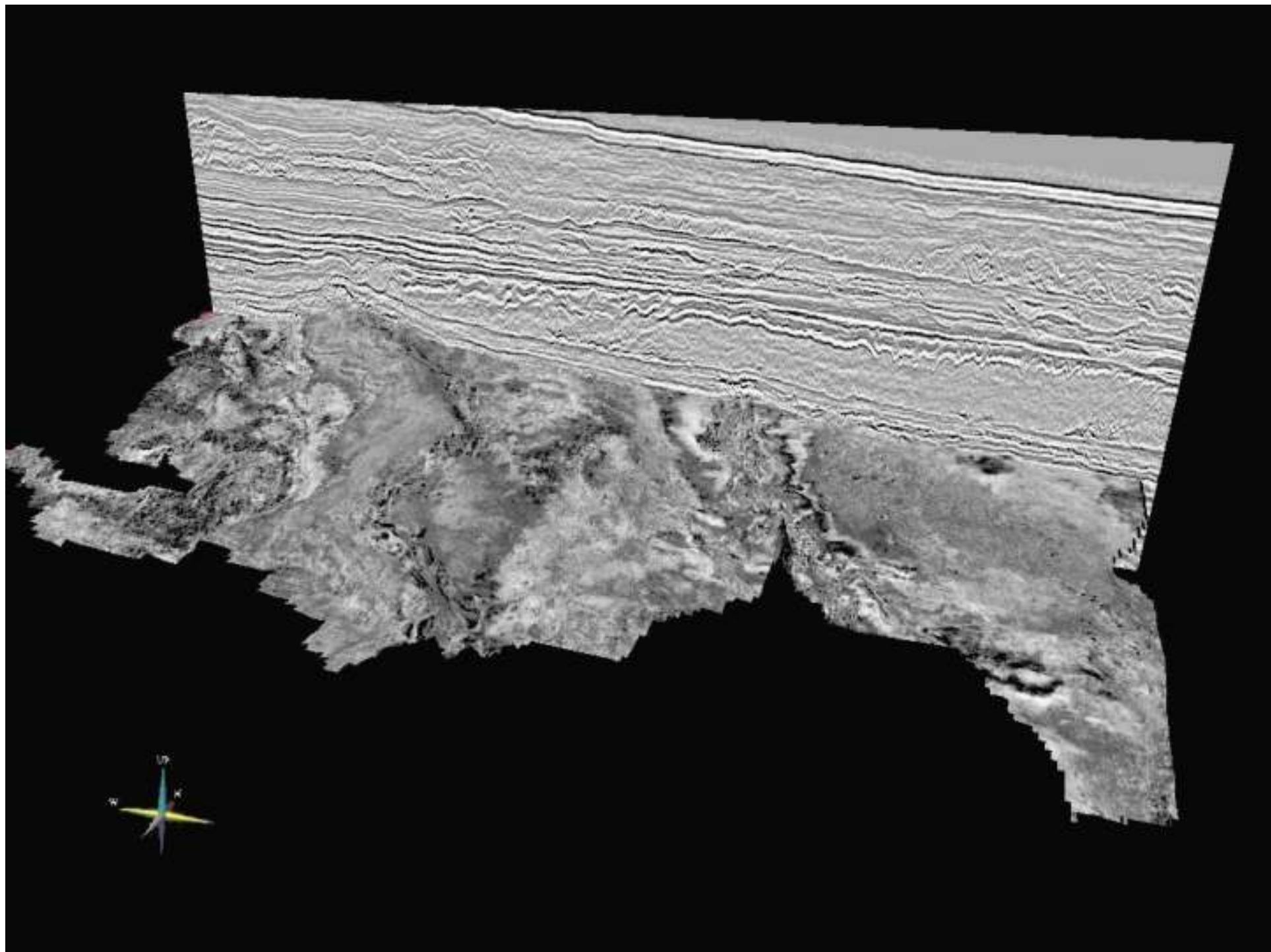
Sediment Waves Associated with Leveed Channel Overbank Areas

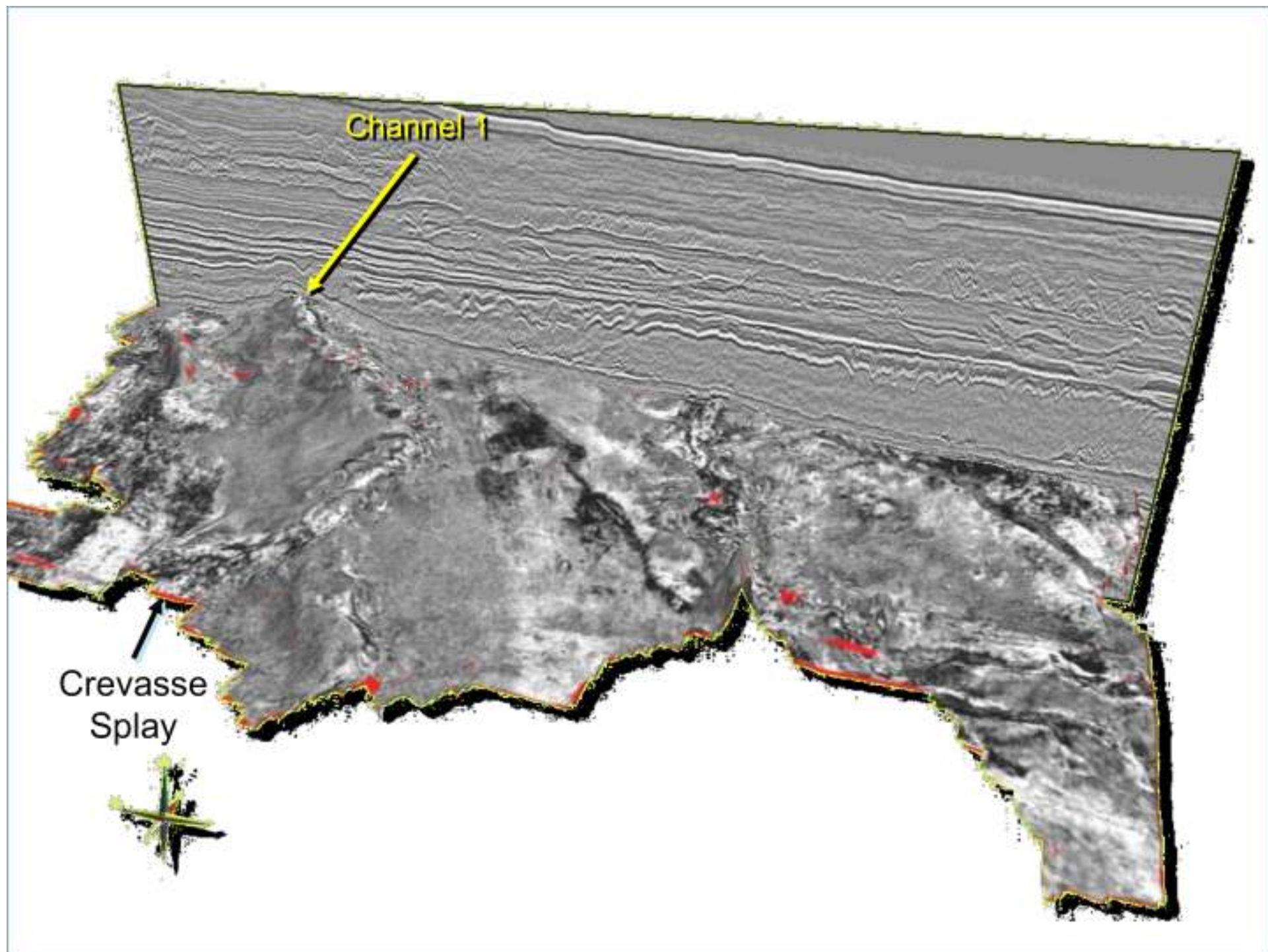


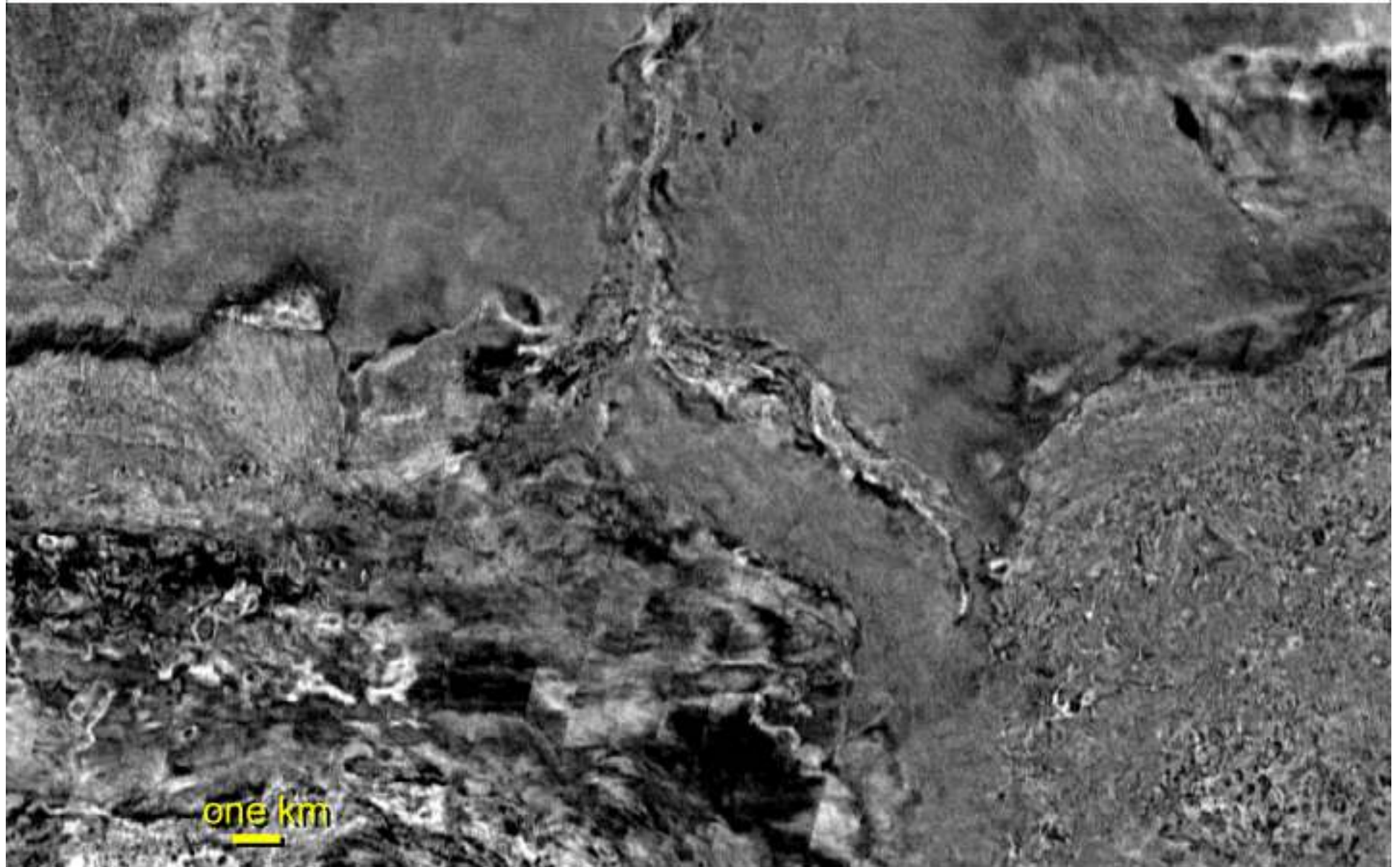
Overbank Splay

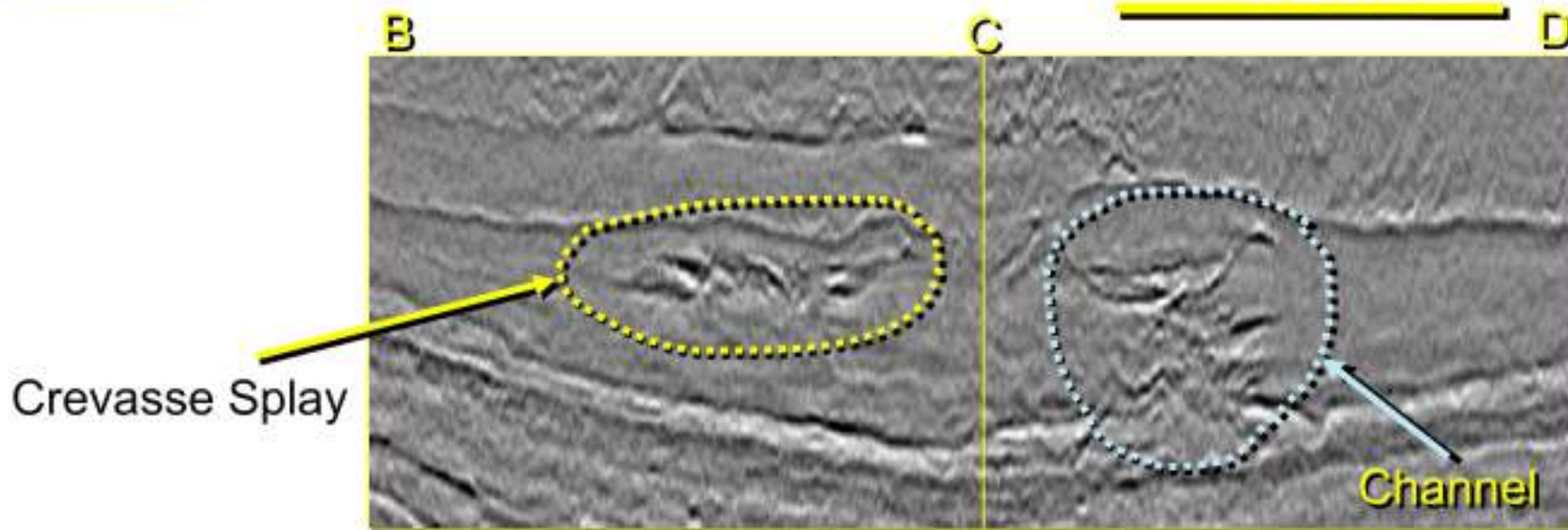
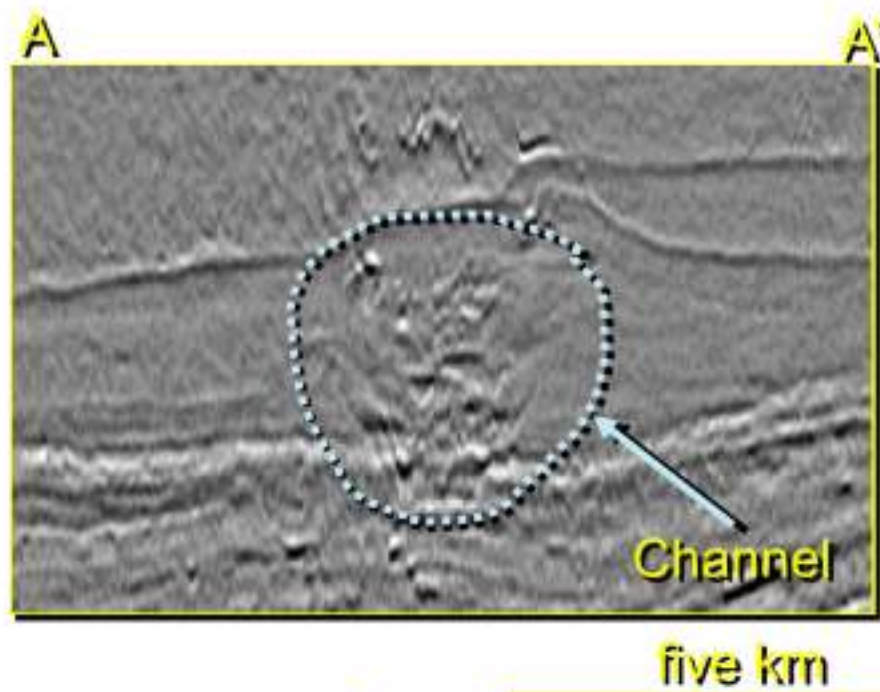
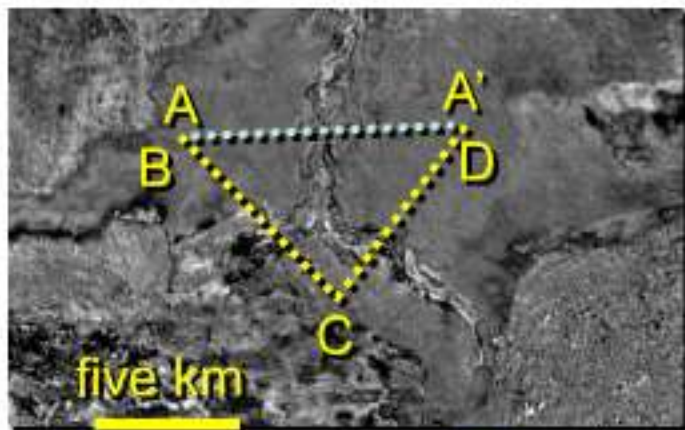


Five km



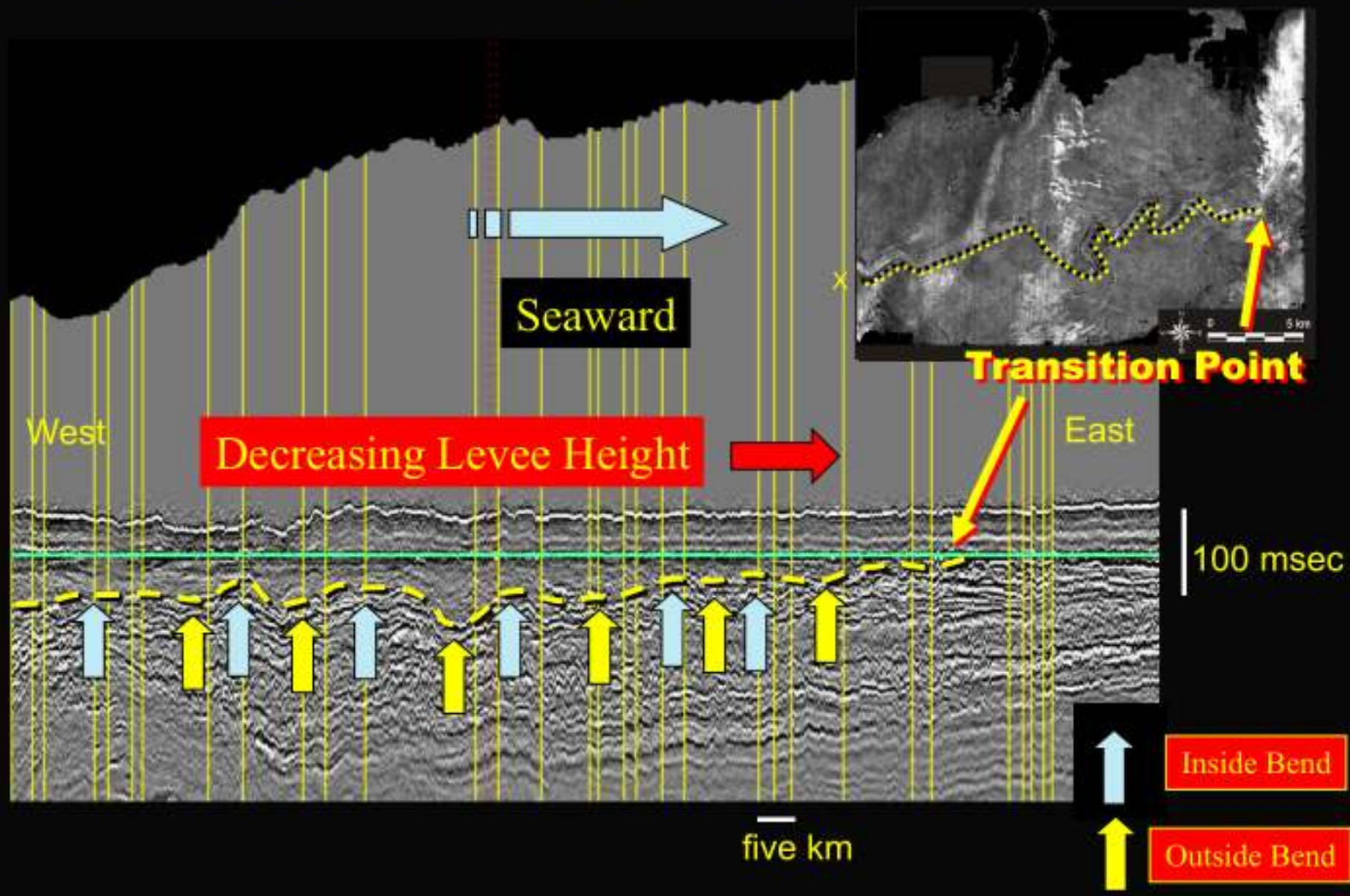




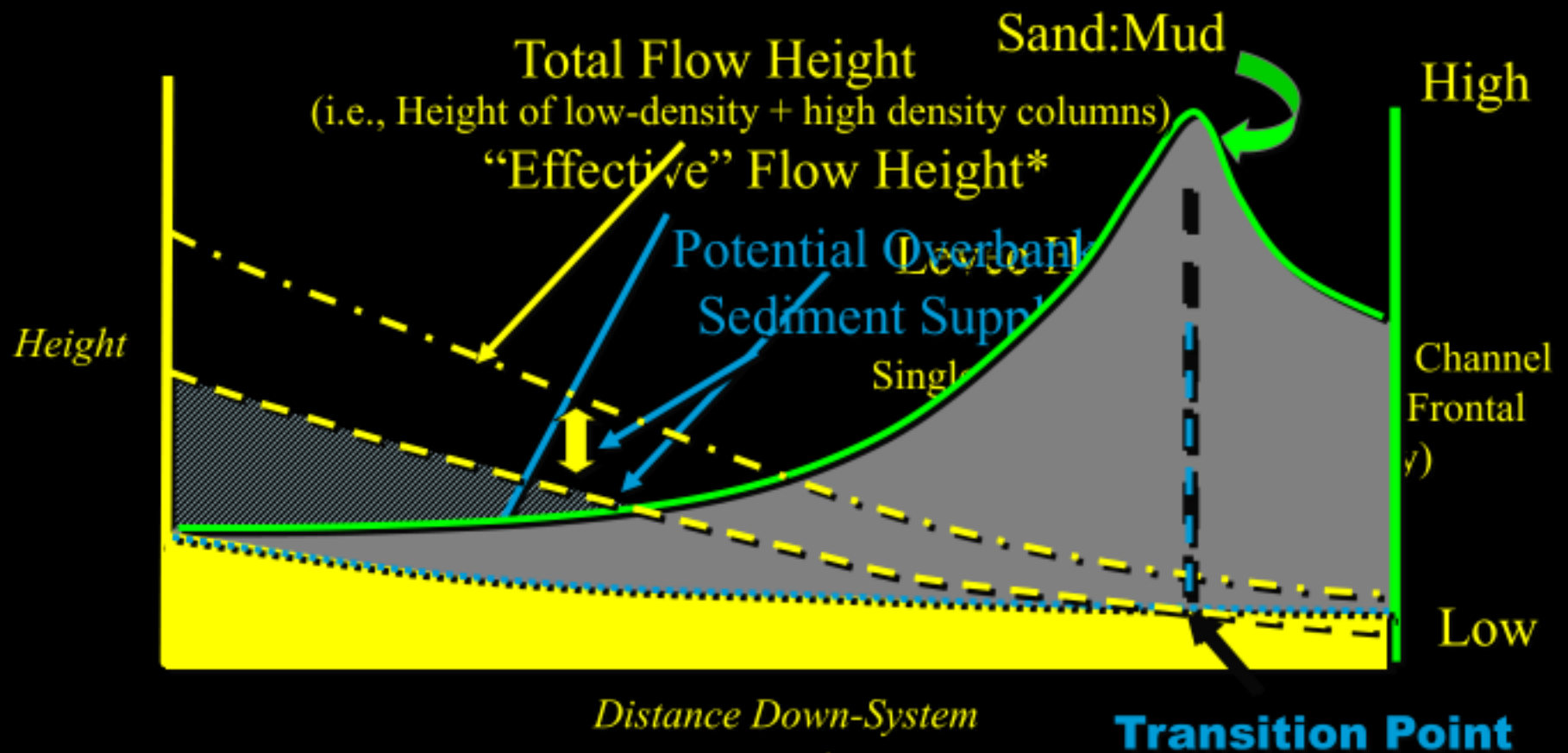


Terminal Lobes

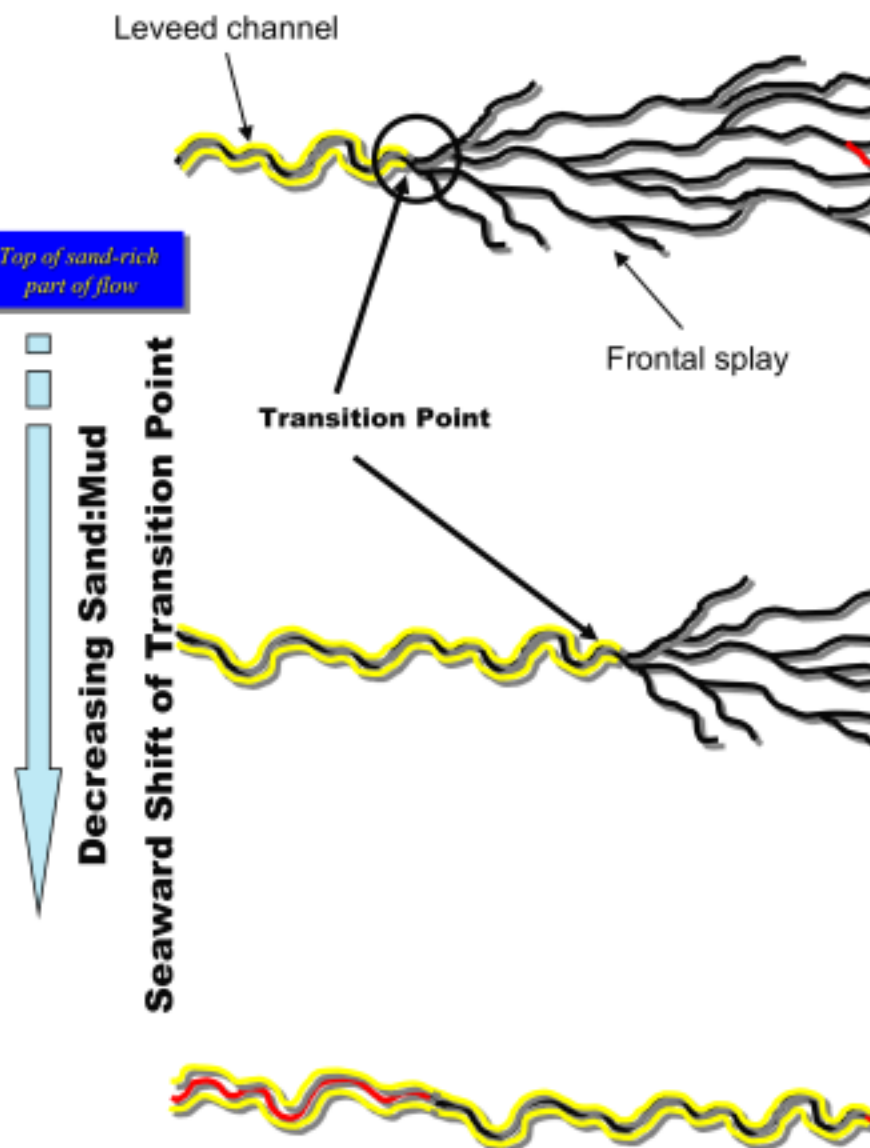
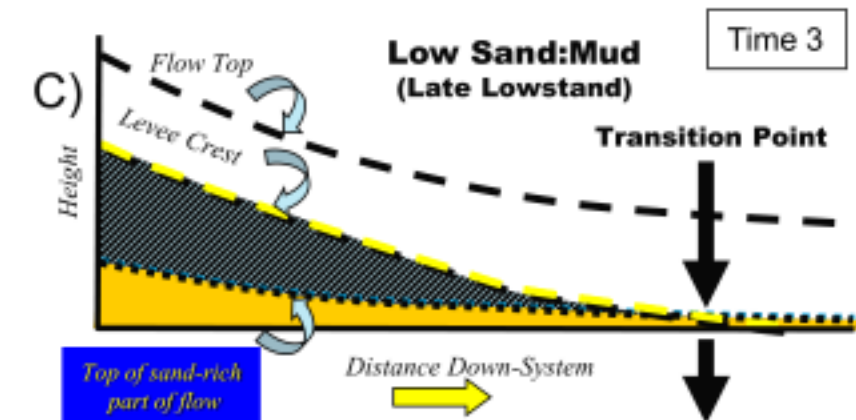
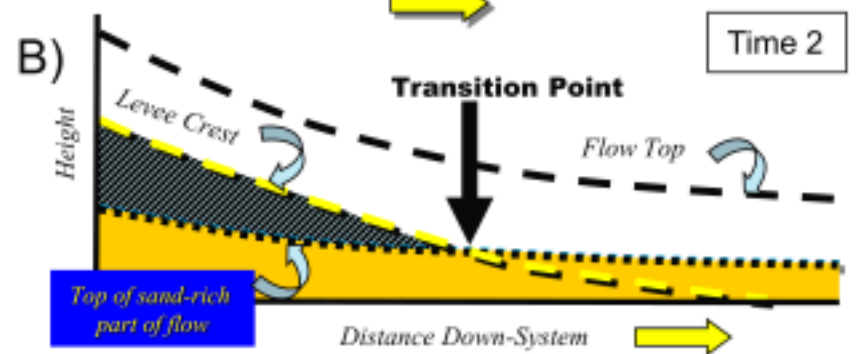
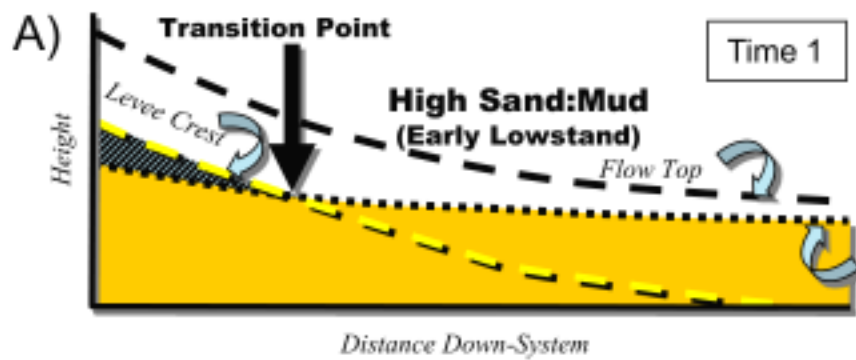
Seismic Traverse Along Levee Crest (Datumed at Top Levee)

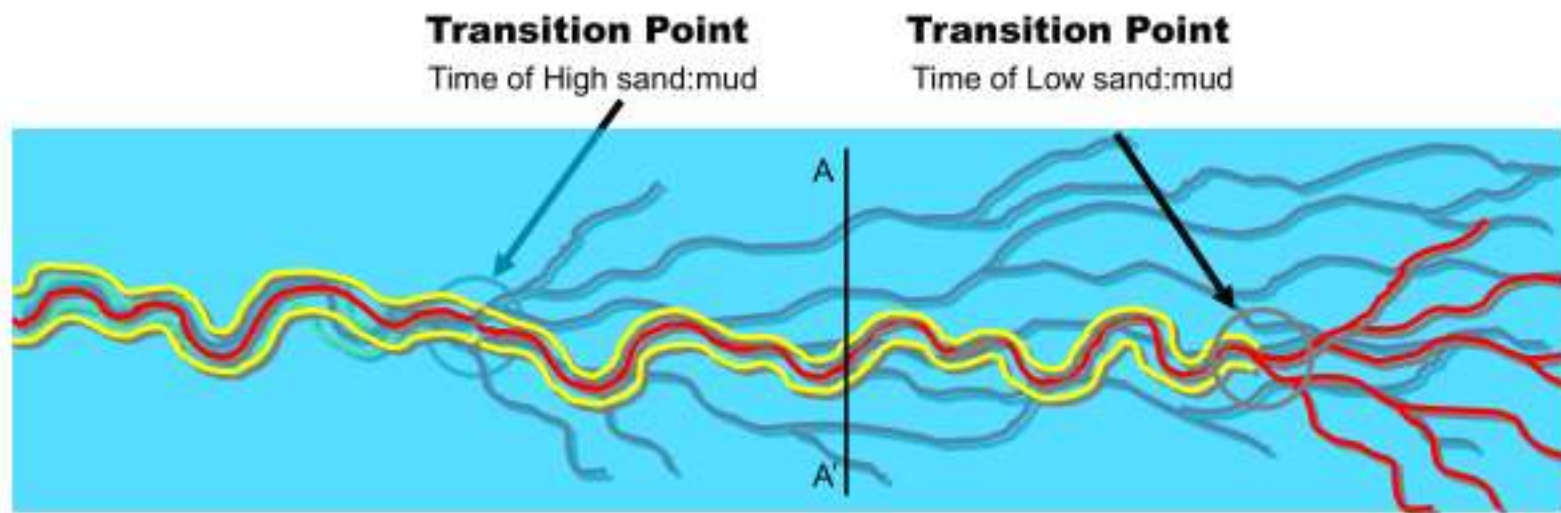


Levee Height and "Effective" Turbidity Flow Height from Proximal to Distal

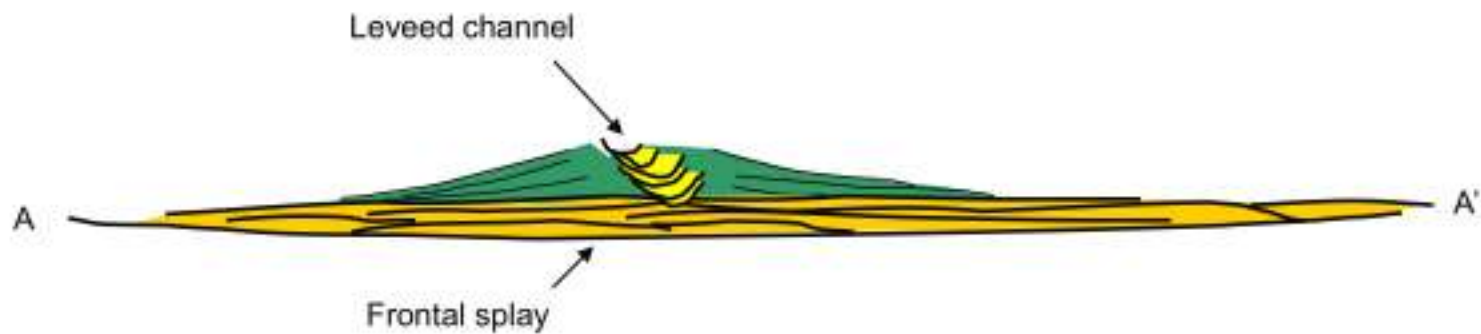


"Effective" Flow Height = Height of high-density
Increased Sand:Mud within Flow
Channel within turbidity flow

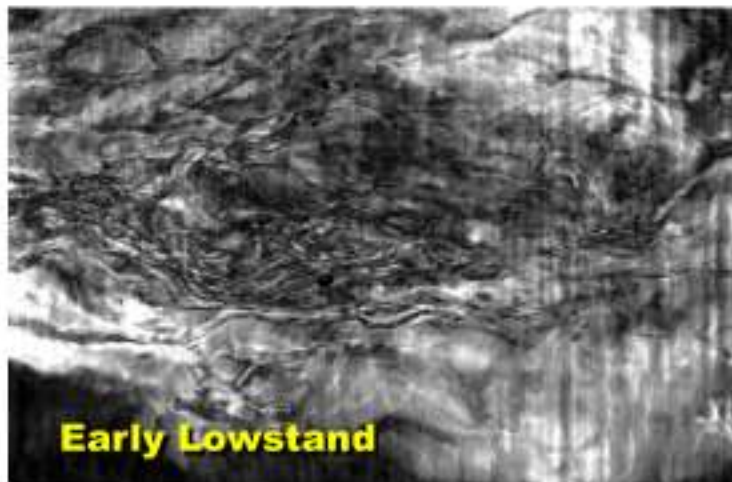
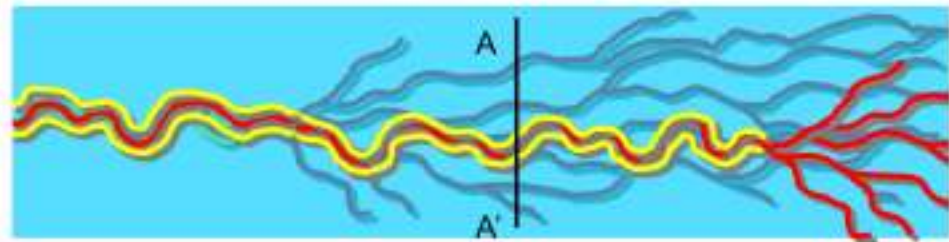
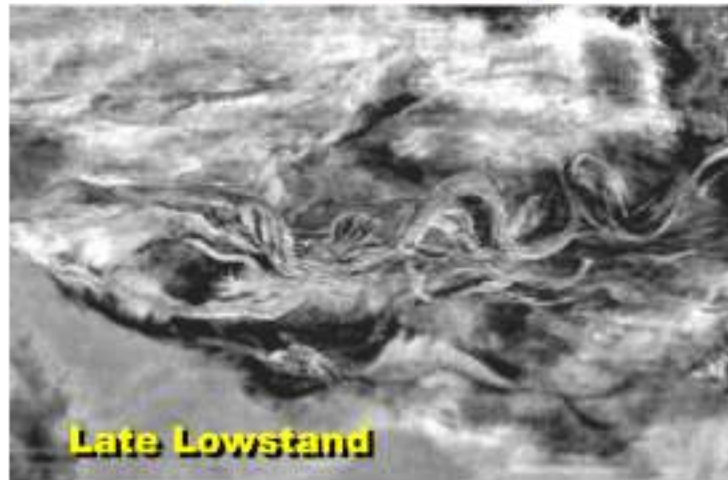


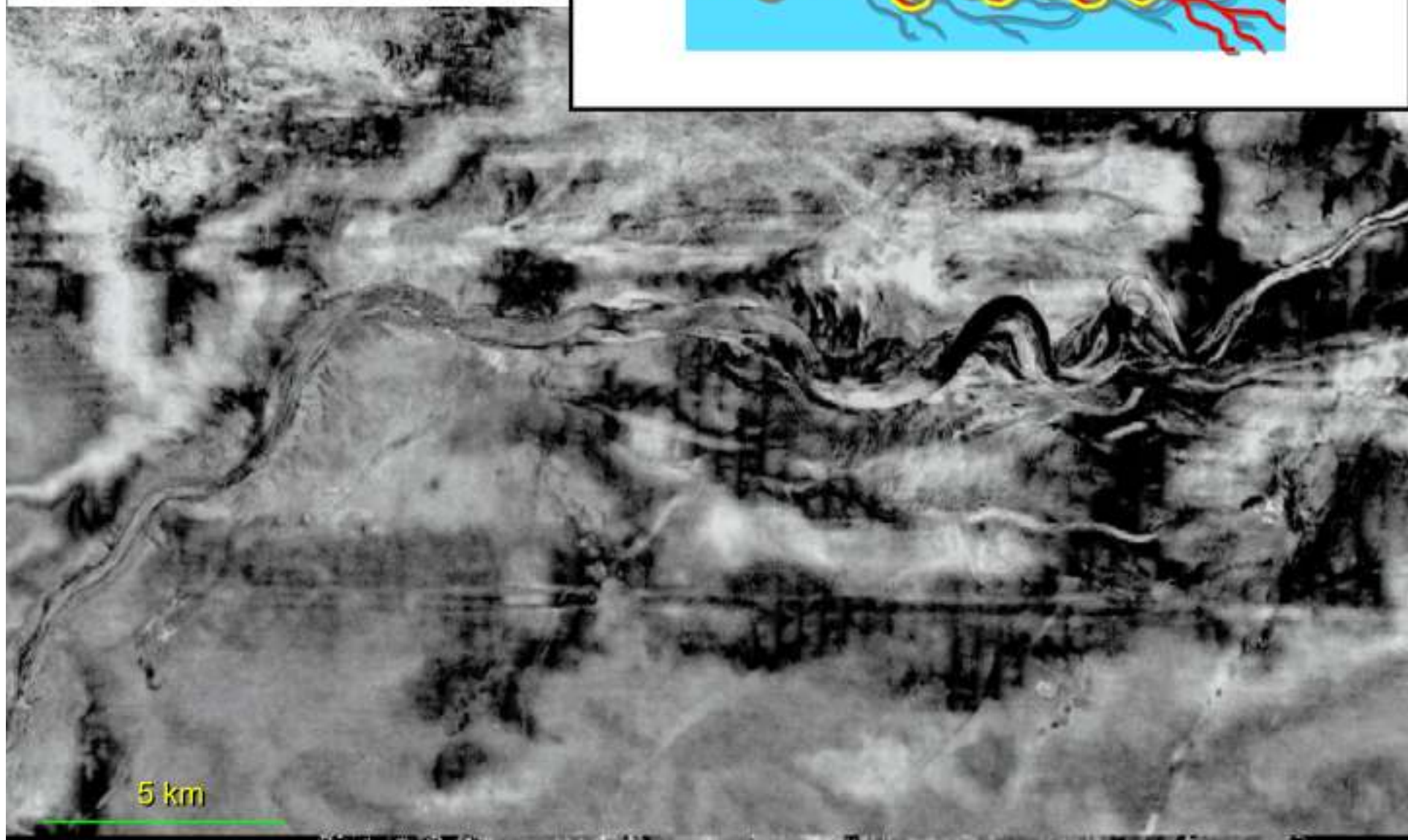
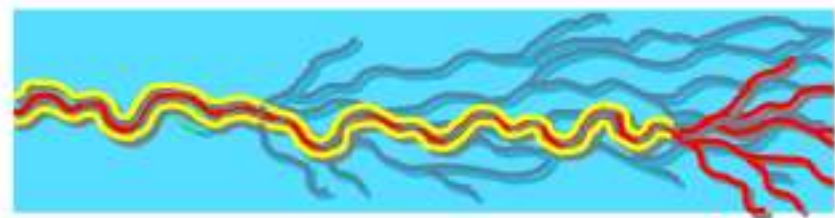


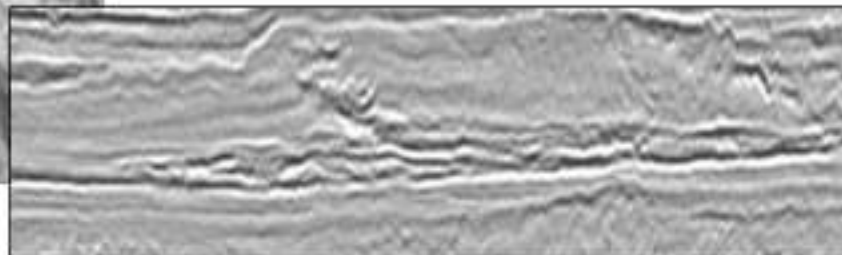
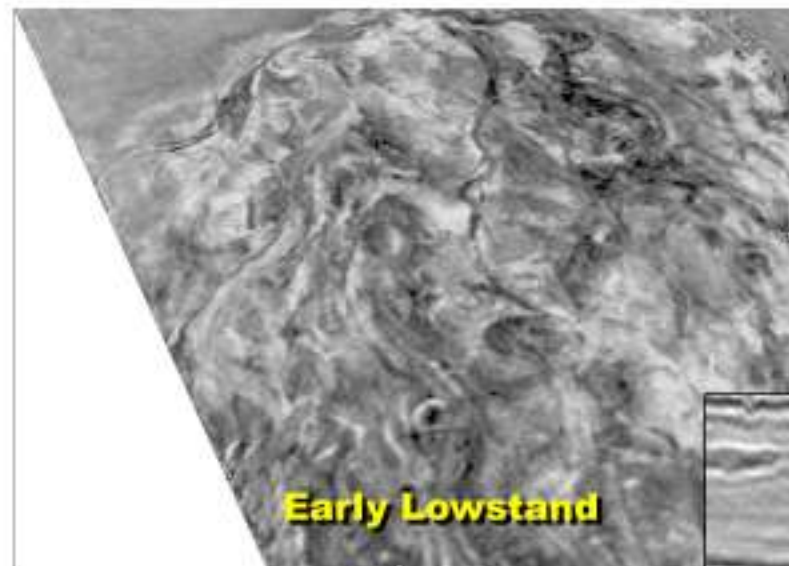
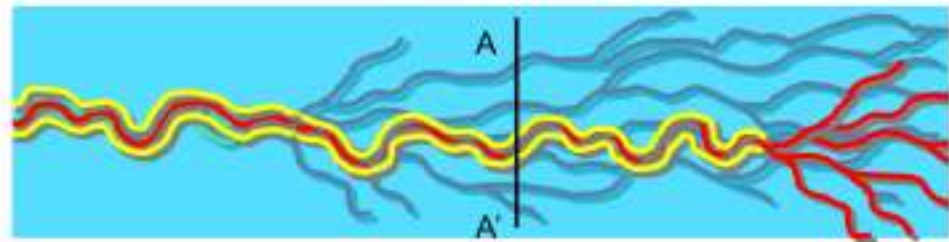
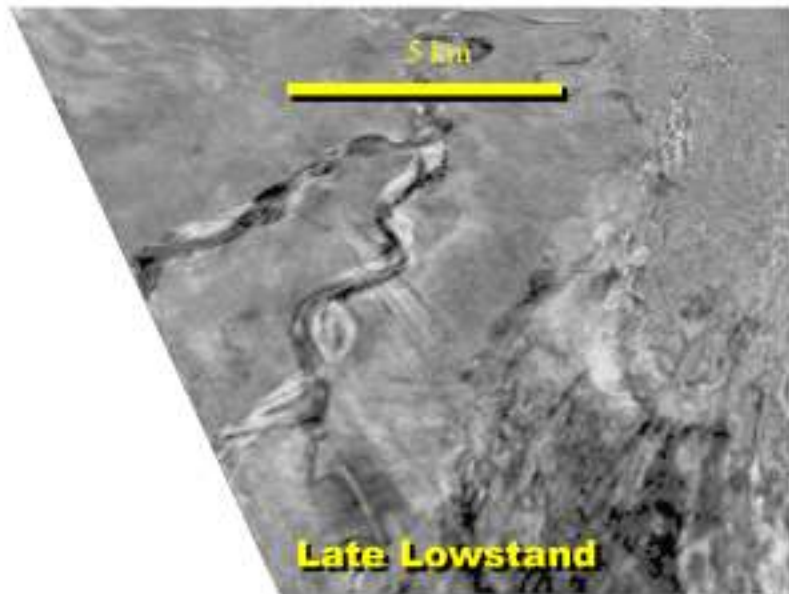
Migration of Transition Point in response
to change from High to Low Sand:Mud



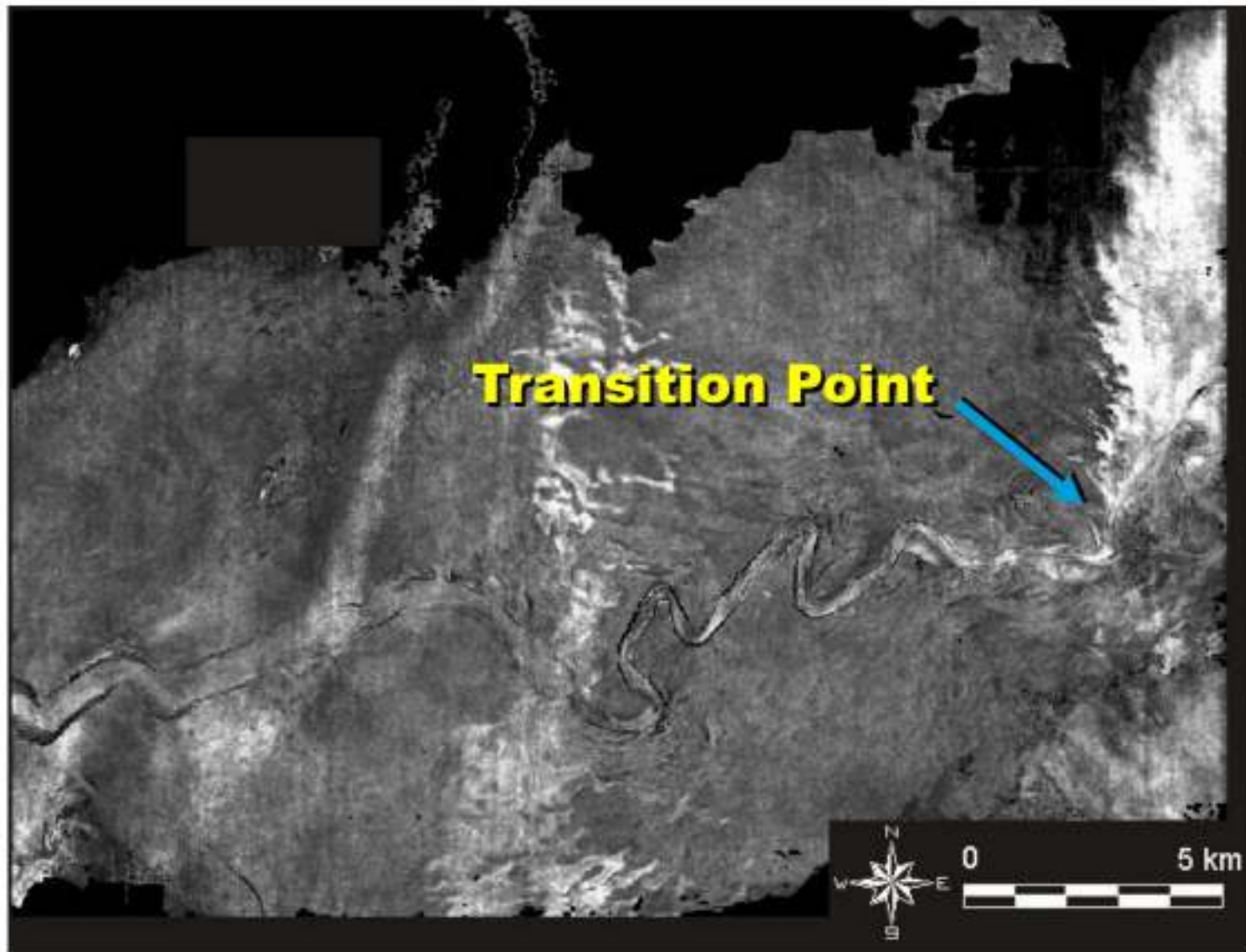
5 km



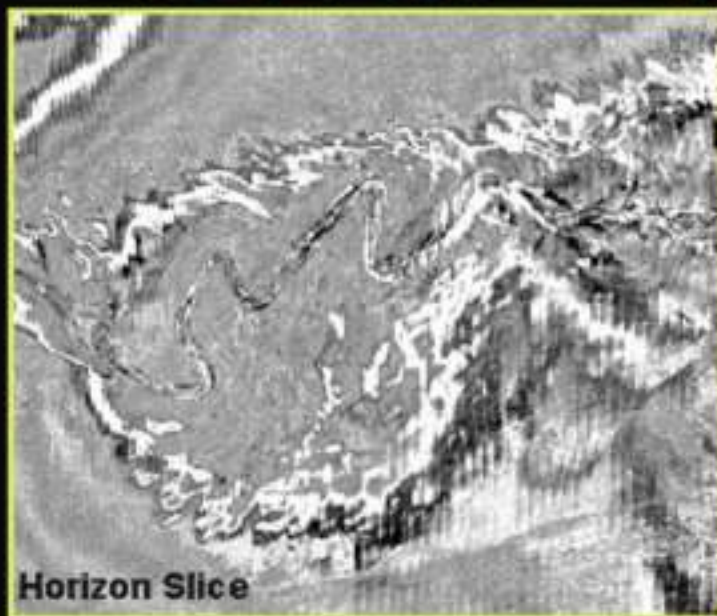
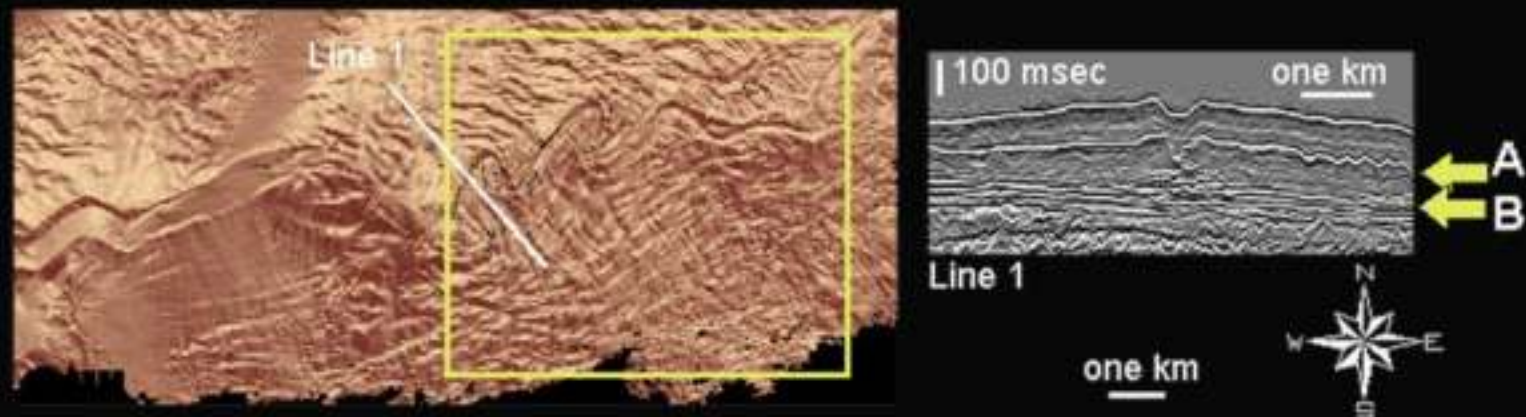




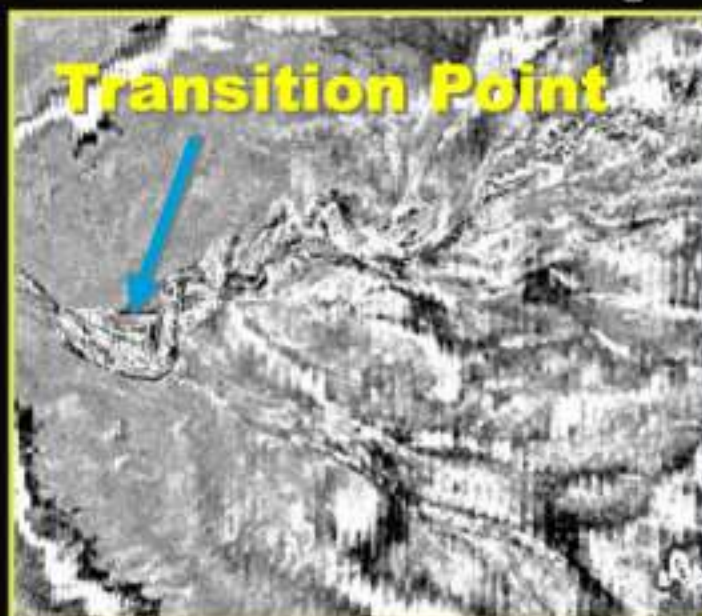
Pleistocene Leveed Channel Reflection Amplitude Extraction



Paired Terminal Lobe and Channel-Levee Complex



A Channel-Levee Complex



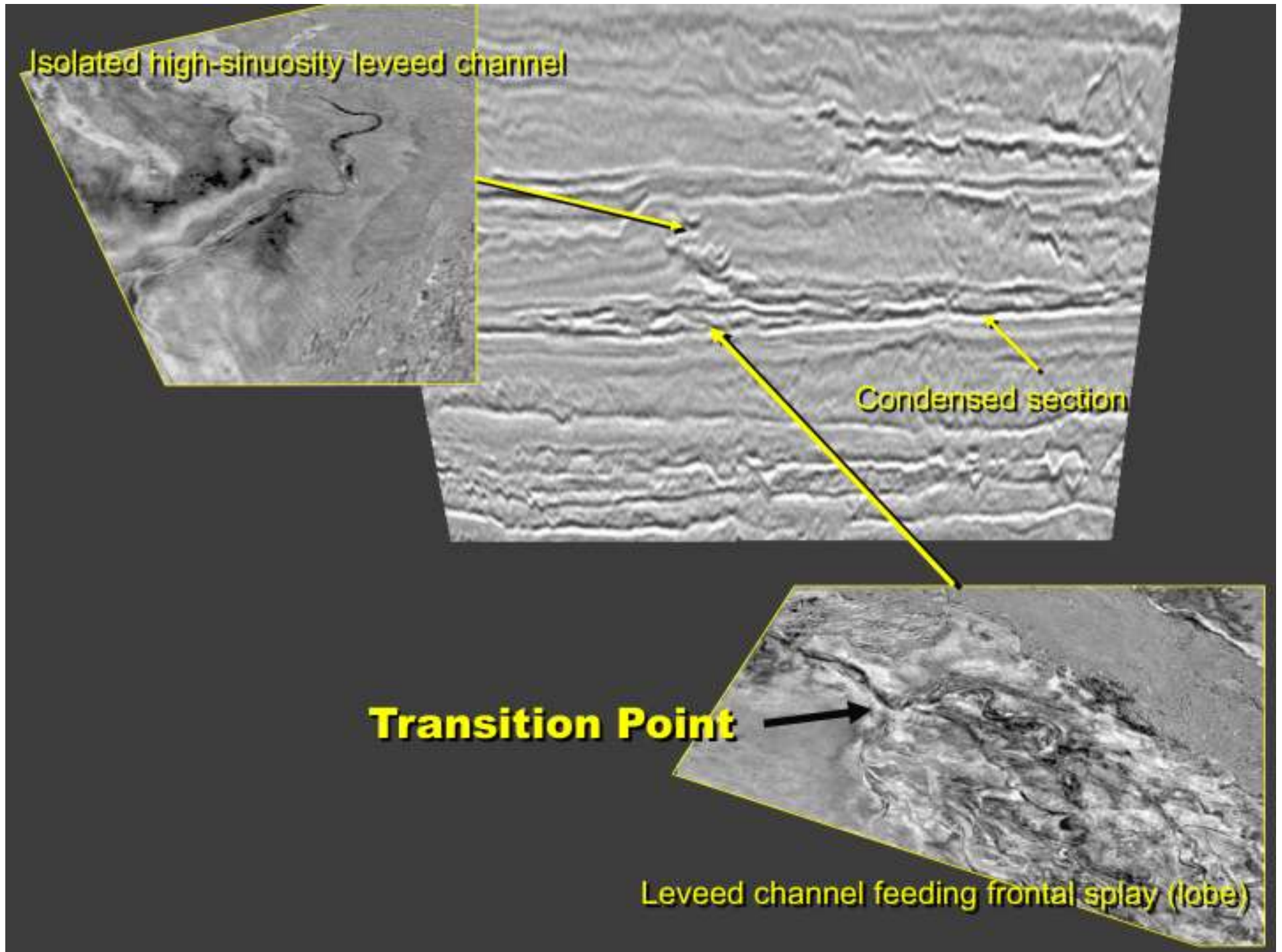
B Distributary Channel Complex
- Frontal Splay

Isolated high-sinuosity leveed channel

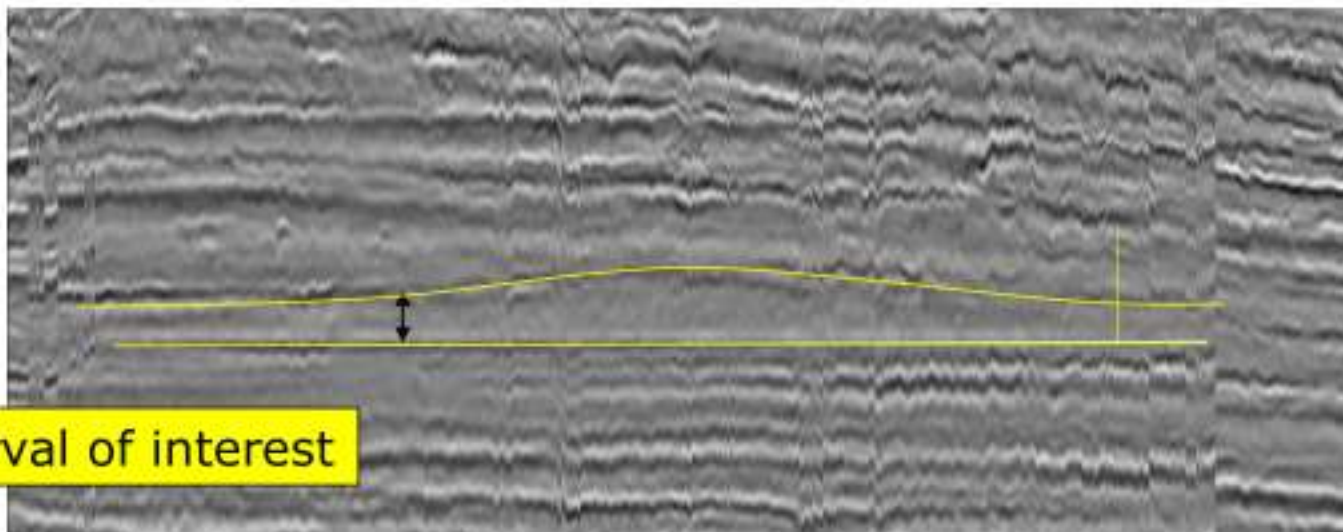
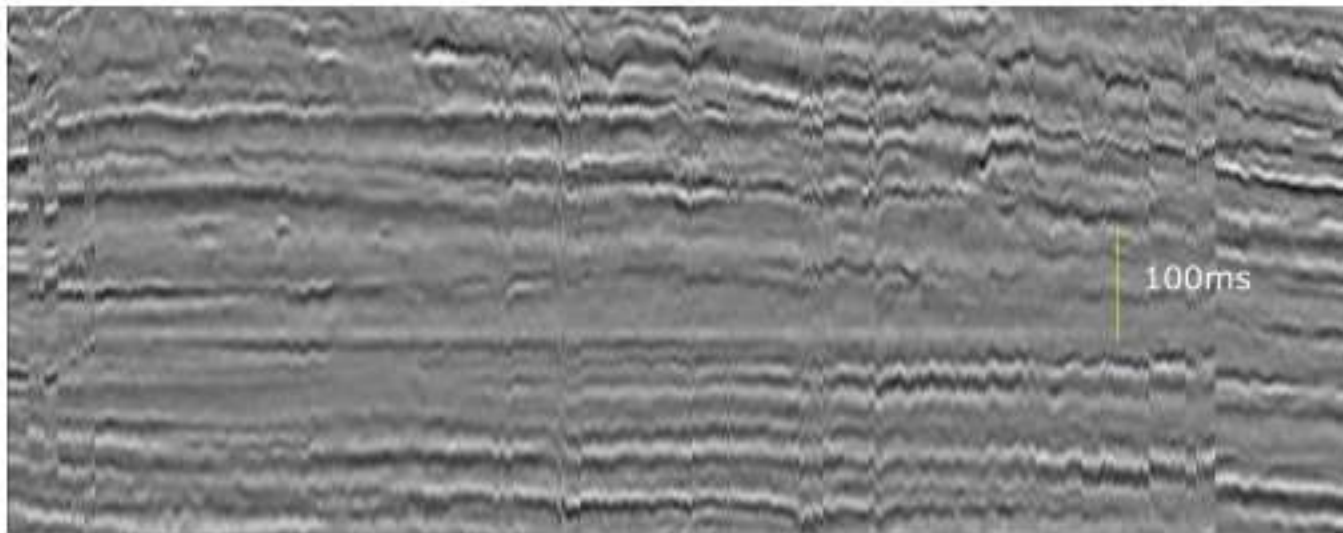
Condensed section

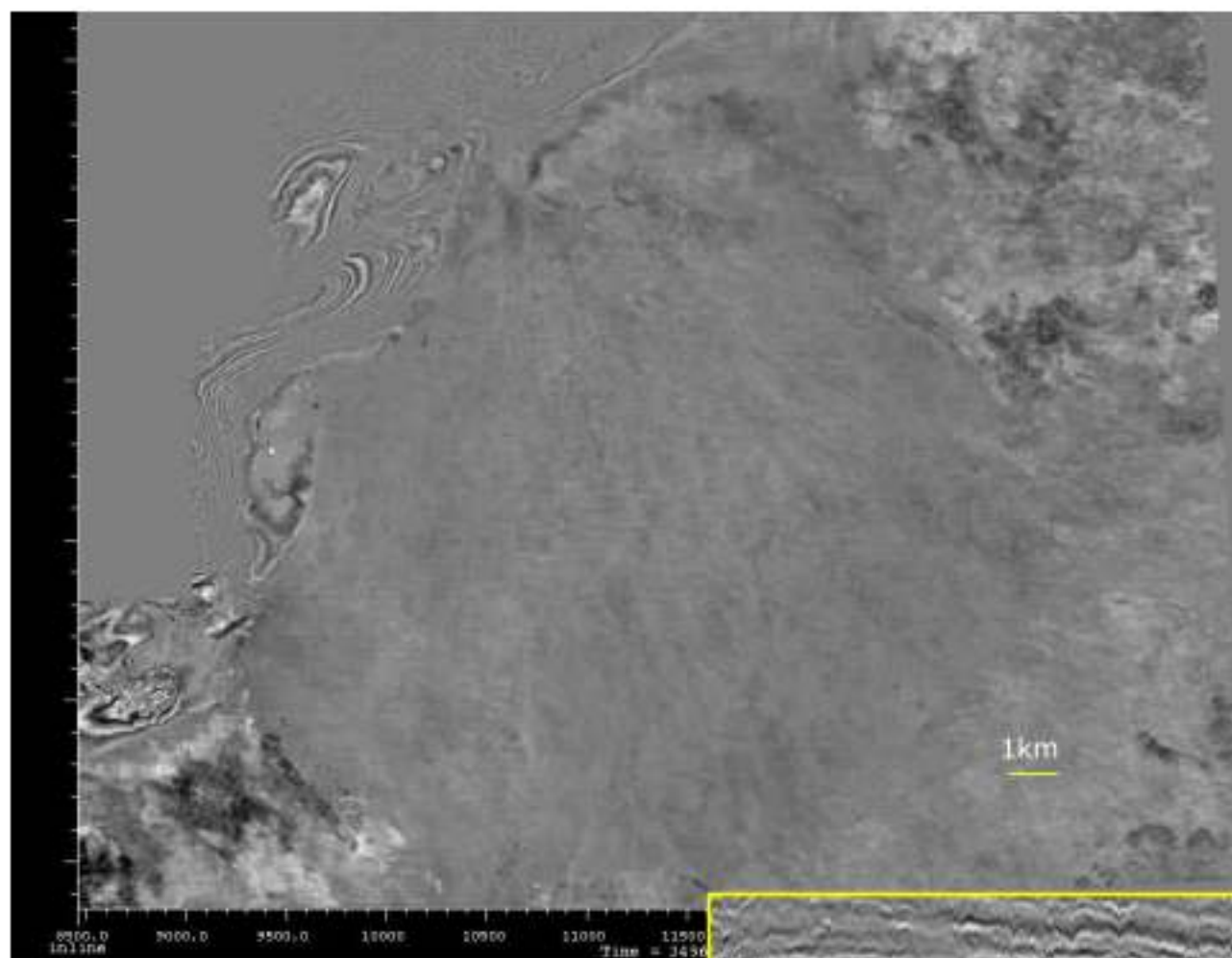
Transition Point

Leveed channel feeding frontal splay (lobe)

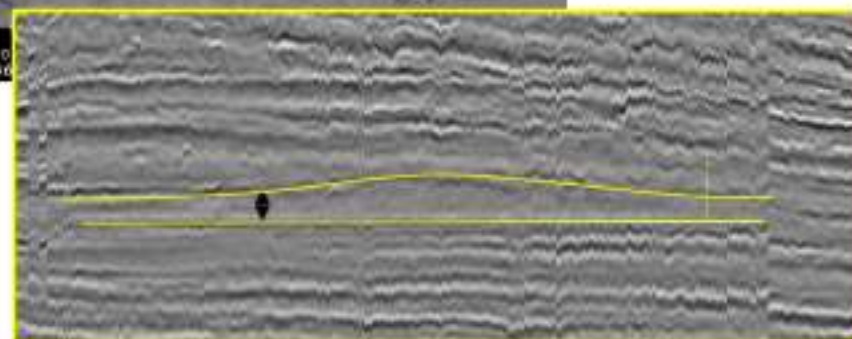


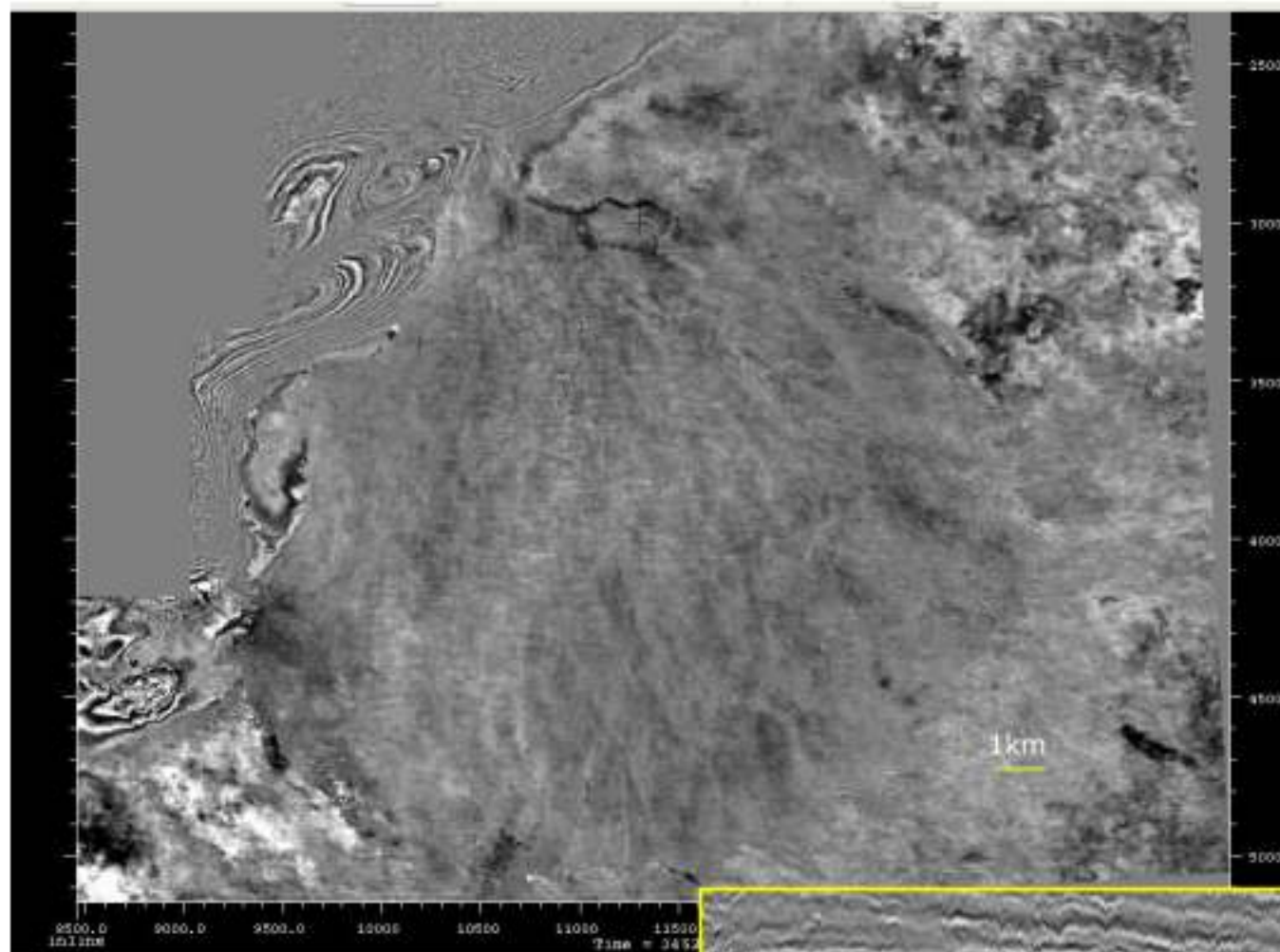
Turbidite Fan – Distributary Channel Complex (Oligo-Miocene – GOM)



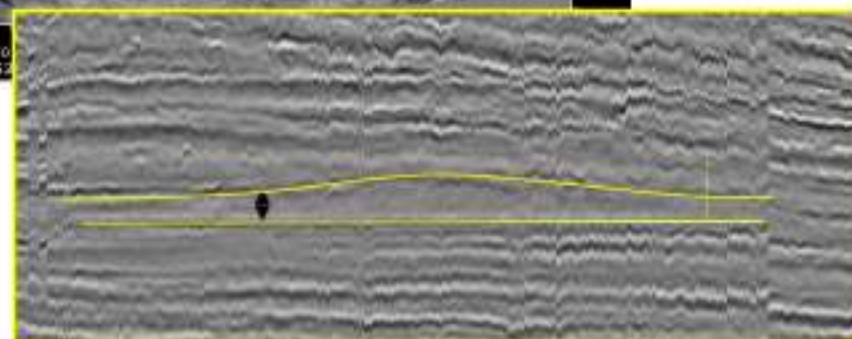


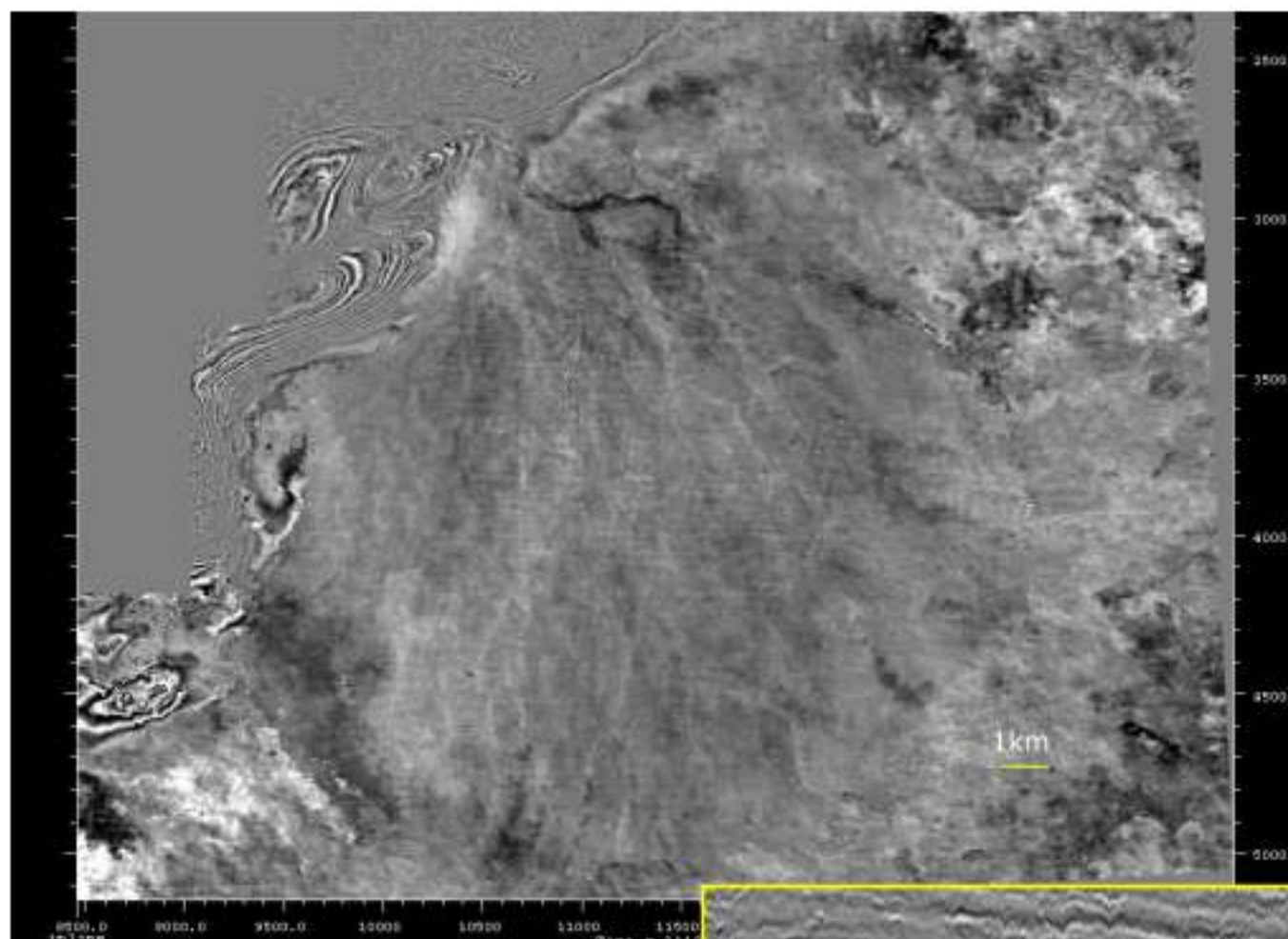
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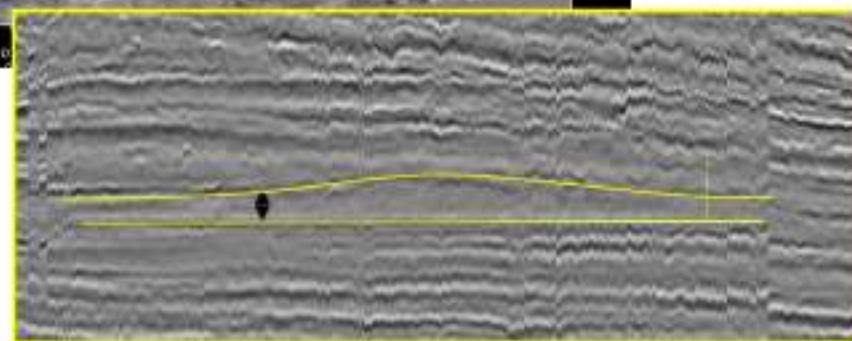


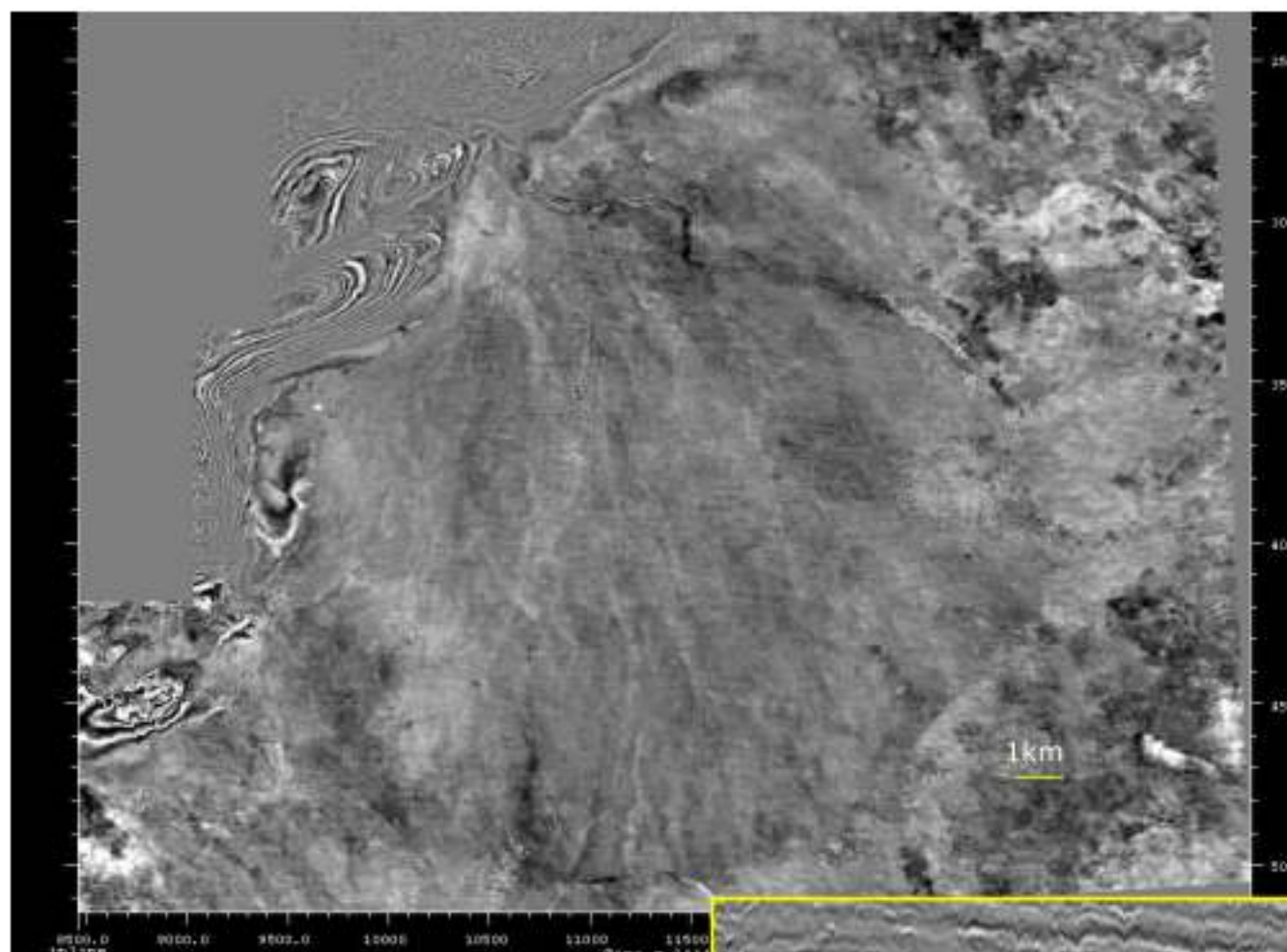
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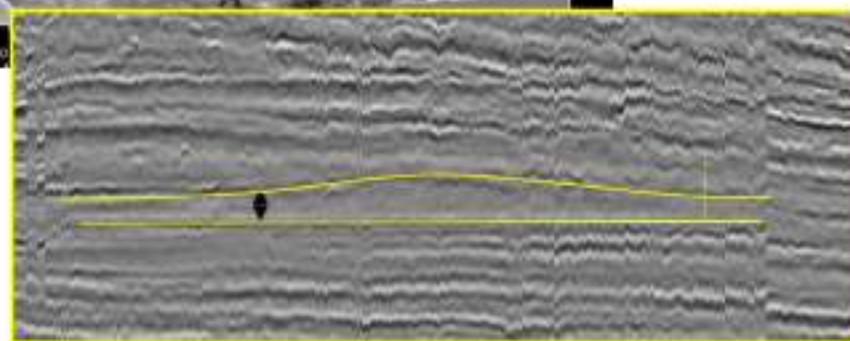


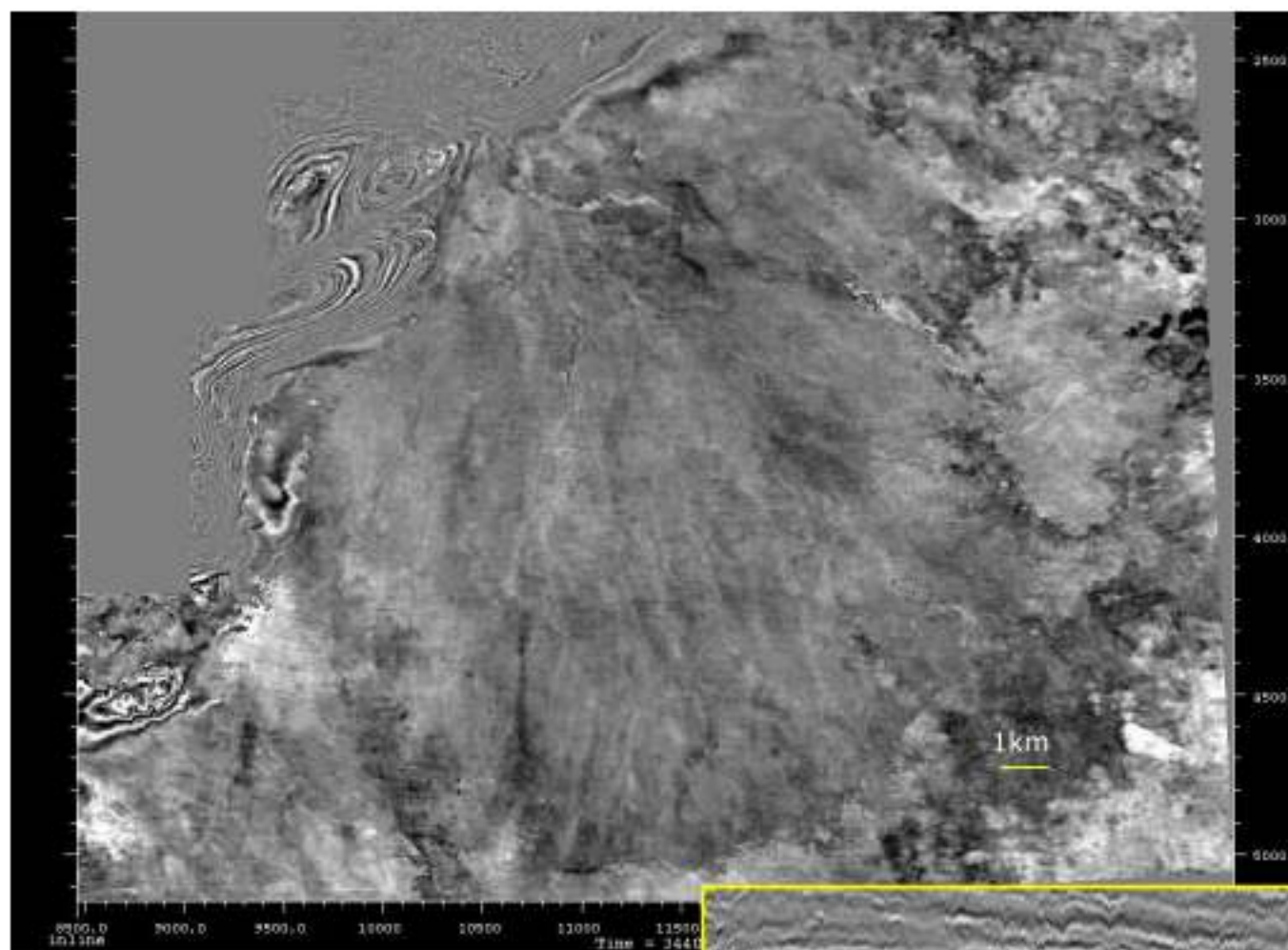
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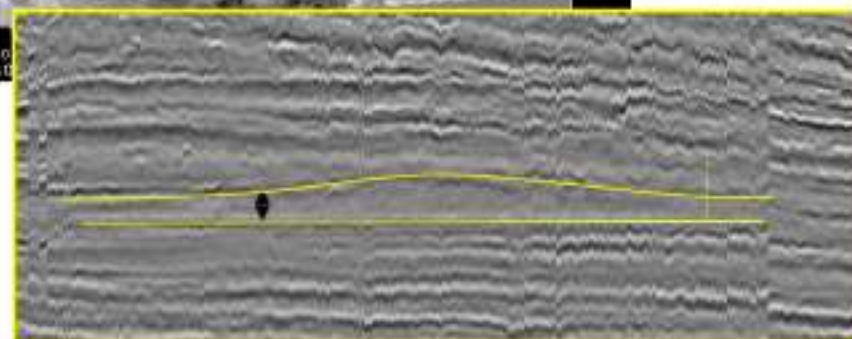


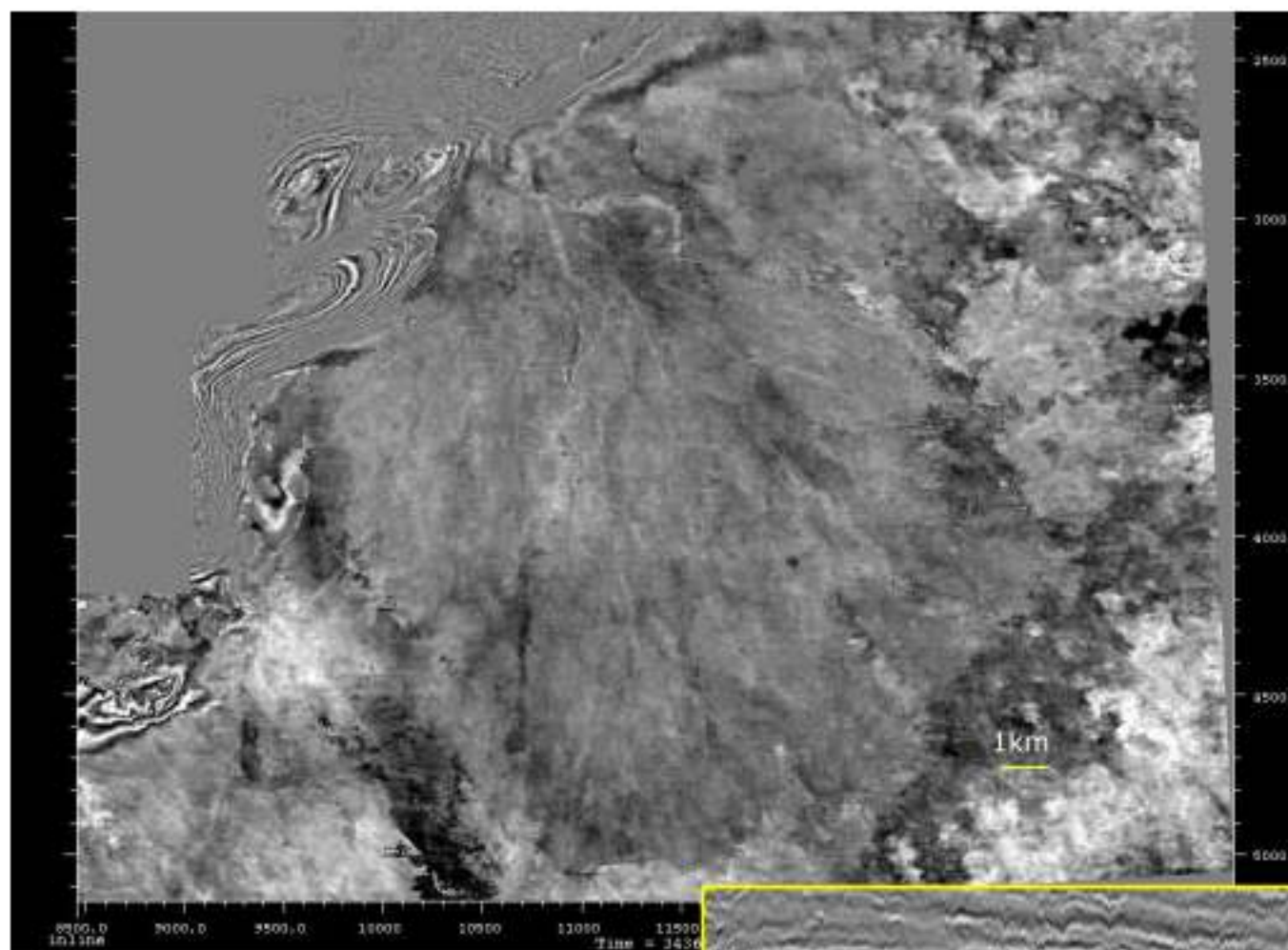
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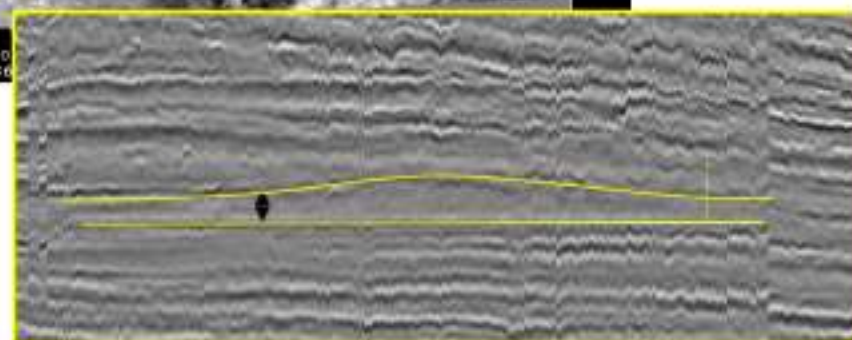


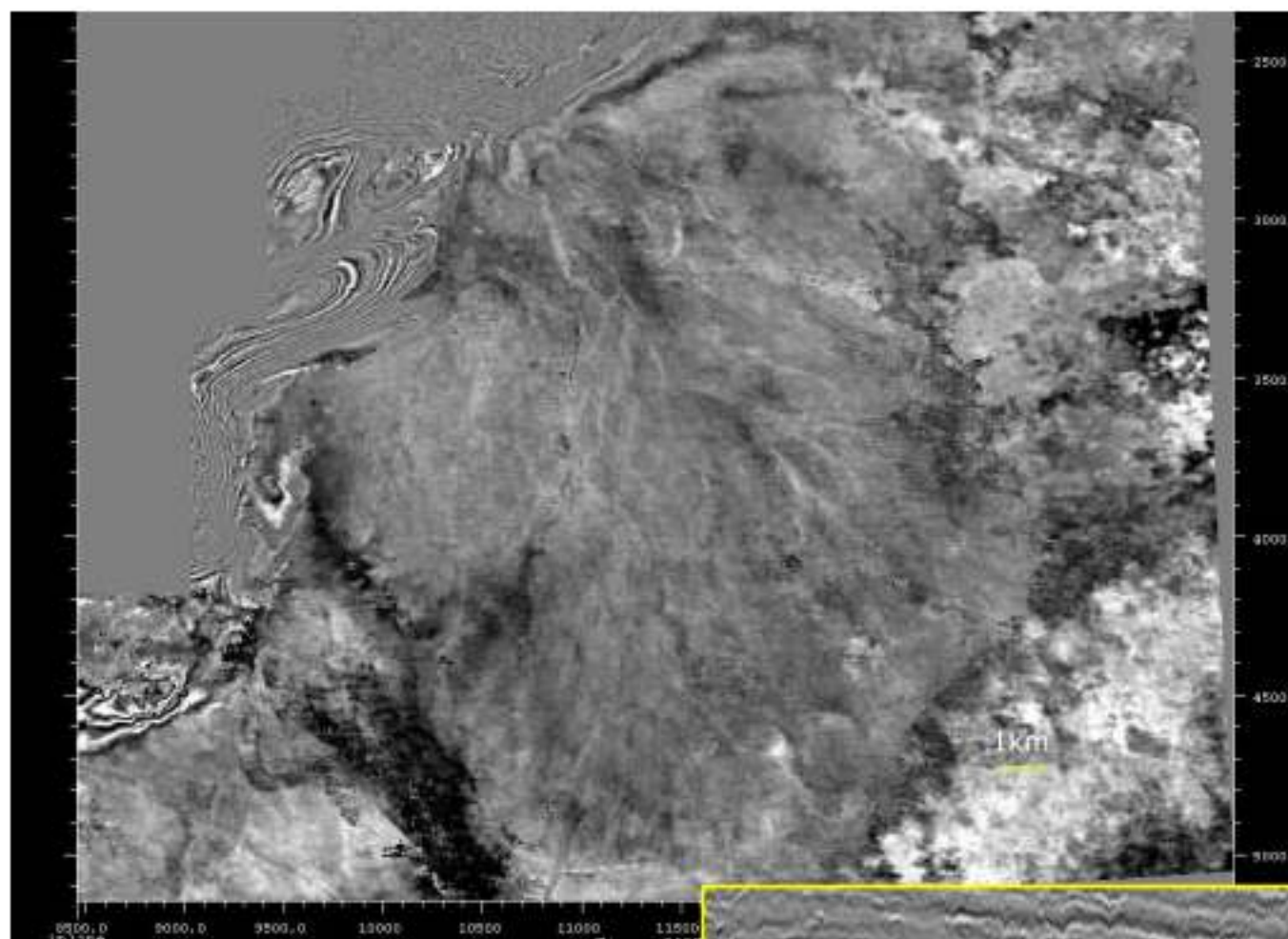
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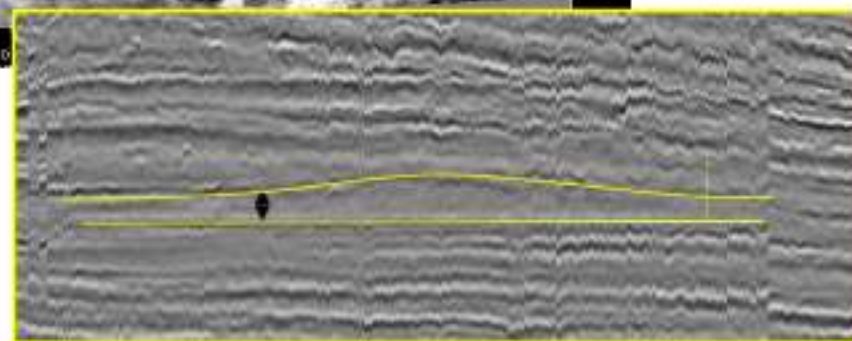


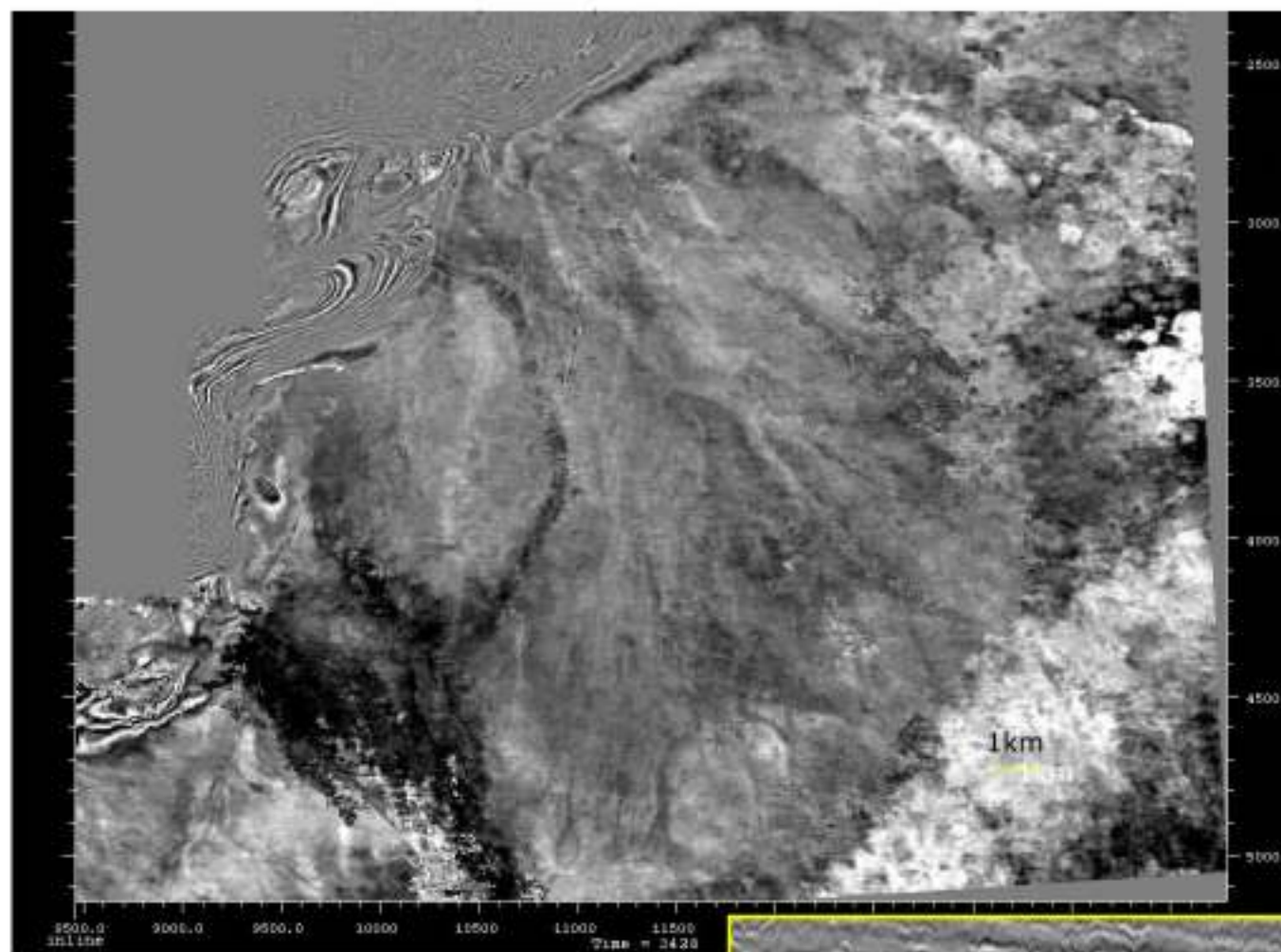
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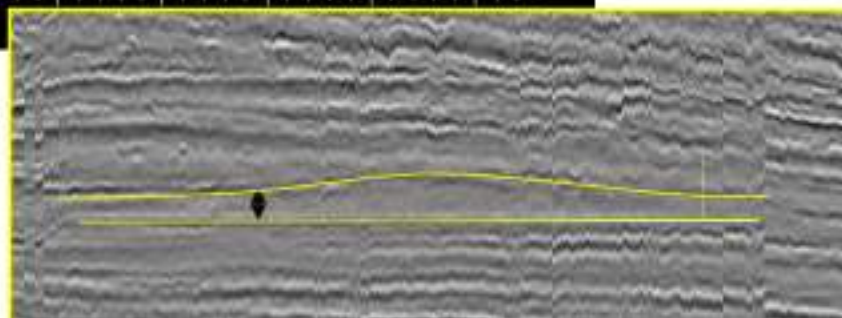


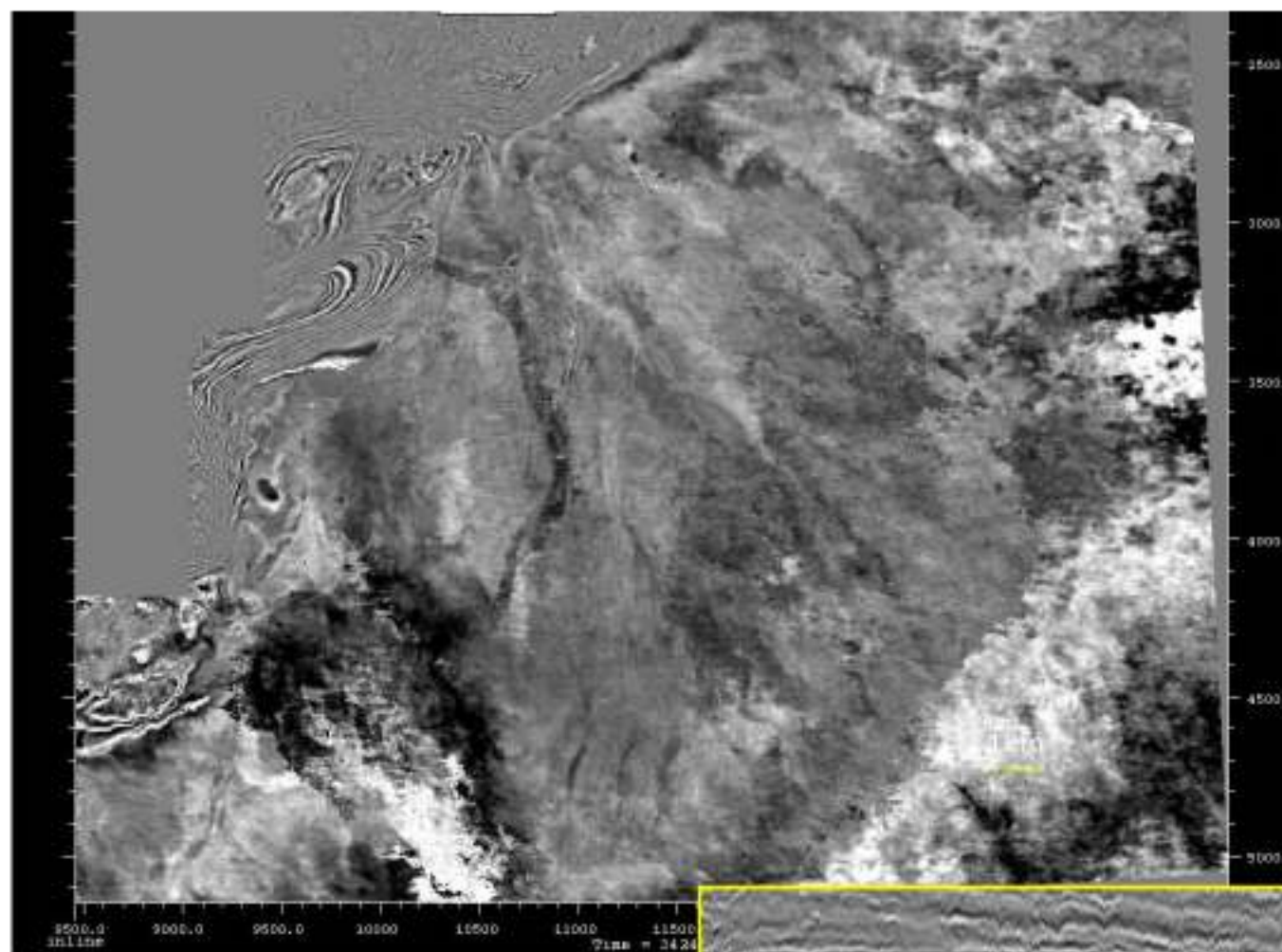
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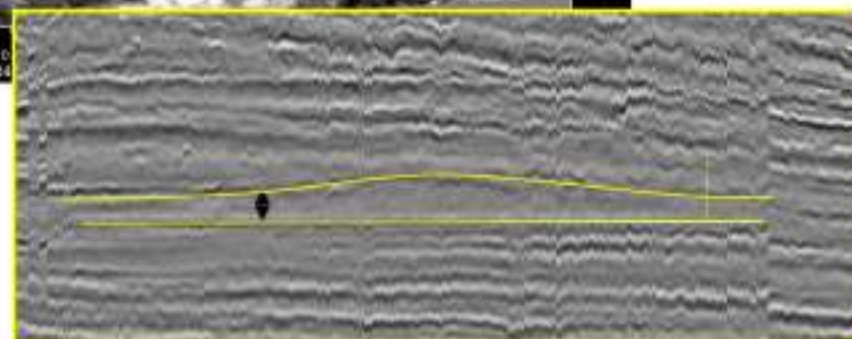


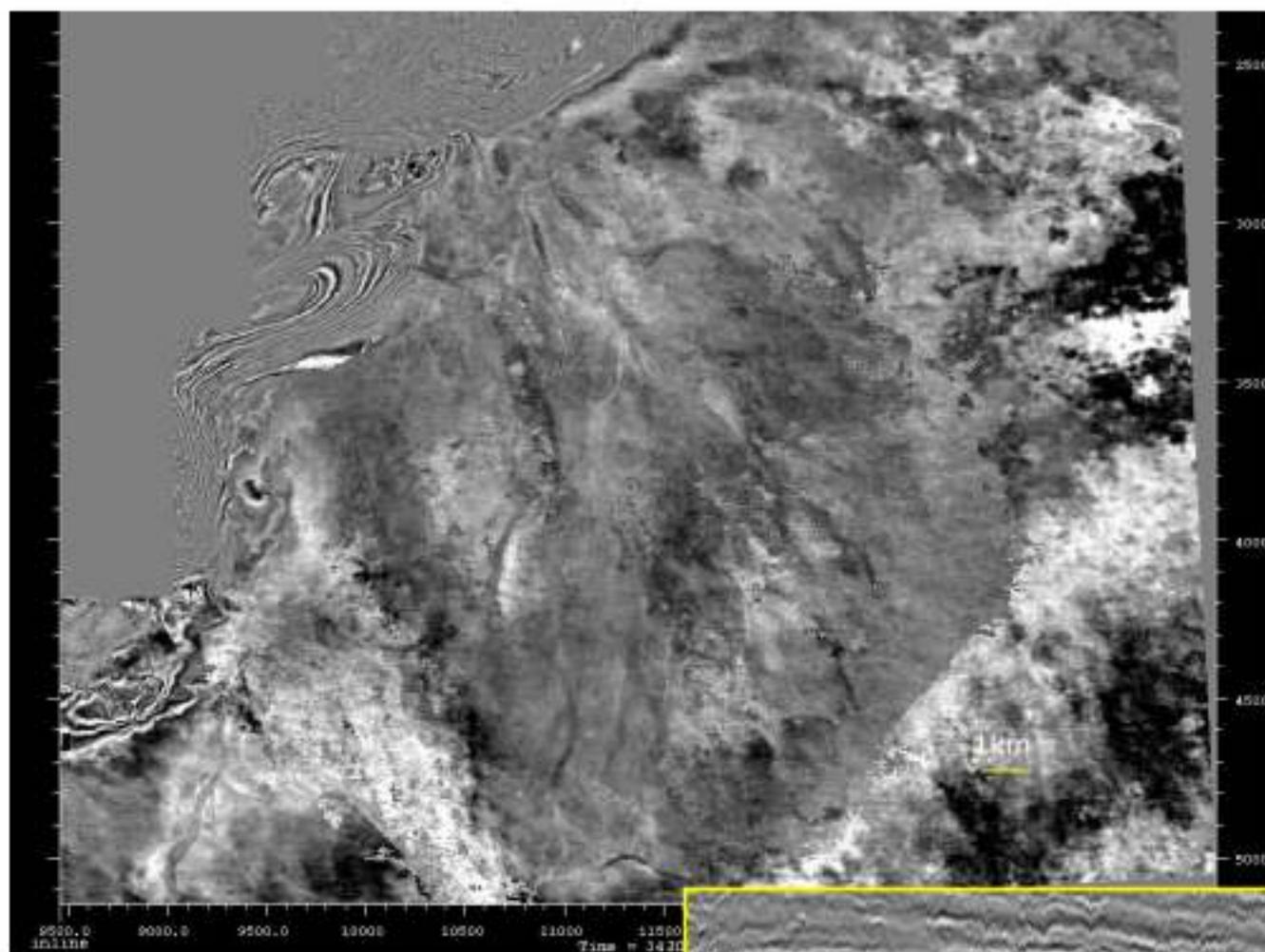
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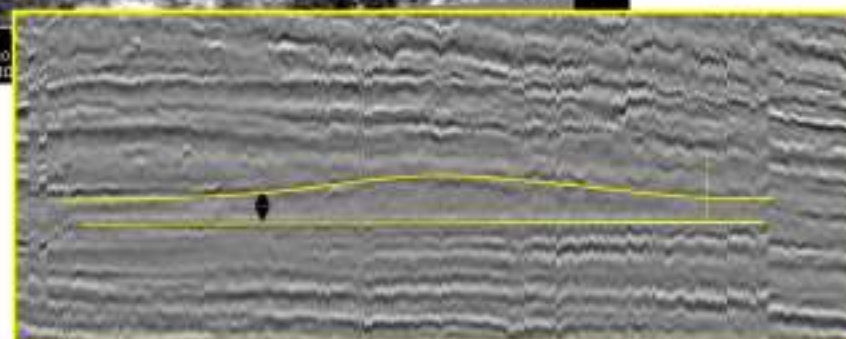


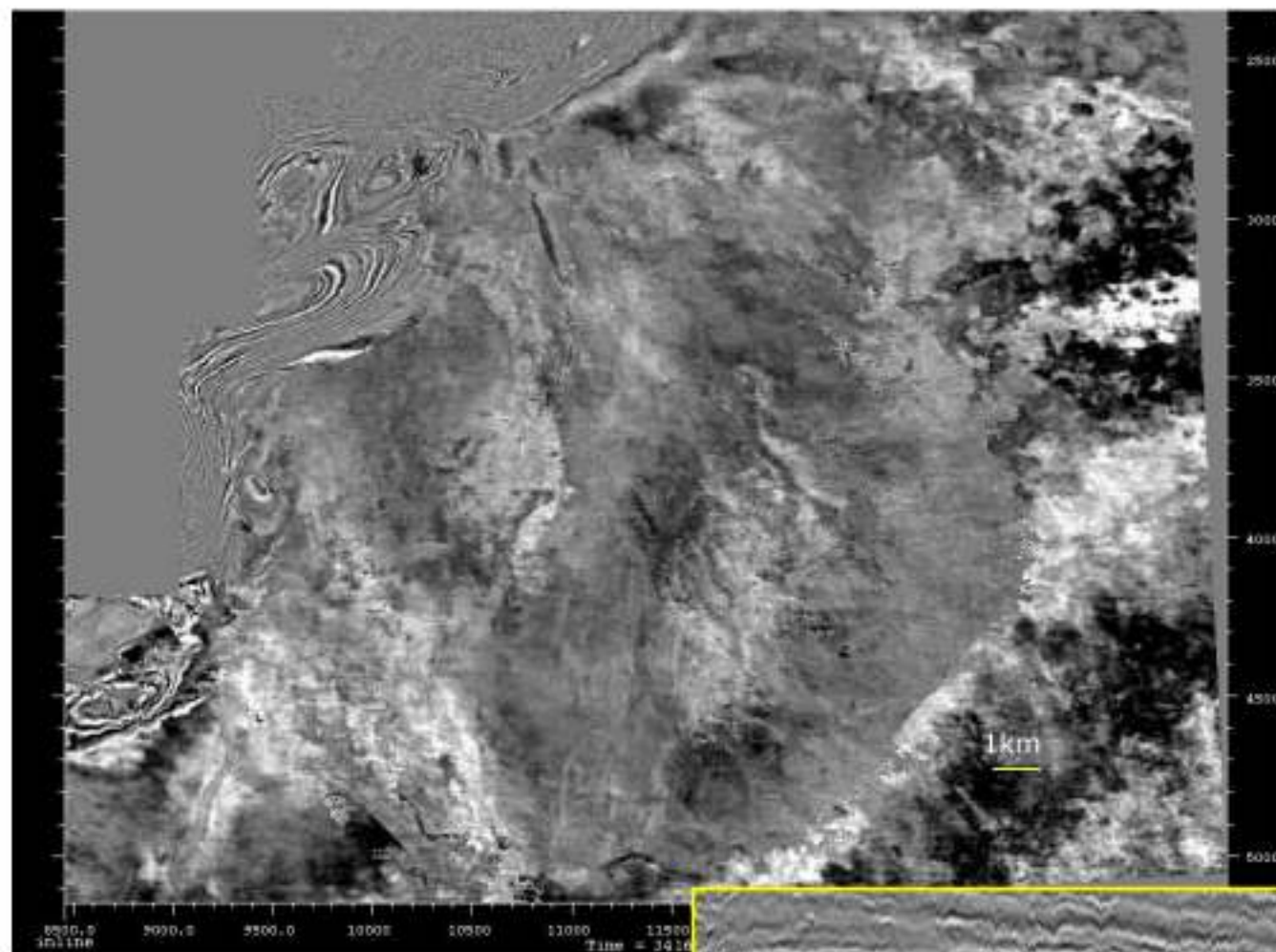
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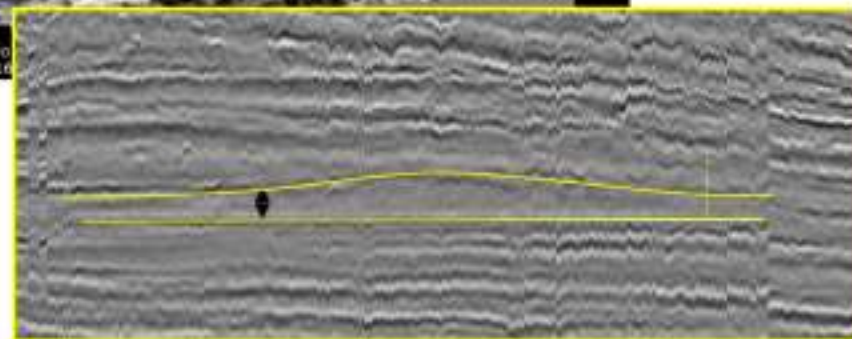


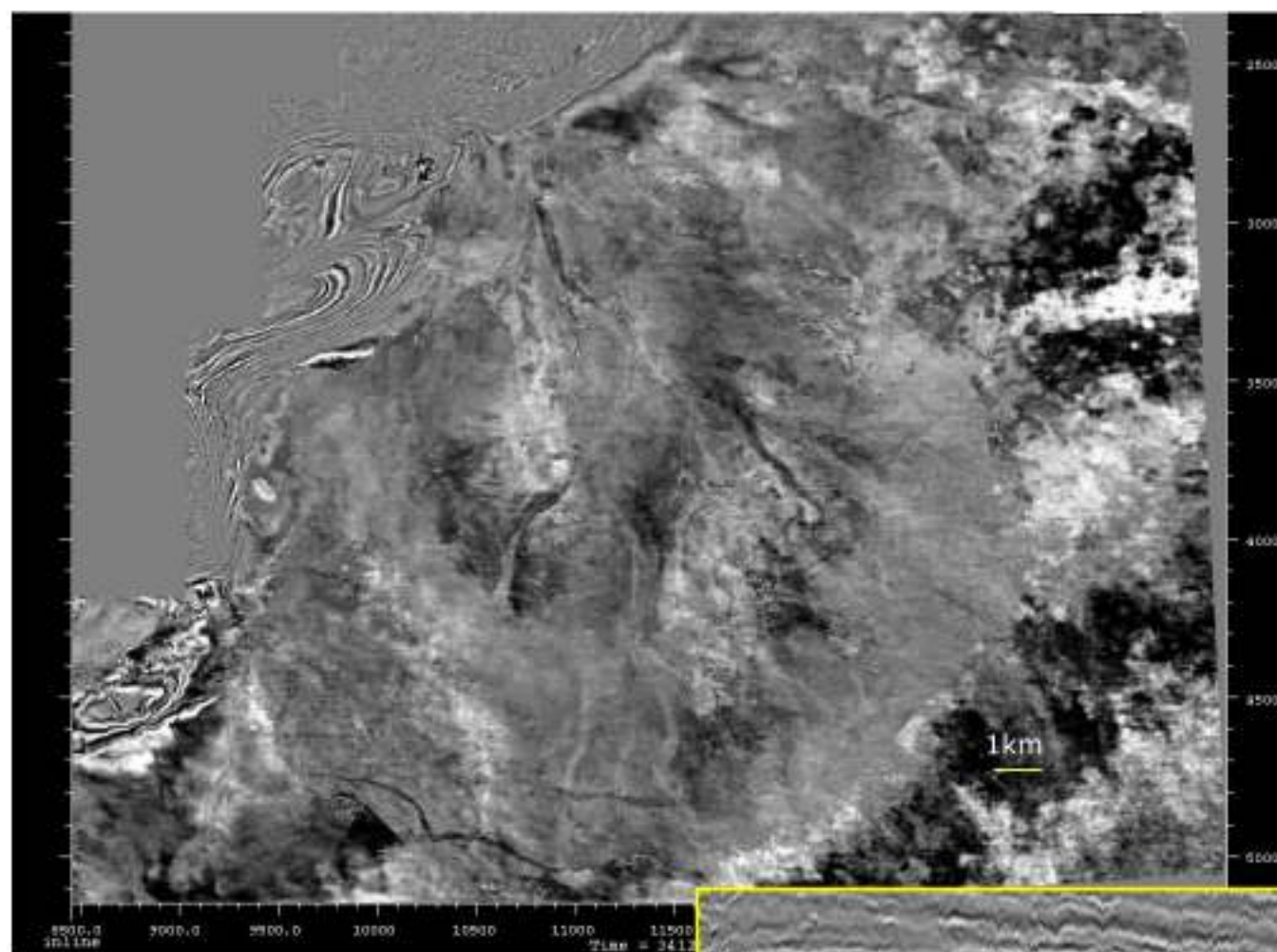
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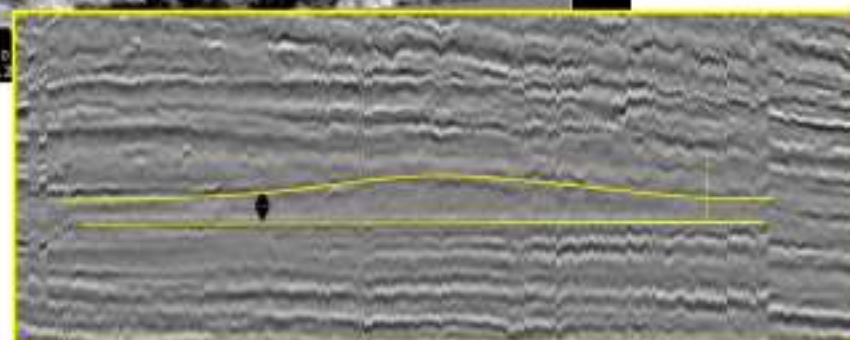


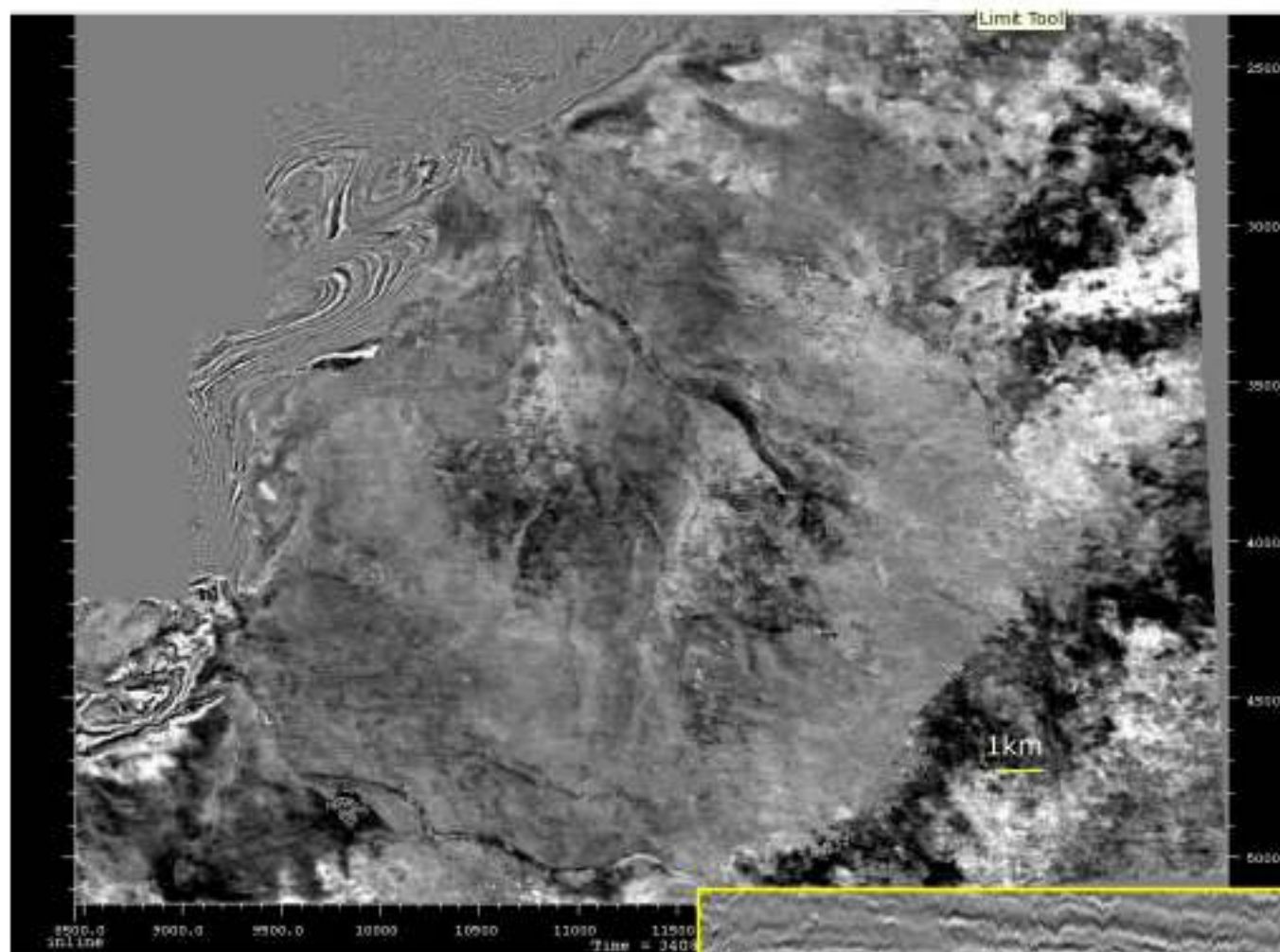
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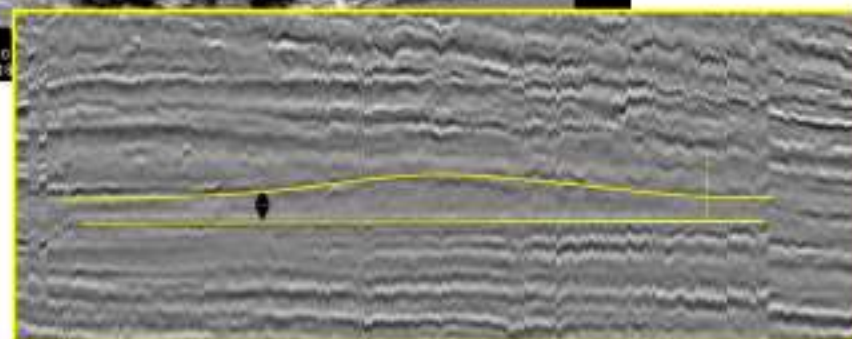


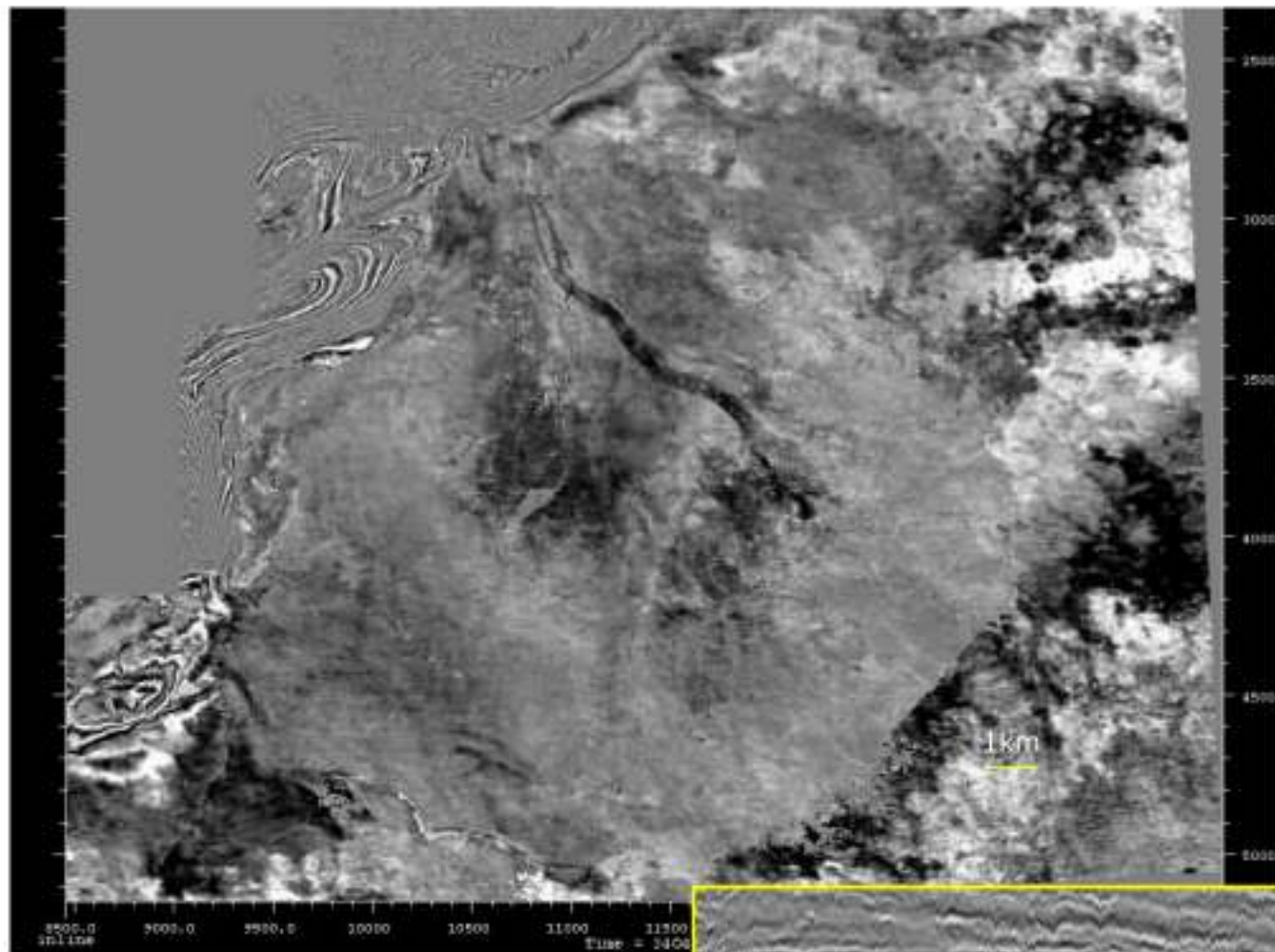
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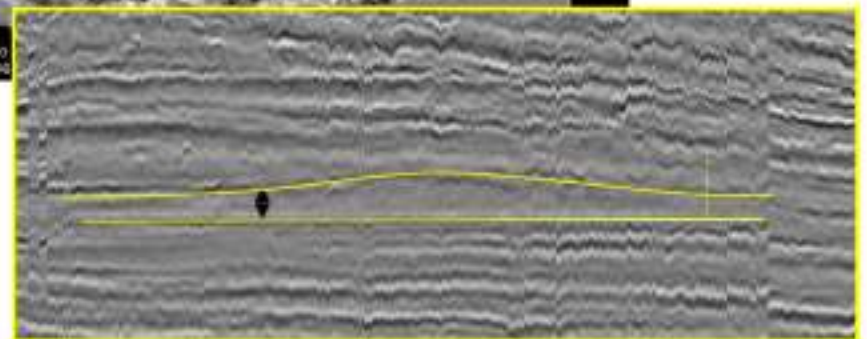


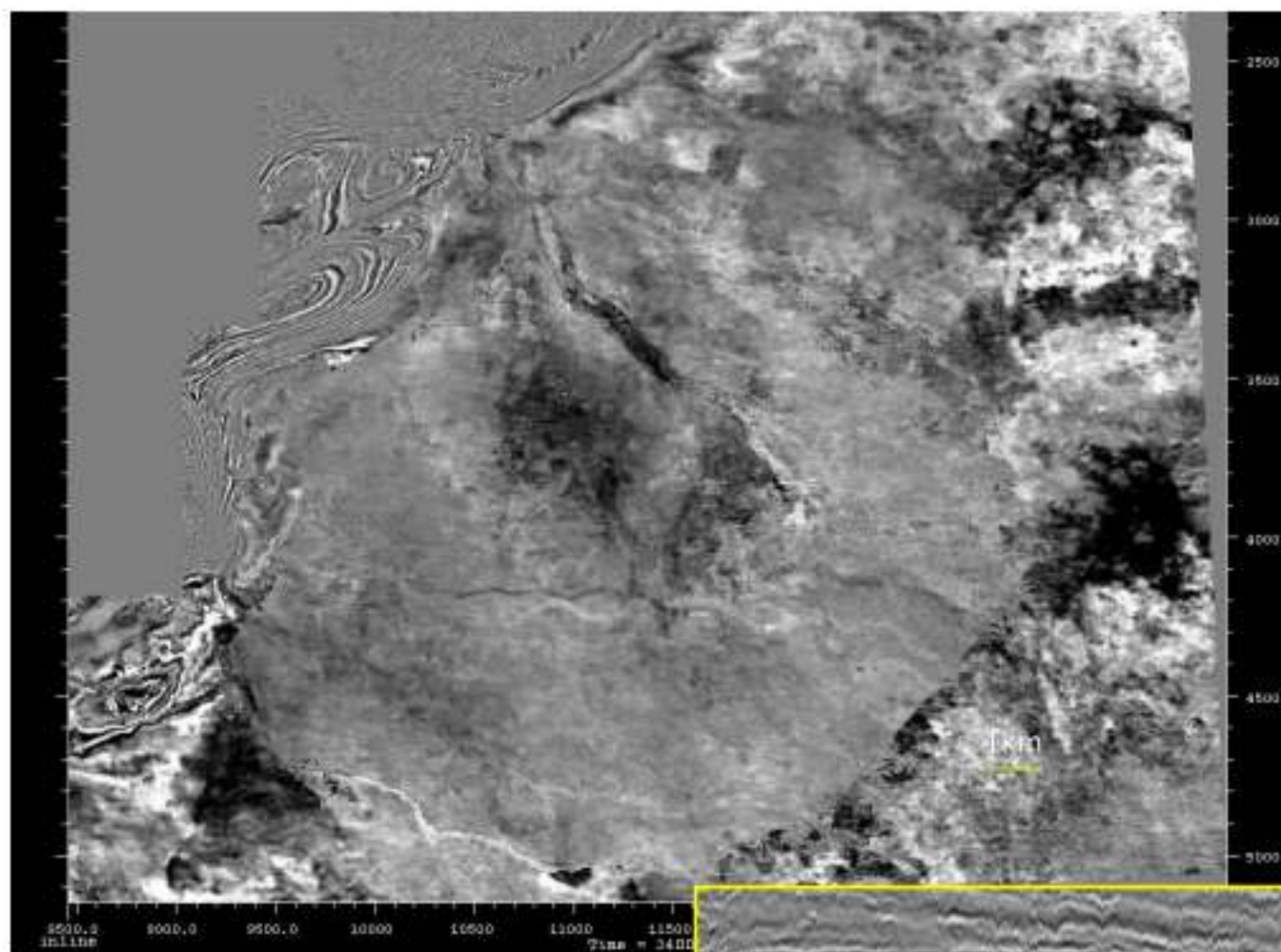
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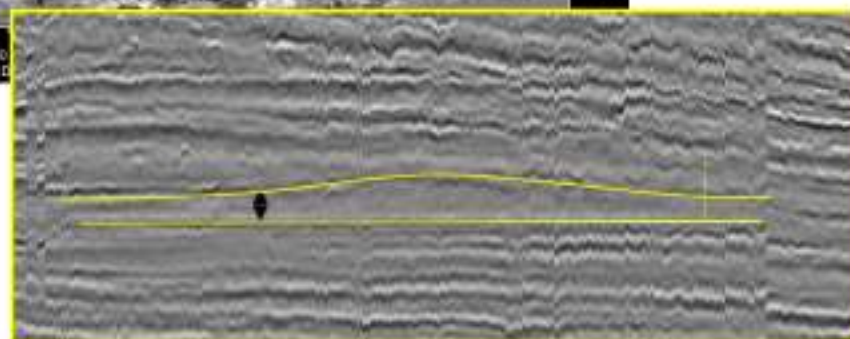


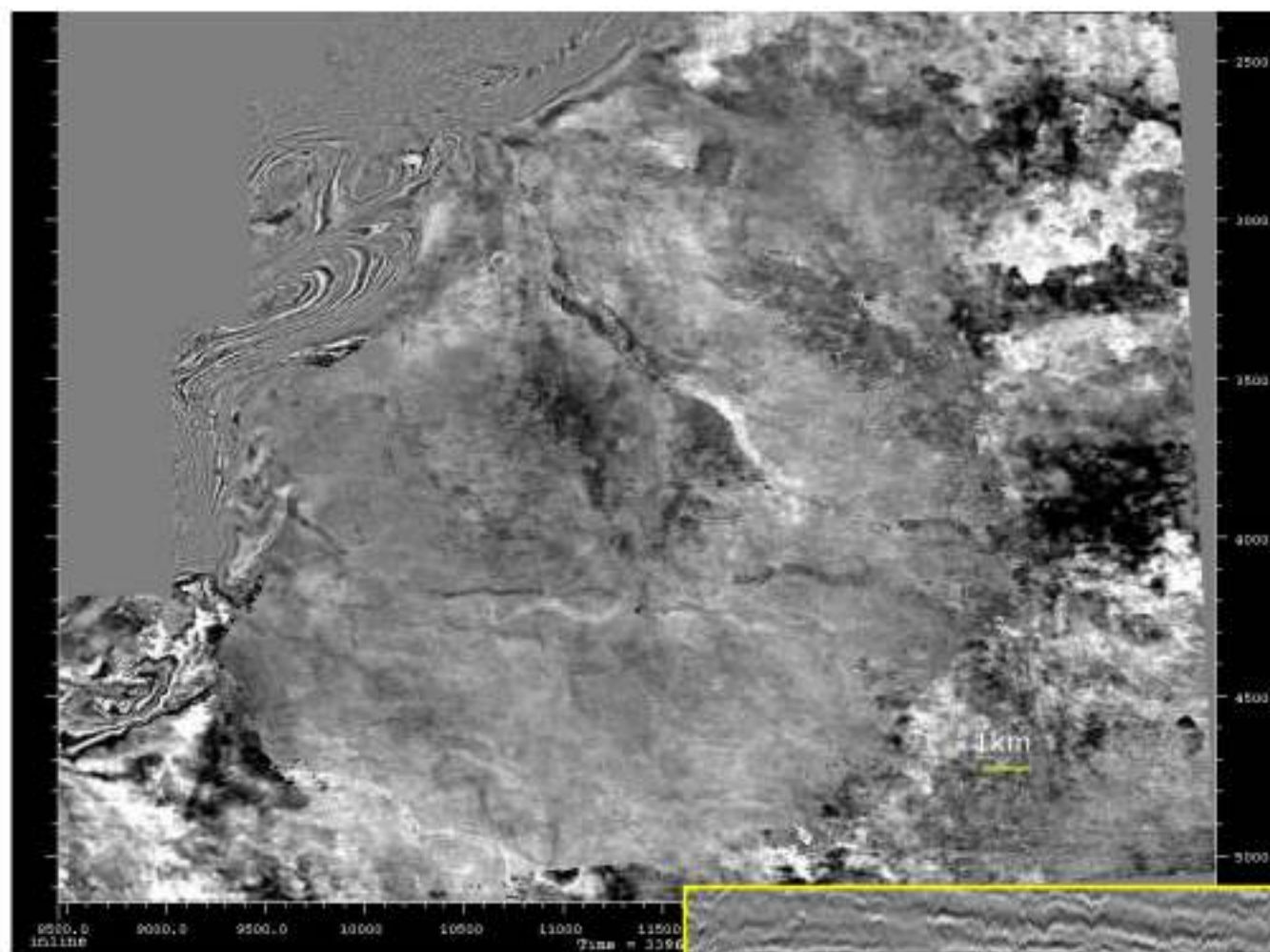
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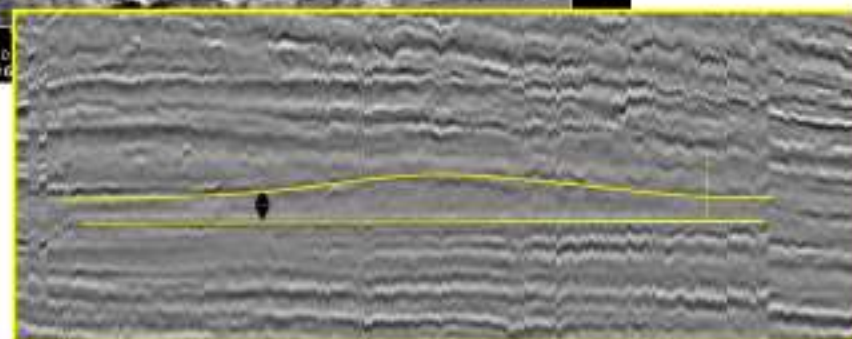


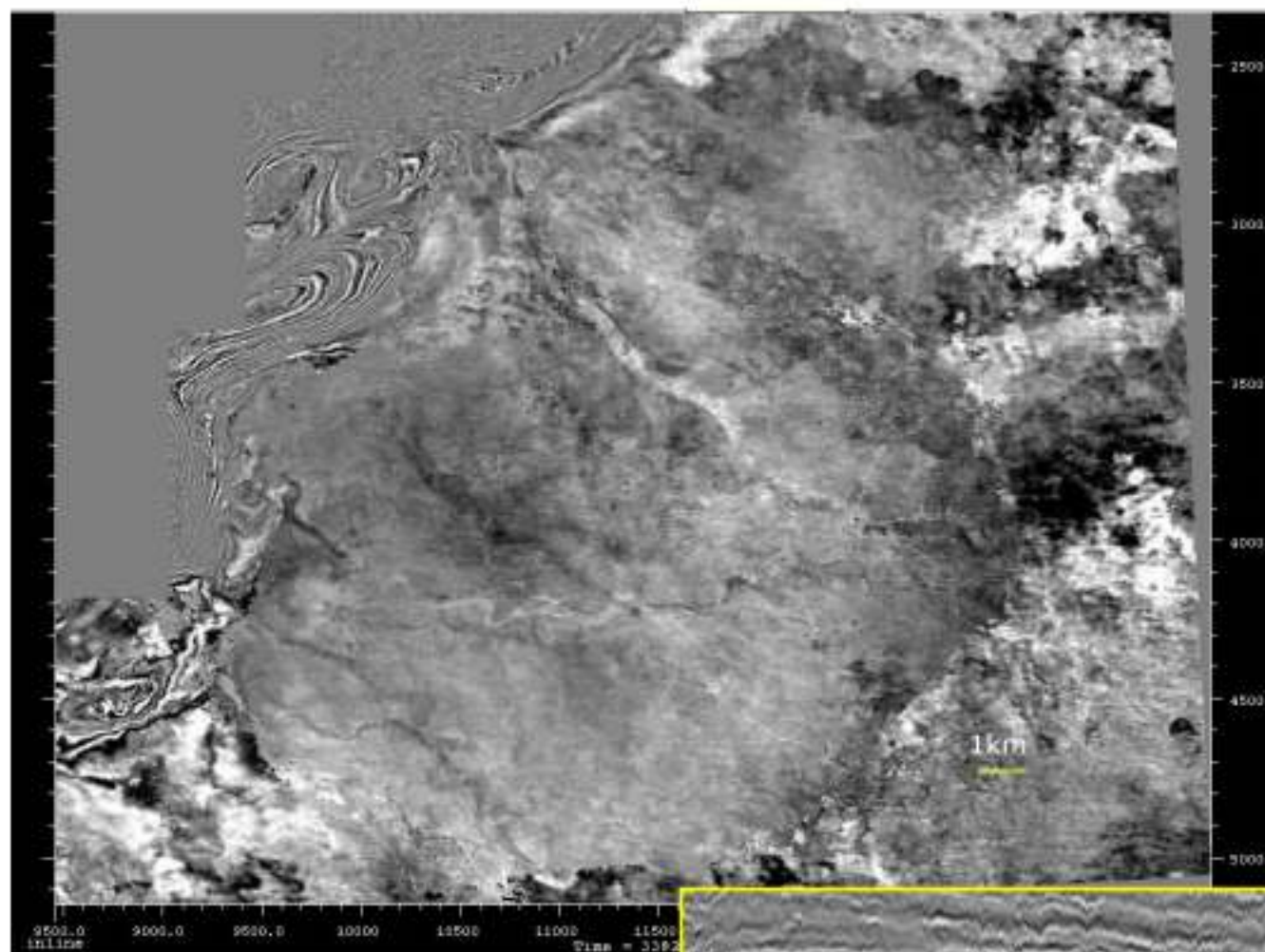
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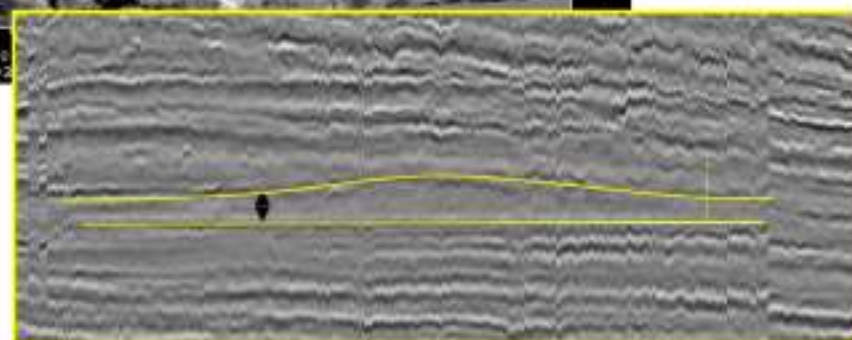


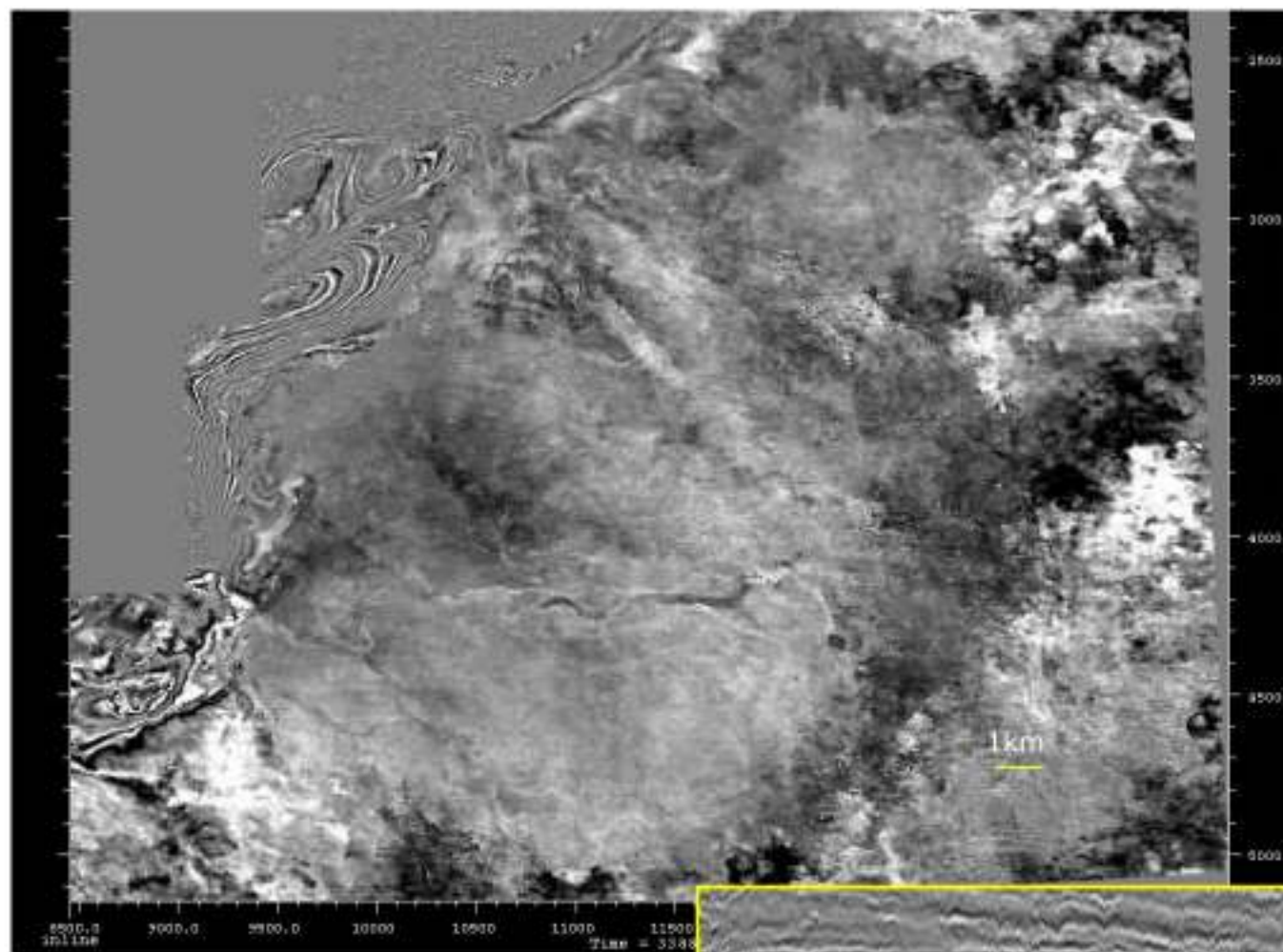
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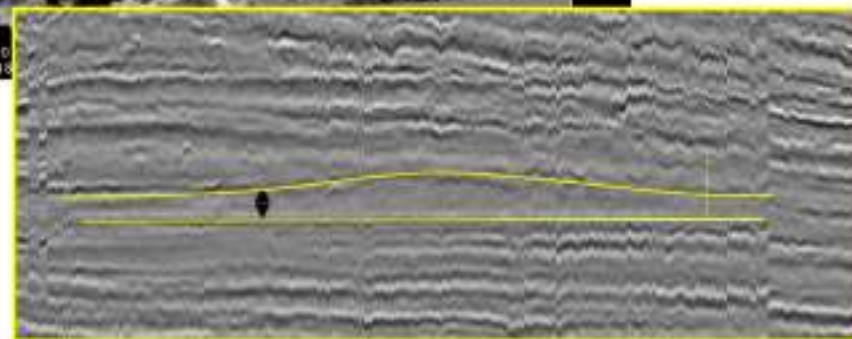


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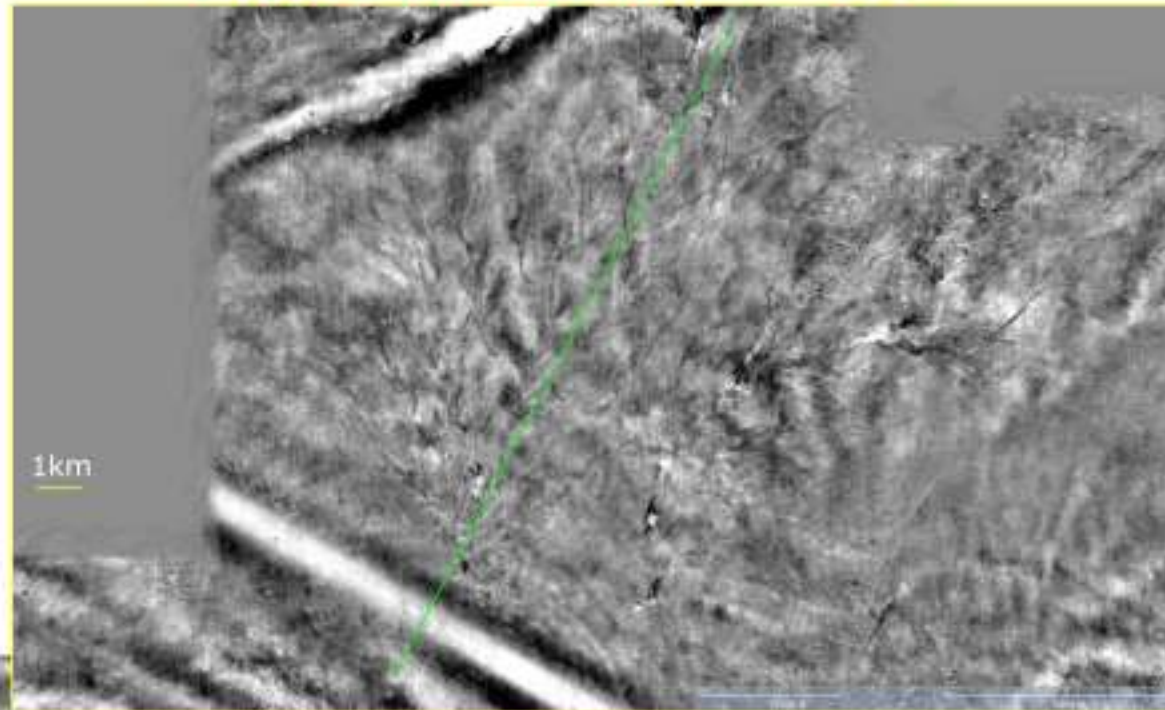




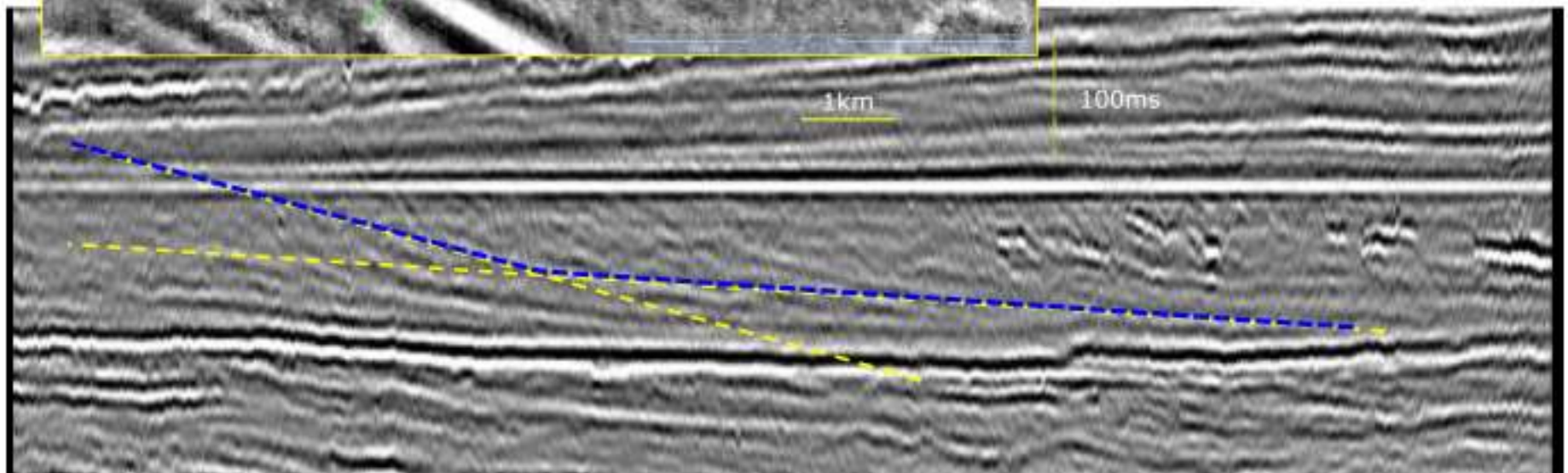
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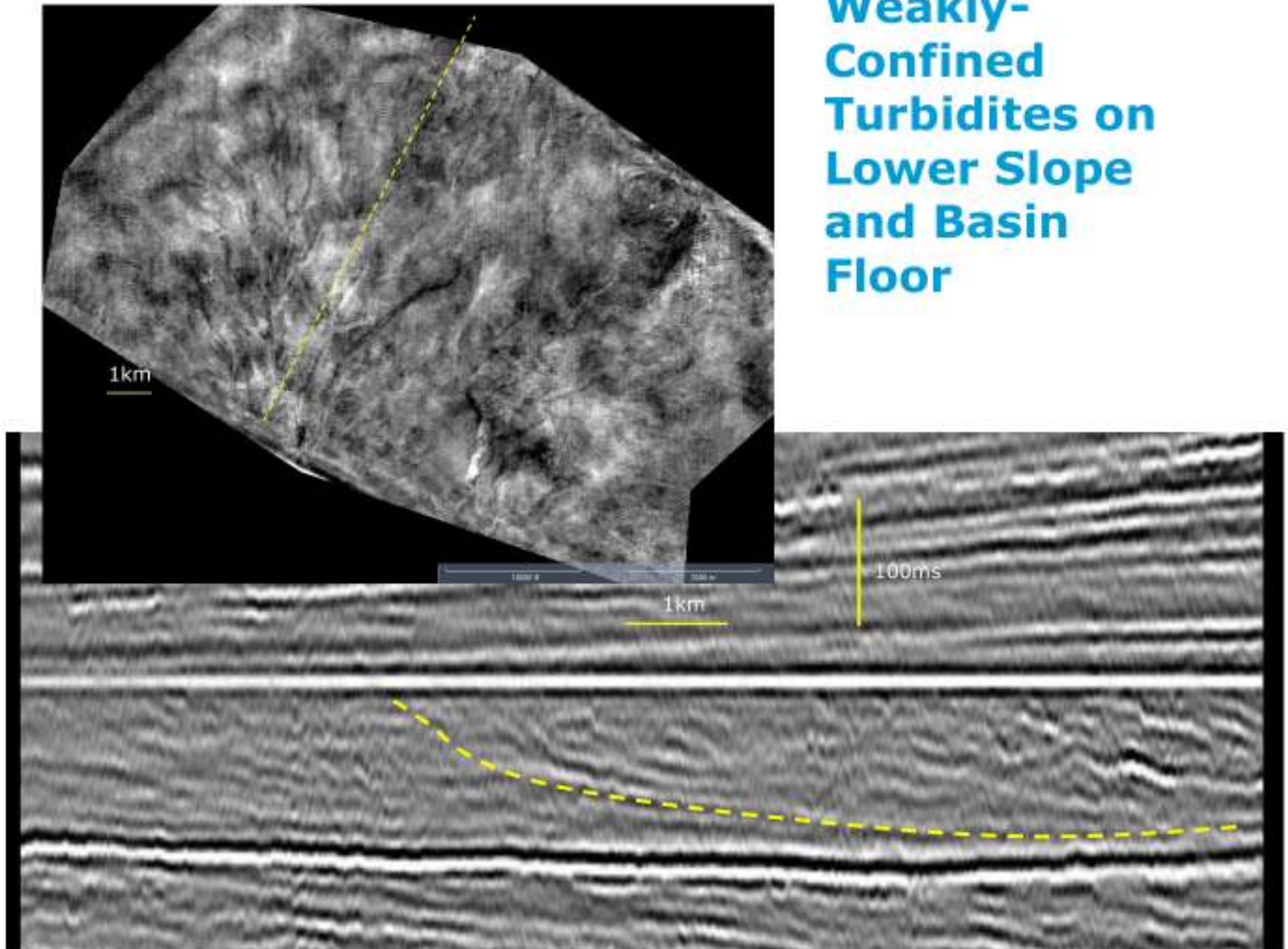
Weakly-Confined Turbidites on Lower Slope and Basin Floor



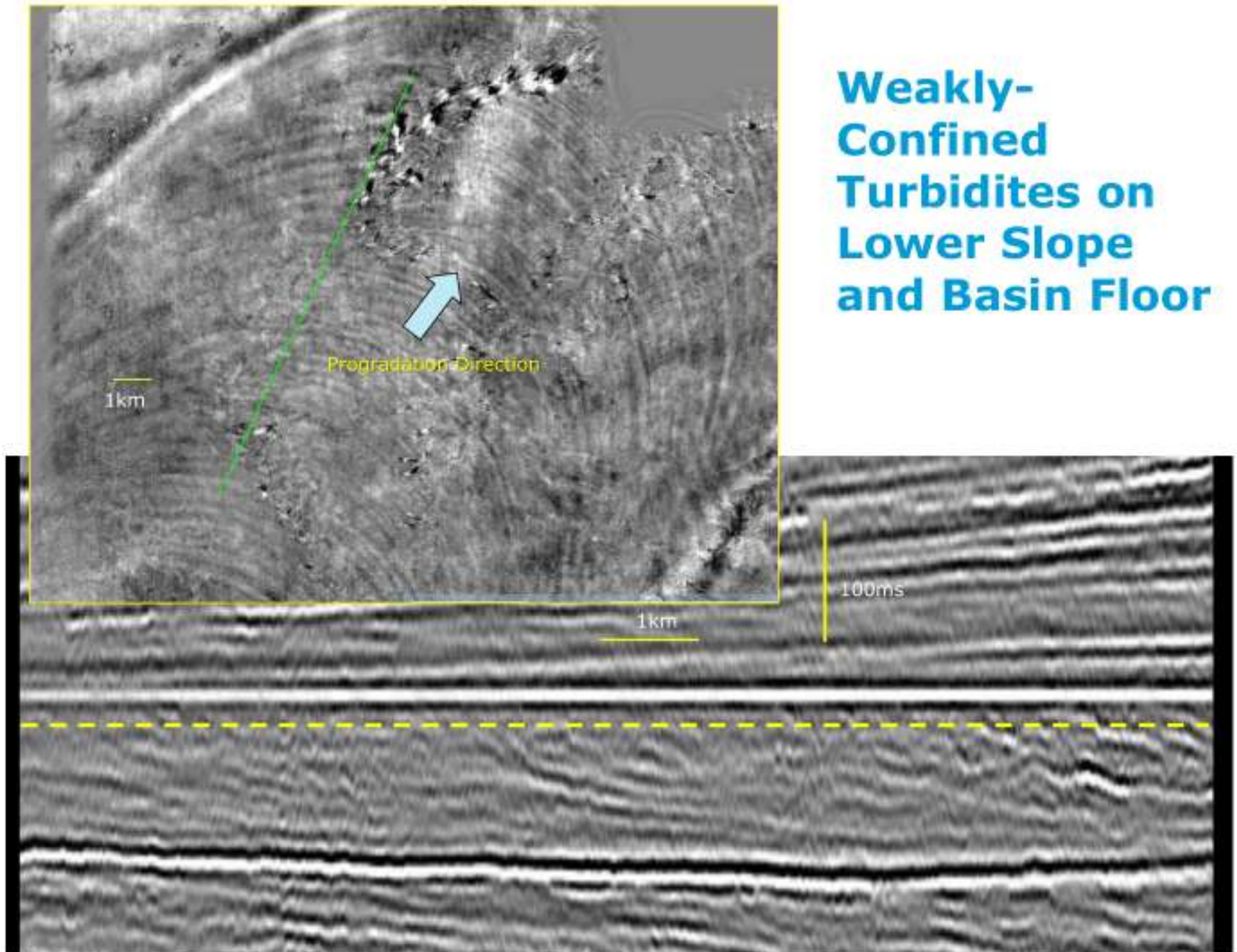
Amplitude extraction from two arbitrary planes



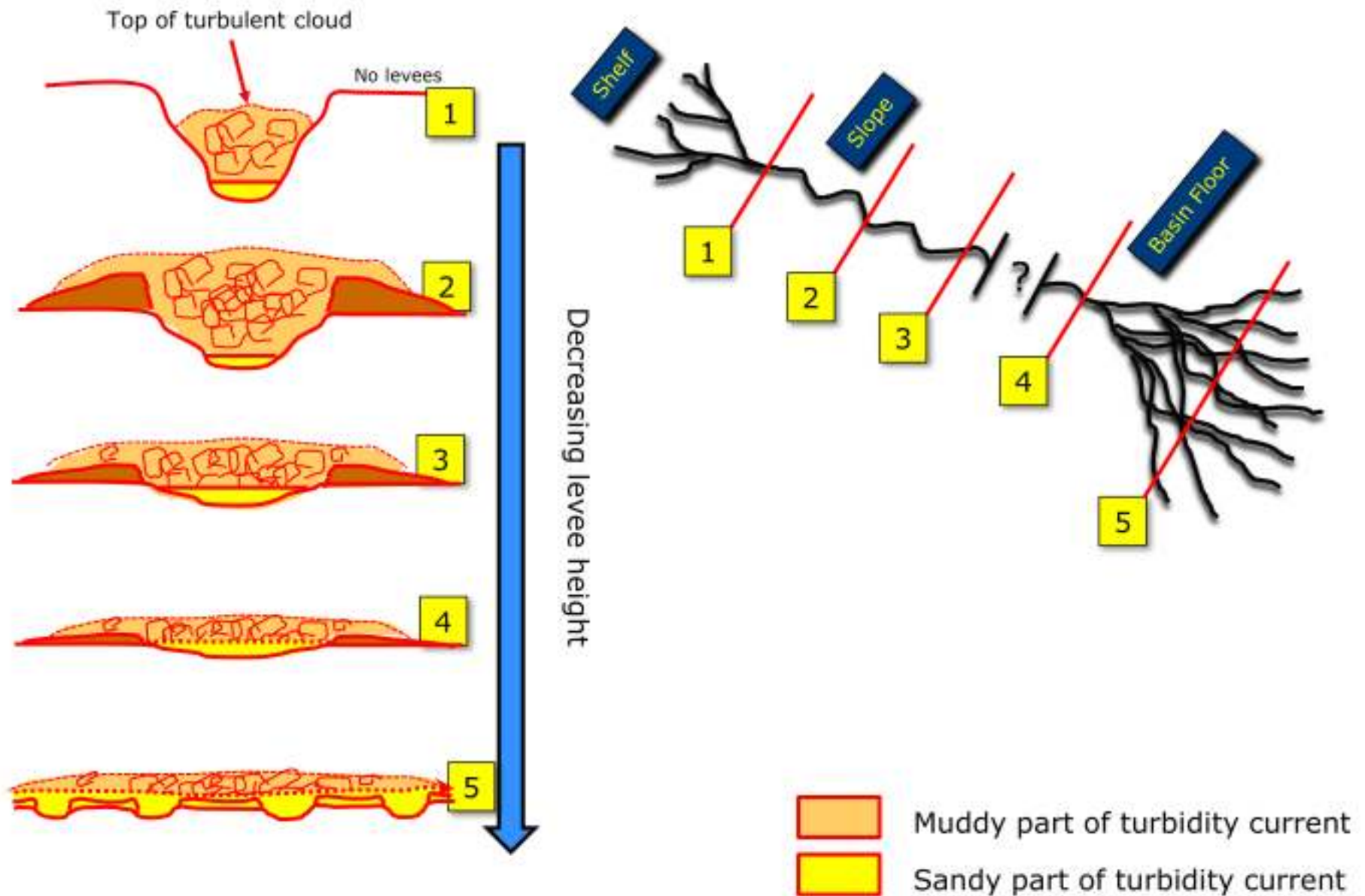
Weakly- Confined Turbidites on Lower Slope and Basin Floor



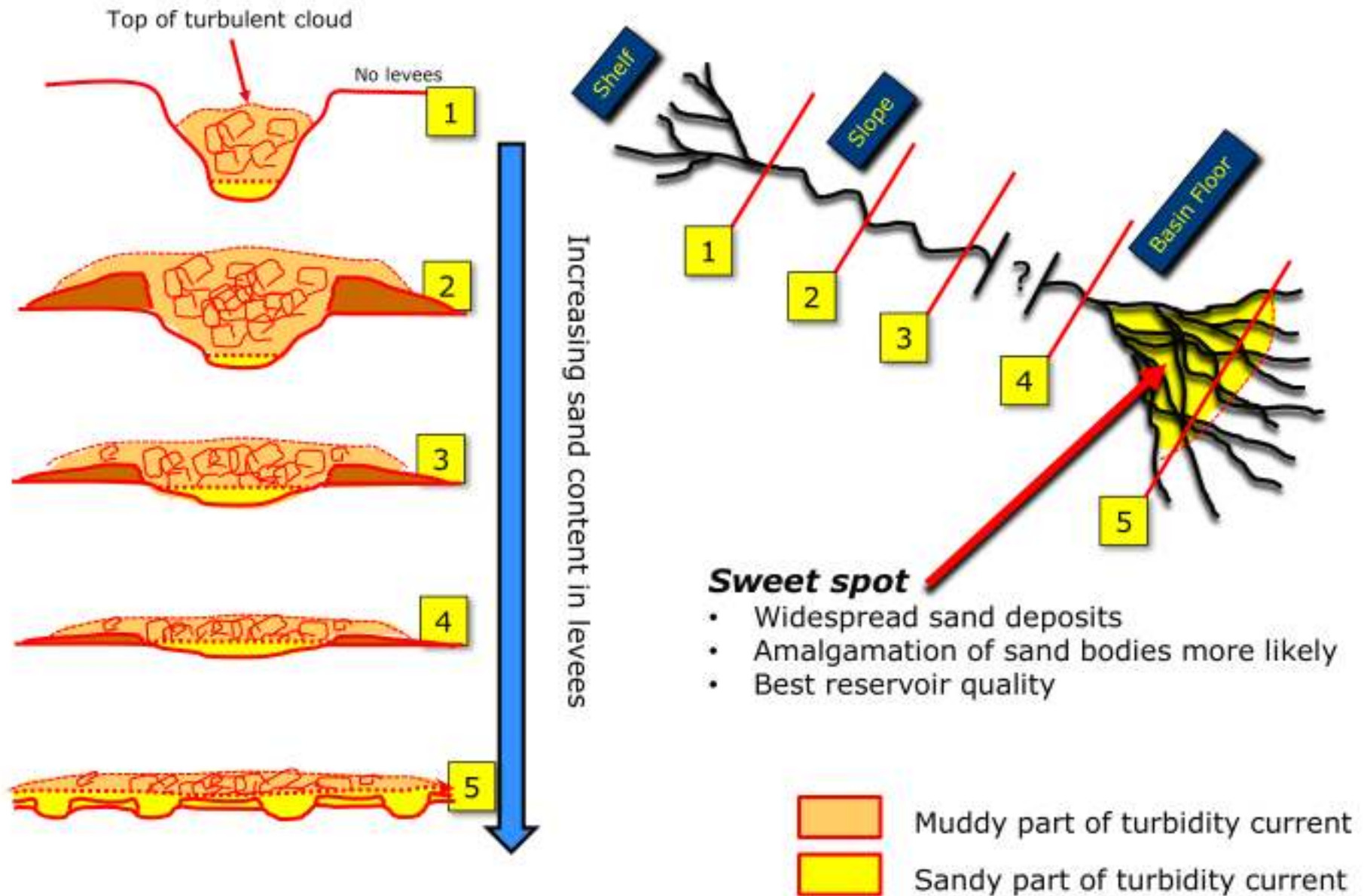
Weakly- Confined Turbidites on Lower Slope and Basin Floor



Turbidite Geomorphology – Conclusions

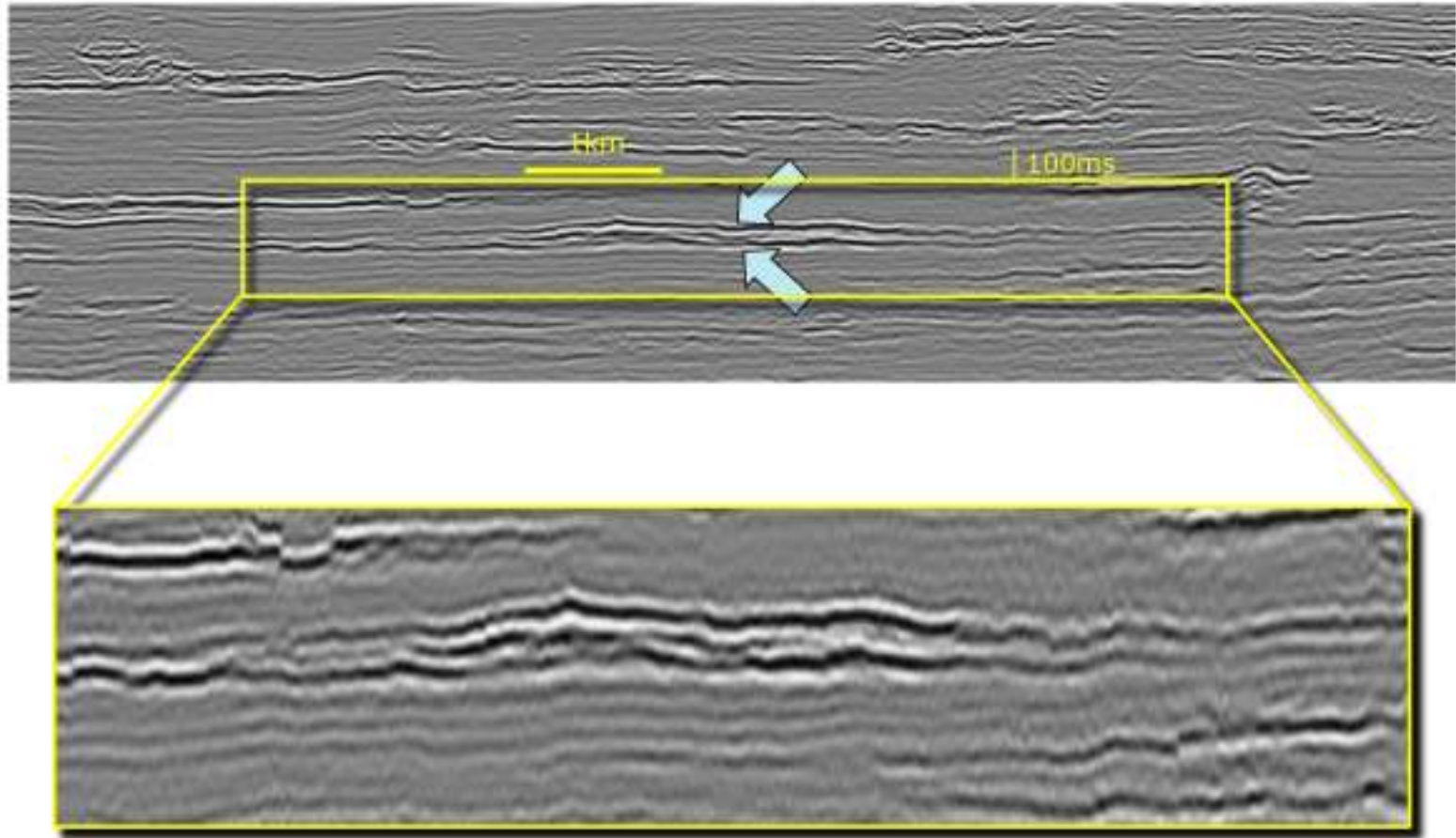


Turbidite Geomorphology – Conclusions



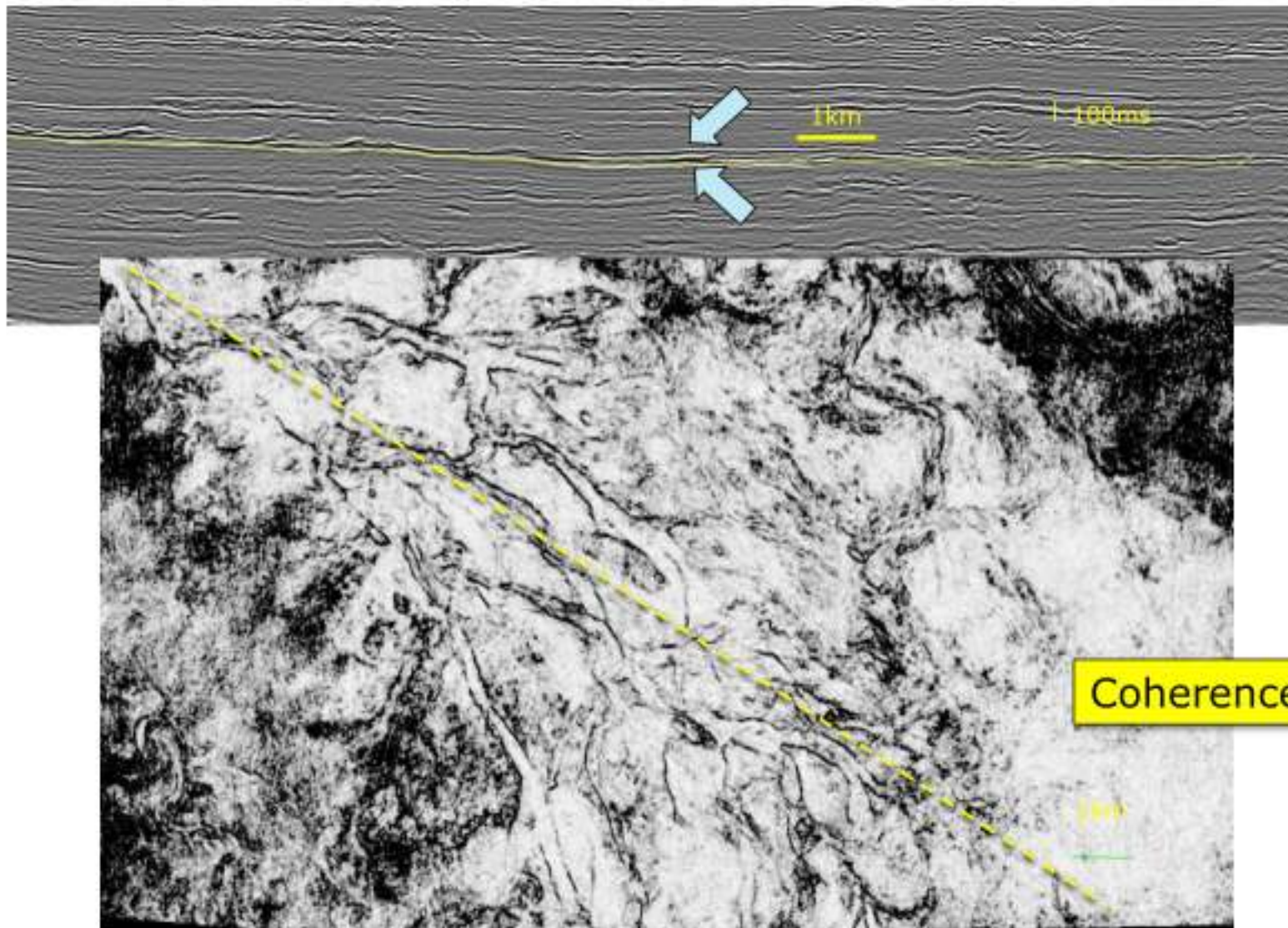
Horizon Slice

Seismic Expression of Weakly Confined Channels



Horizon Slice

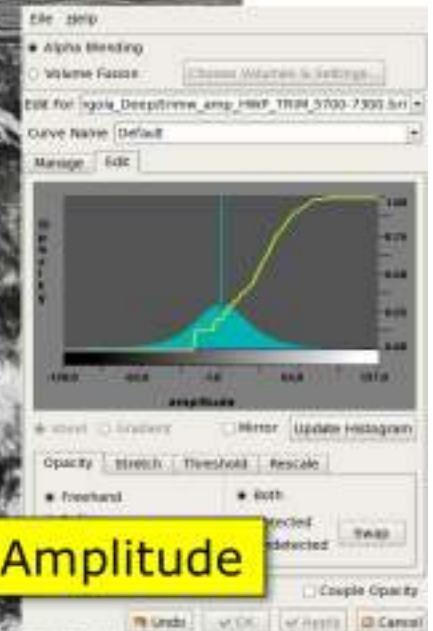
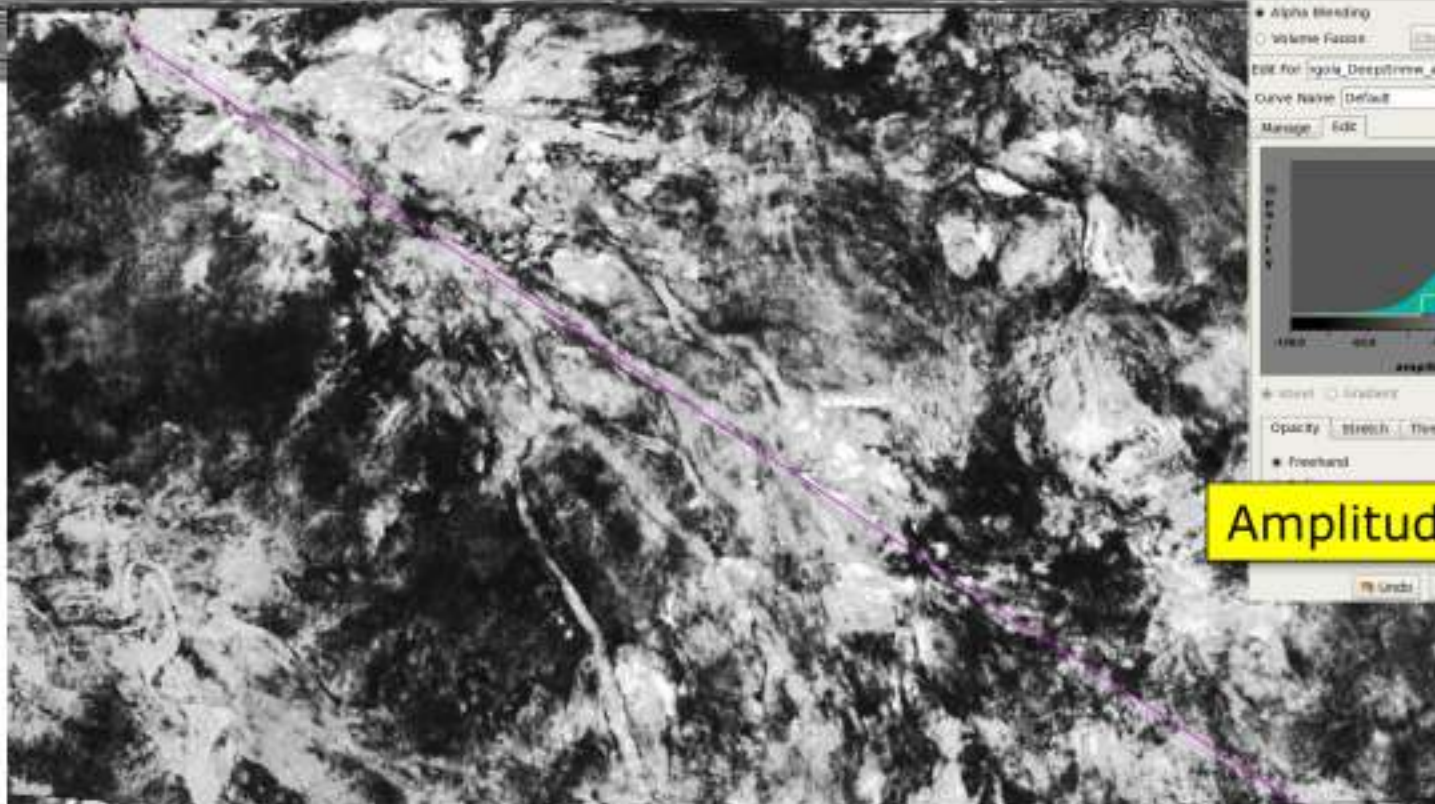
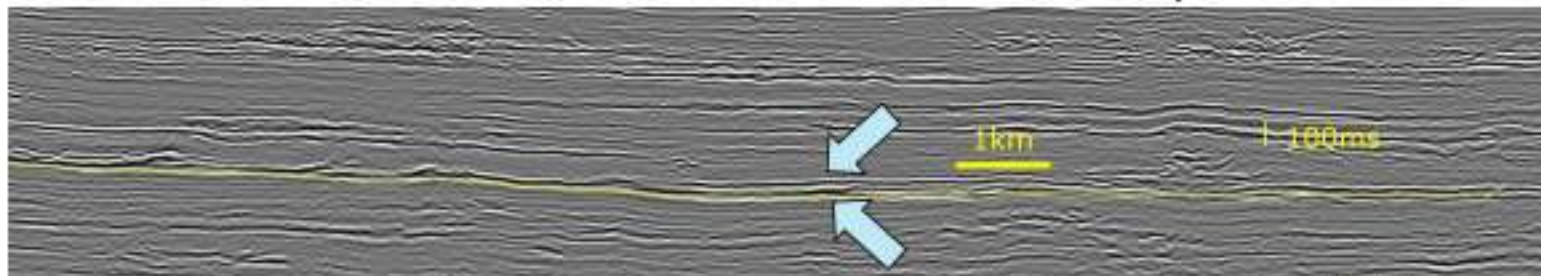
Seismic Expression of Weakly Confined Channels

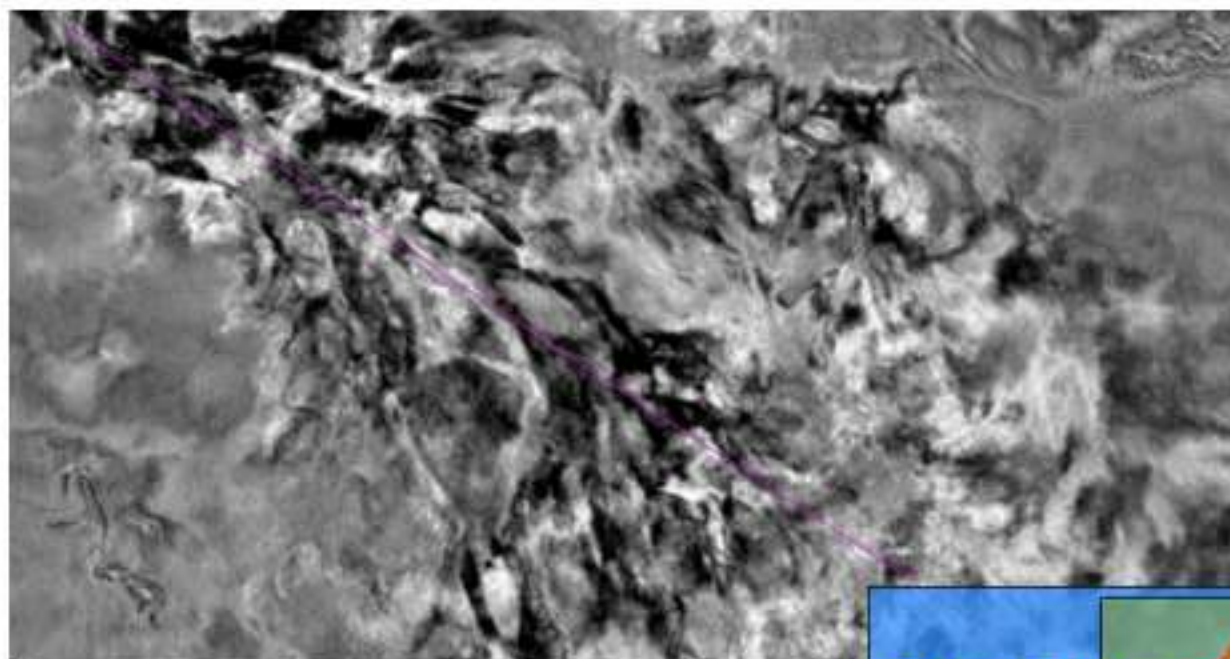


Horizon Slice

Seismic Expression of Weakly Confined Channels

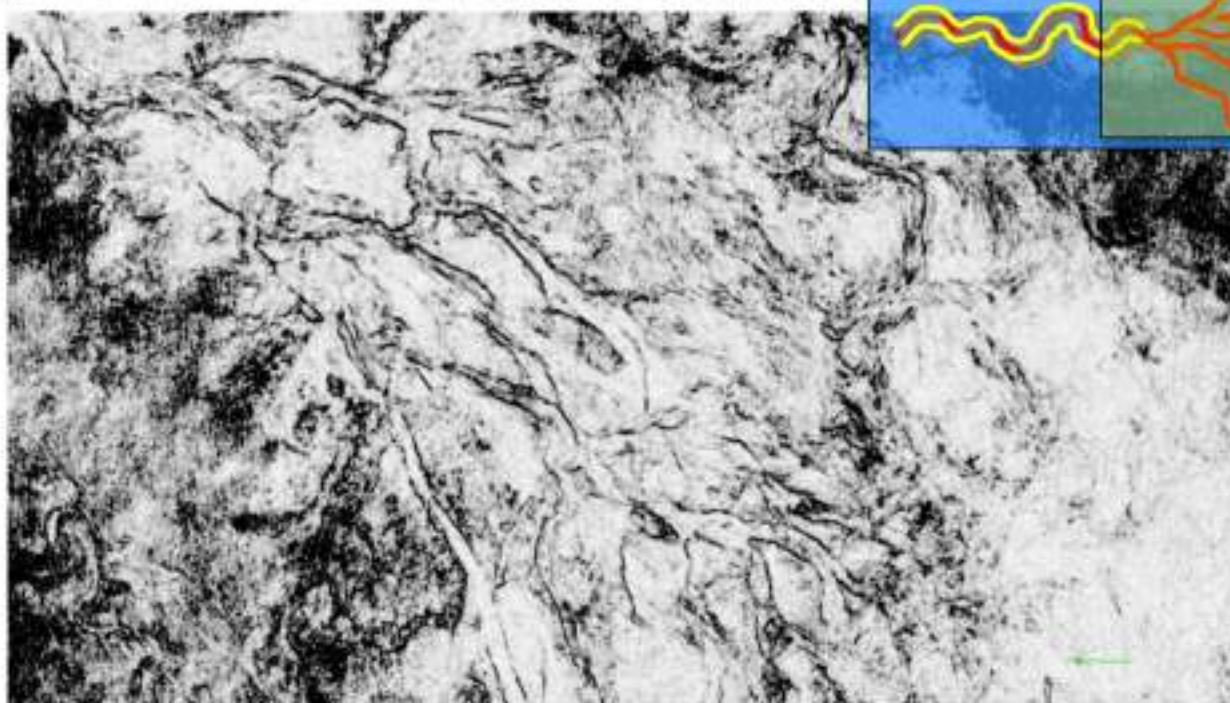
Optical stack - 20 slices



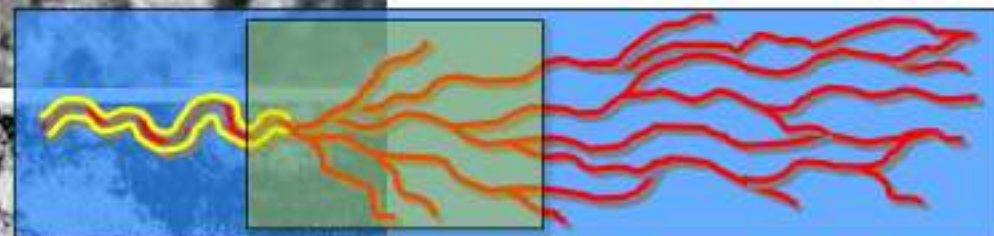


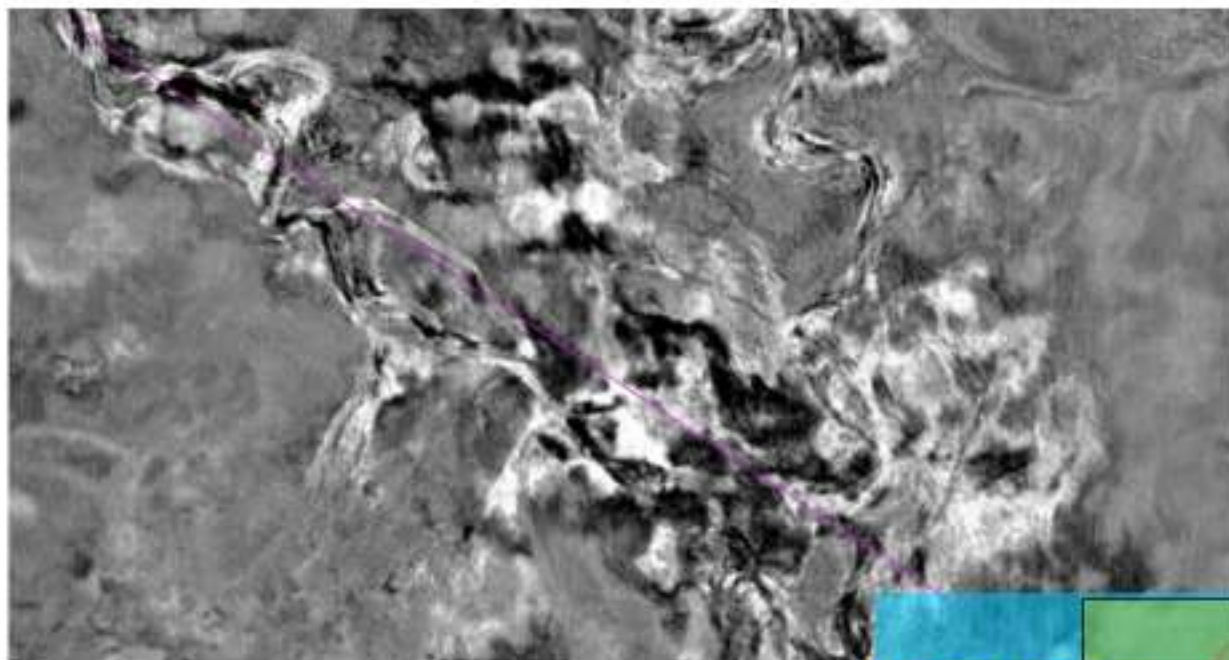
Early
Lowstand

Horizon slice
(Amplitude)



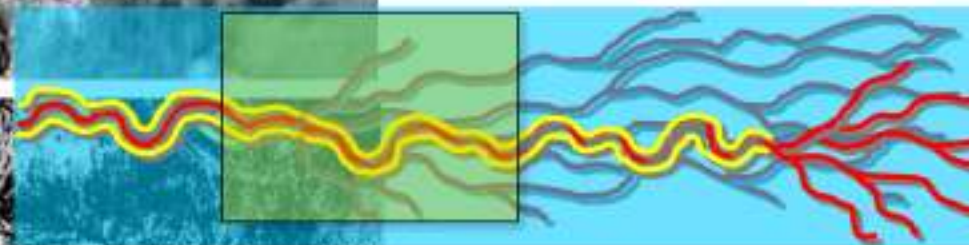
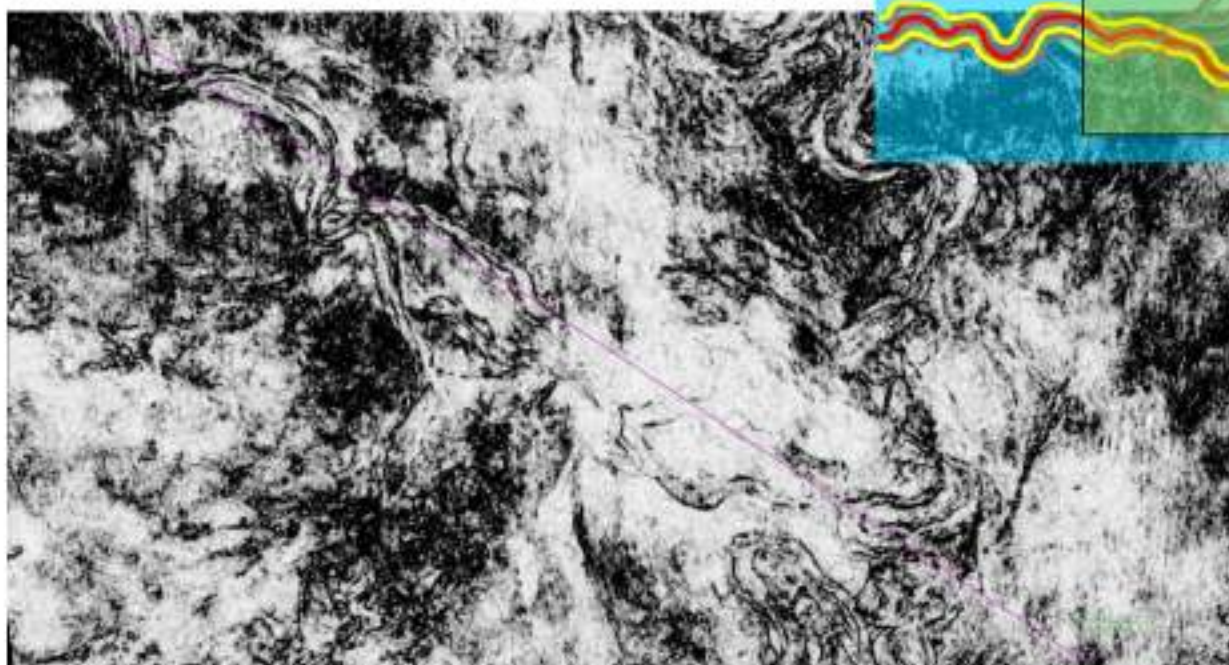
Horizon slice
(Coherence)





Late
Lowstand

Horizon slice
(Amplitude)

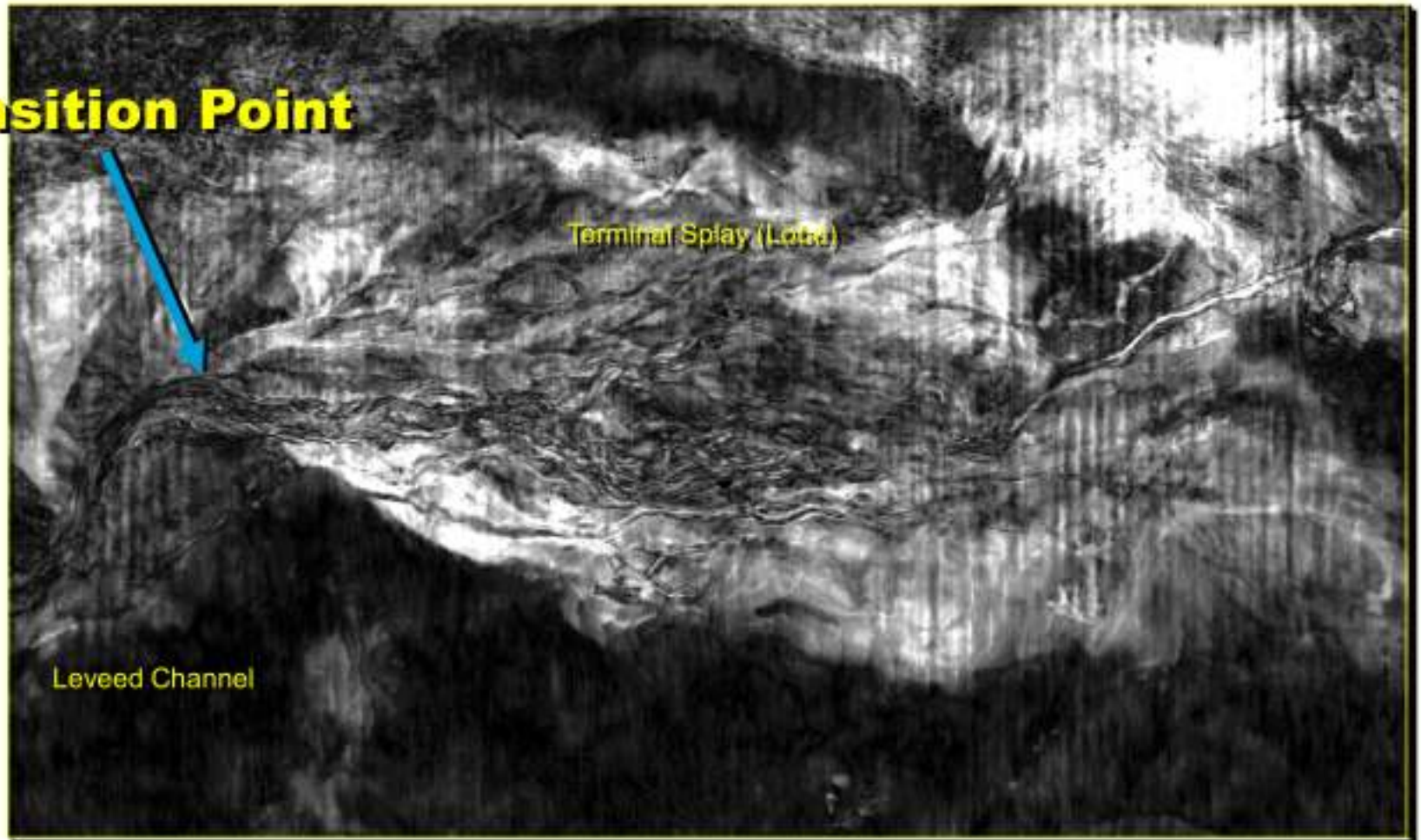


Horizon slice
(Coherence)

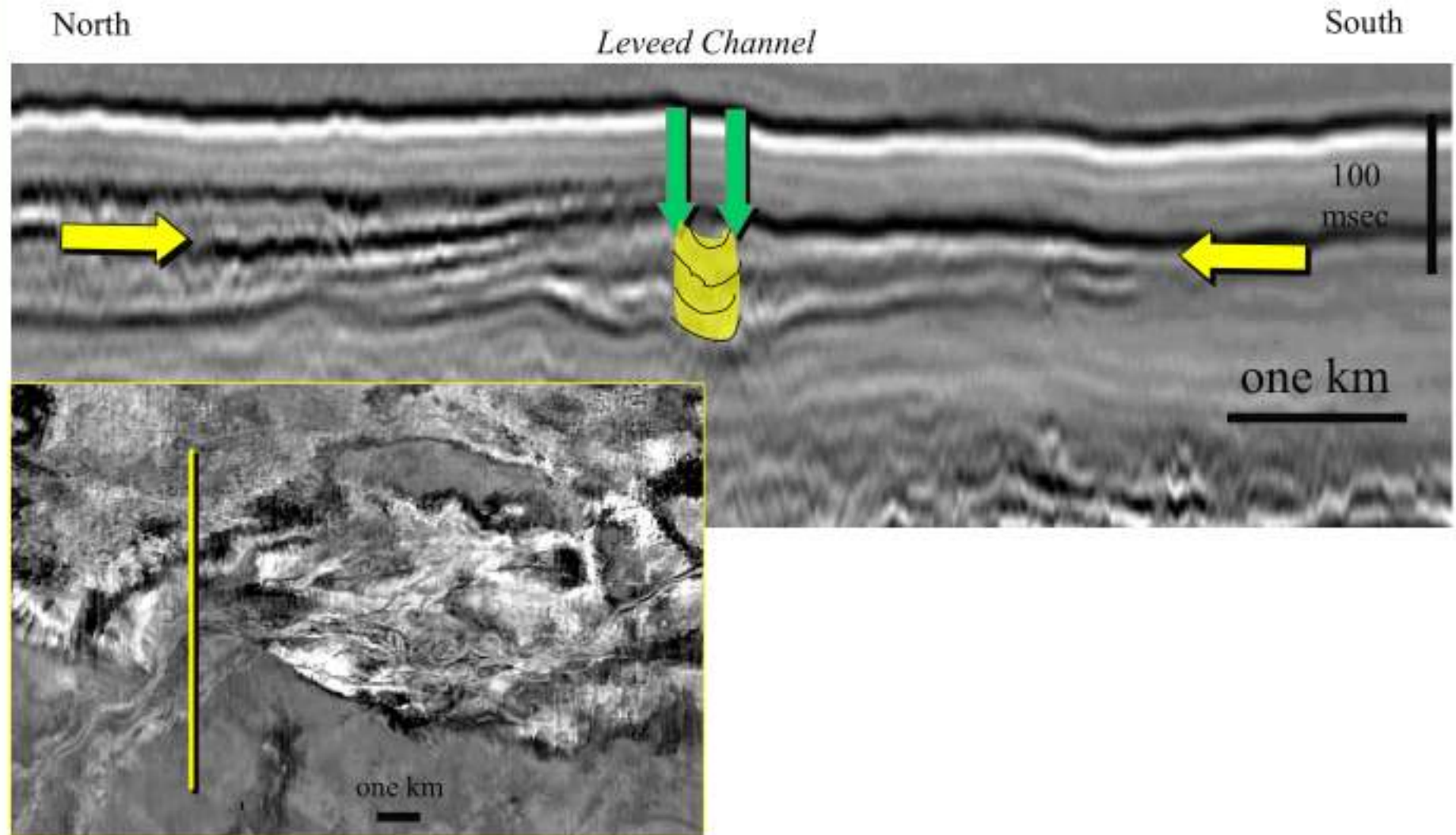
Gulf of Mexico – Leveed Channel Feeding Terminal Splay/Lobe

5 km

Transition Point



Crevasse Channel Transect

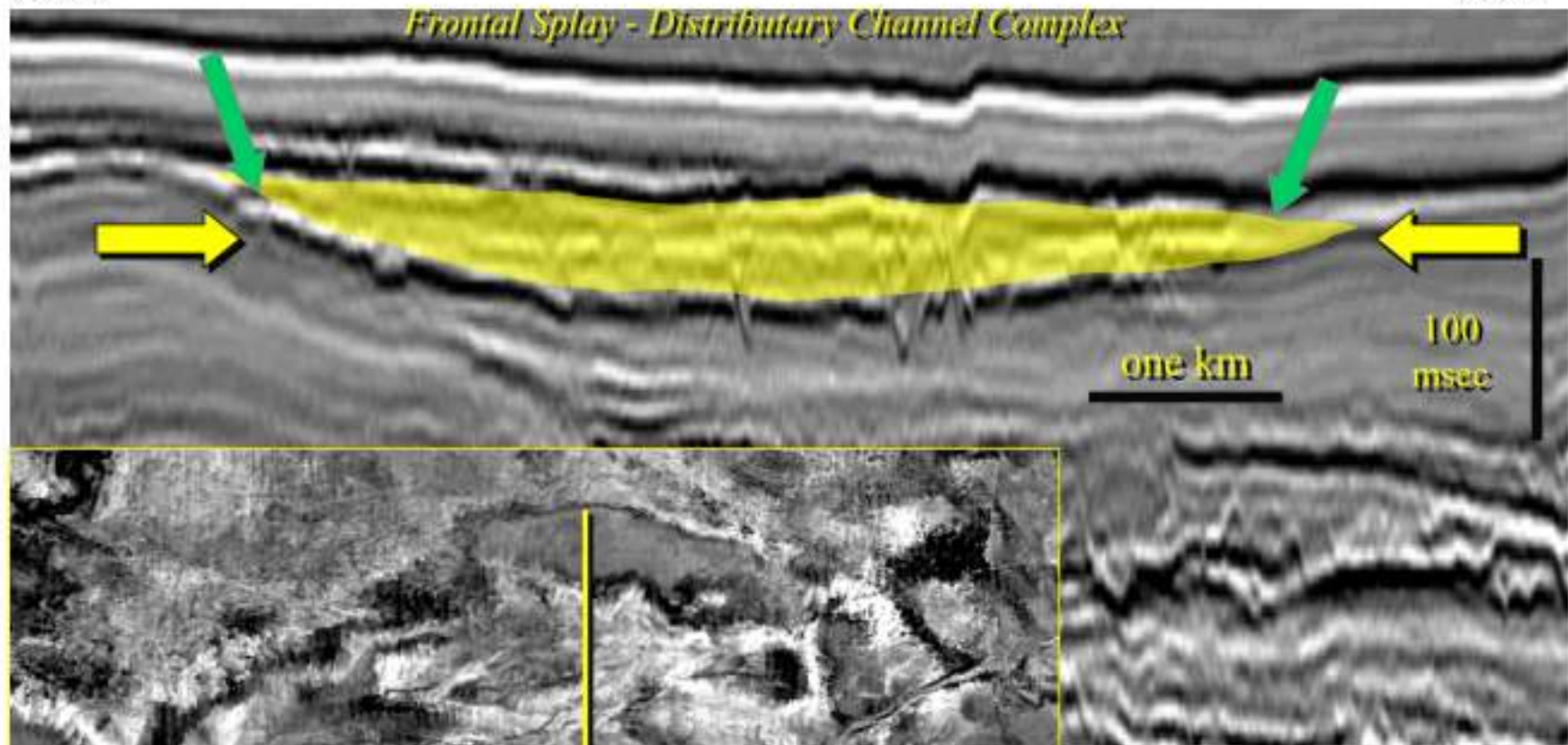


Distributary Channel Complex Transect

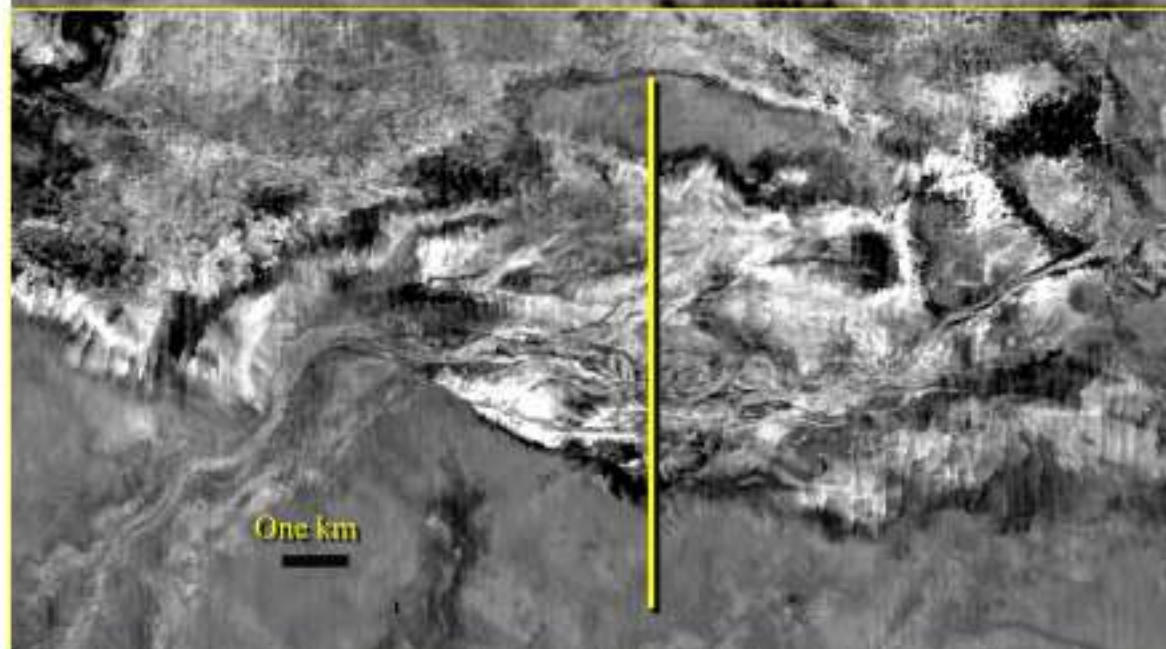
North

South

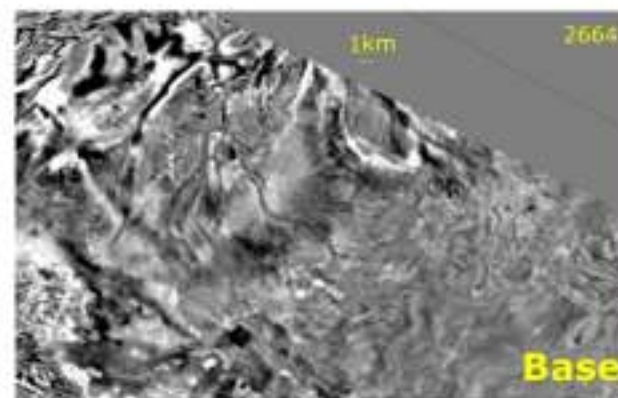
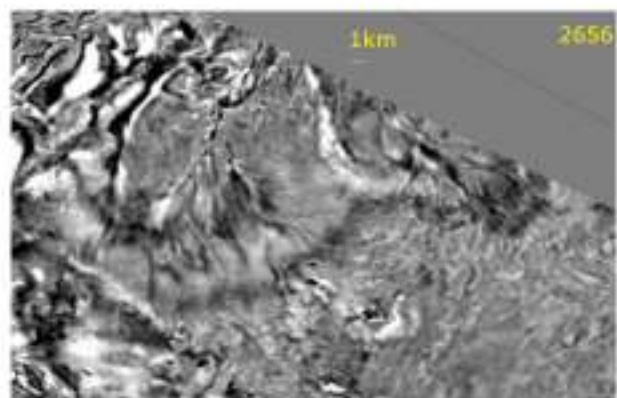
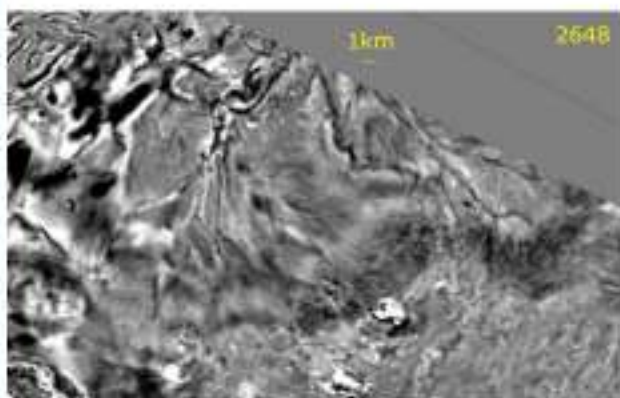
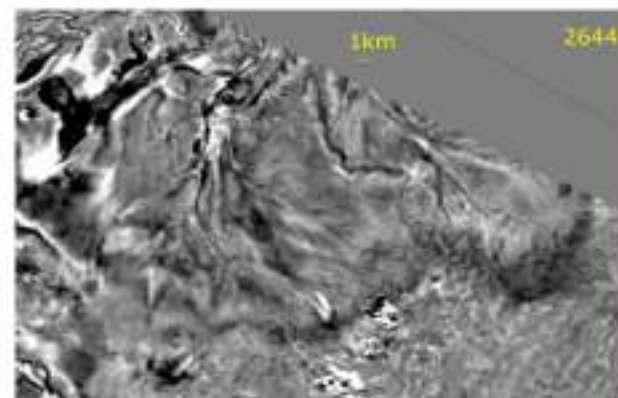
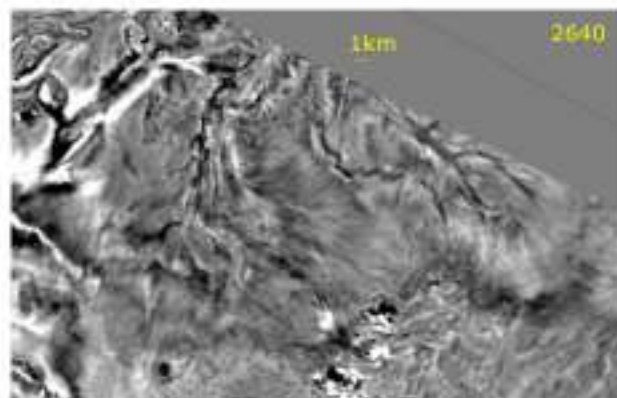
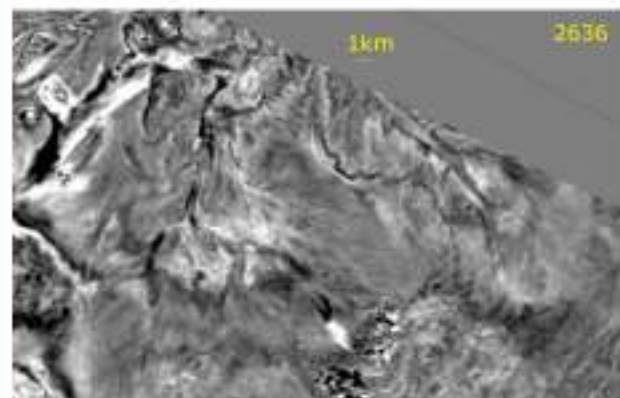
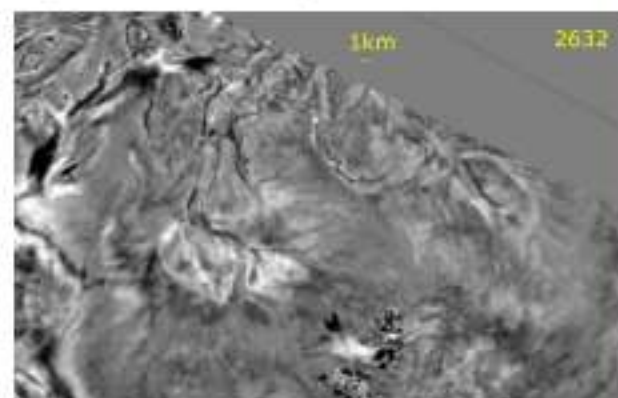
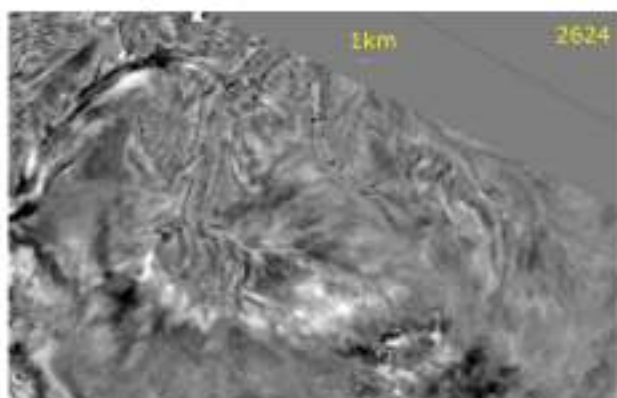
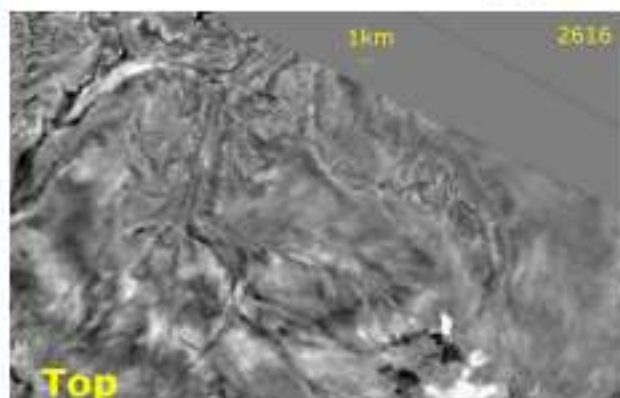
Frontal Splay - Distributary Channel Complex



InLine 16000



Pliocene (?) Terminal Splay/Lobe Outboard of Sigsbee Escarpment



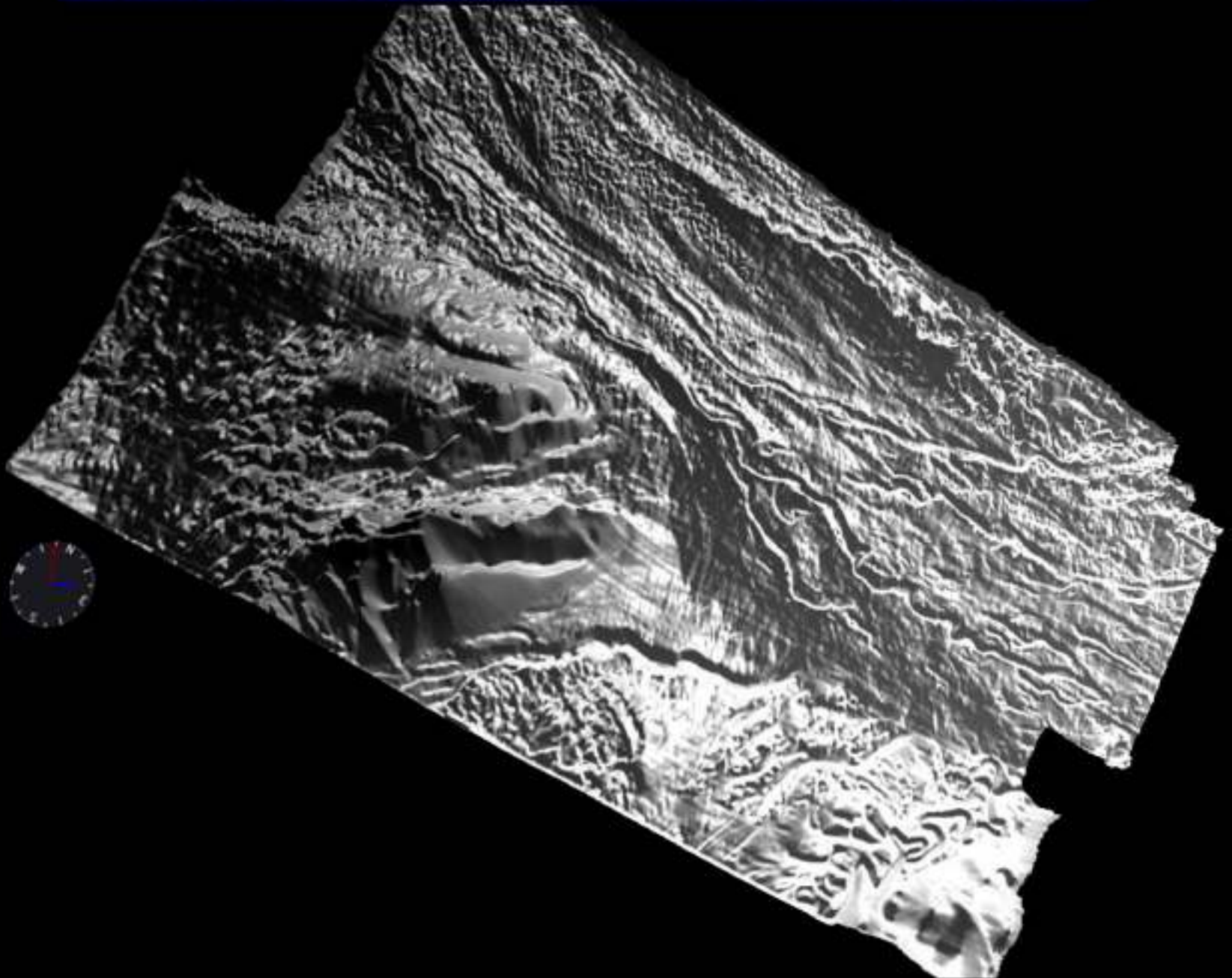
Terminal Splay Top – Dip Azimuth Map



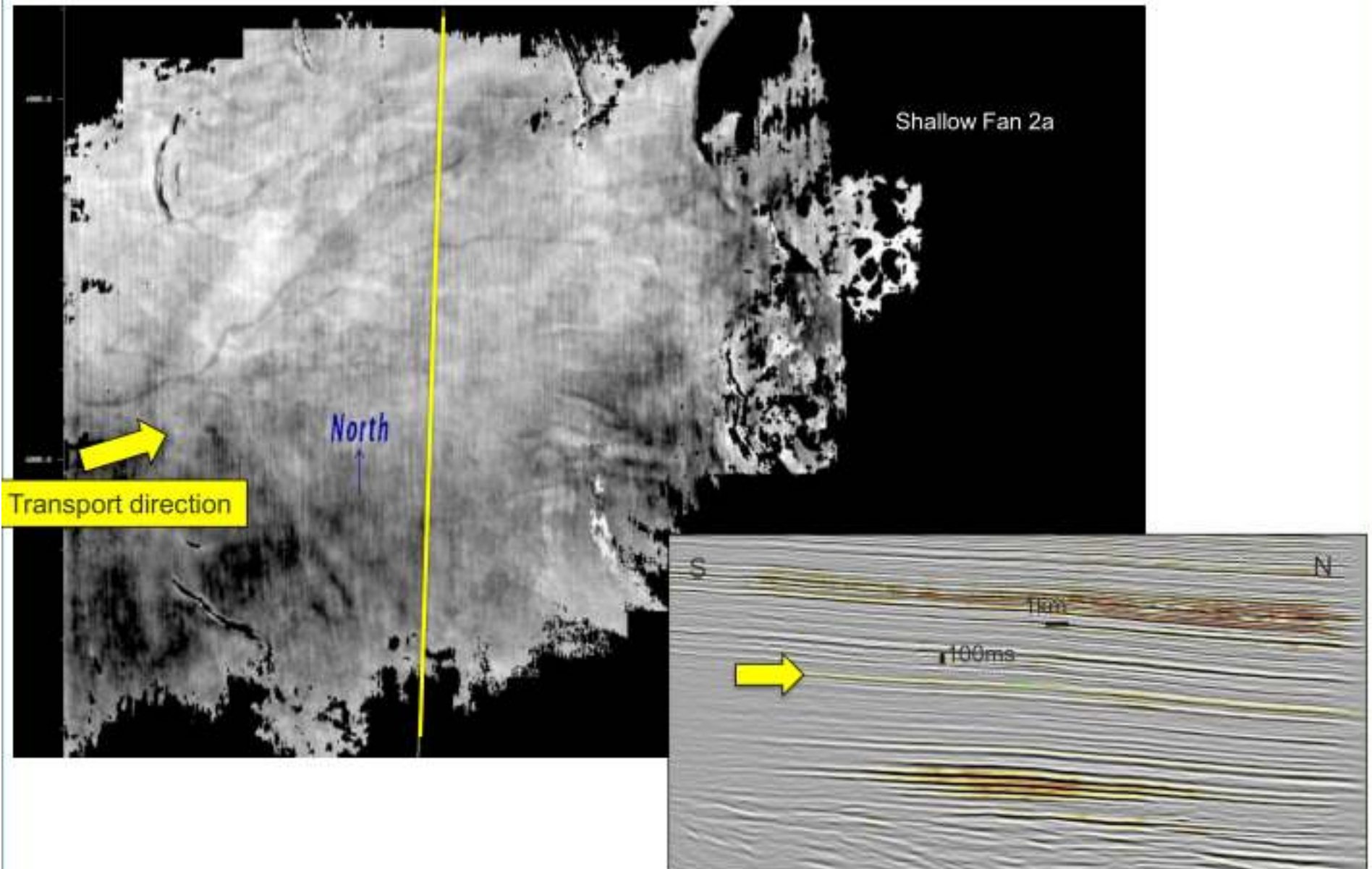
5 km



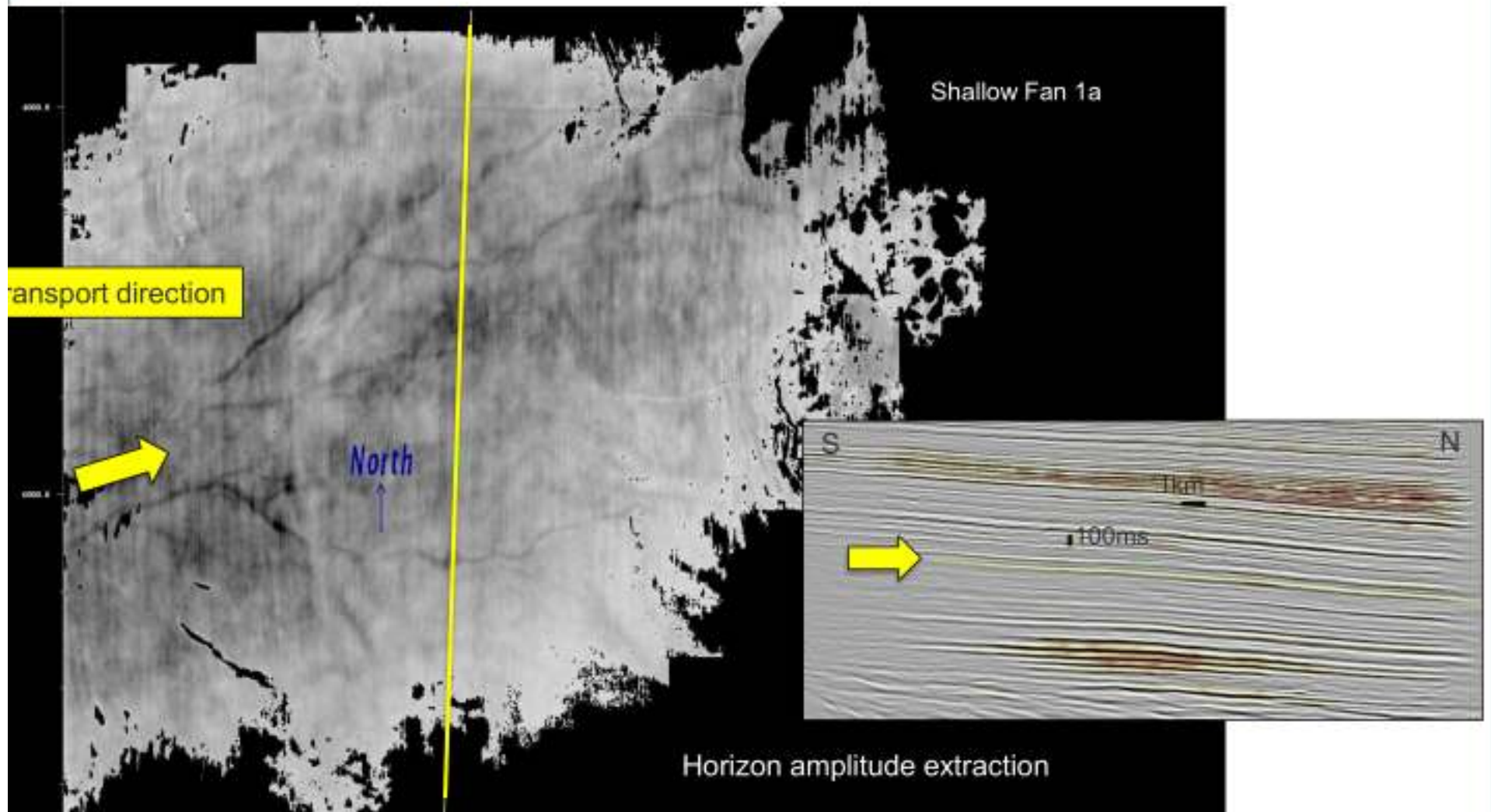
Terminal Splay Top – Dip Azimuth Map



Deep-water Turbidites – Black Sea

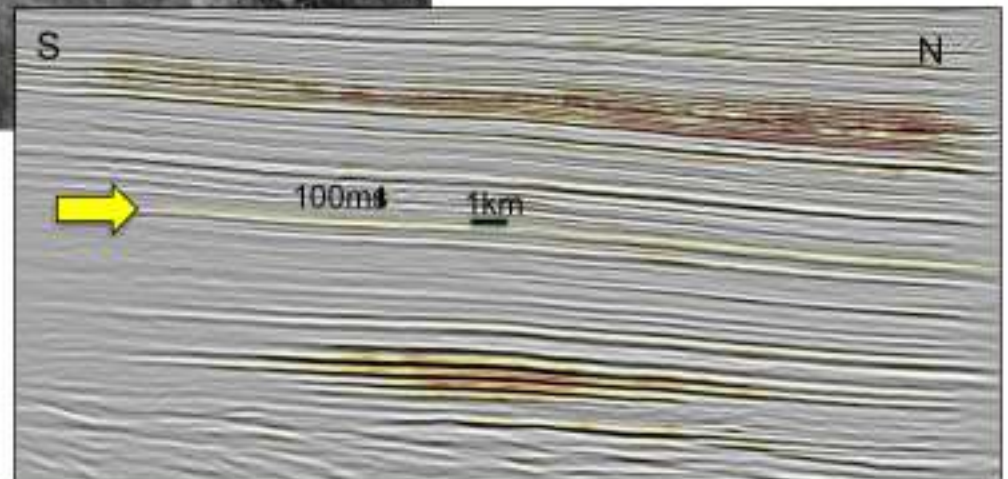
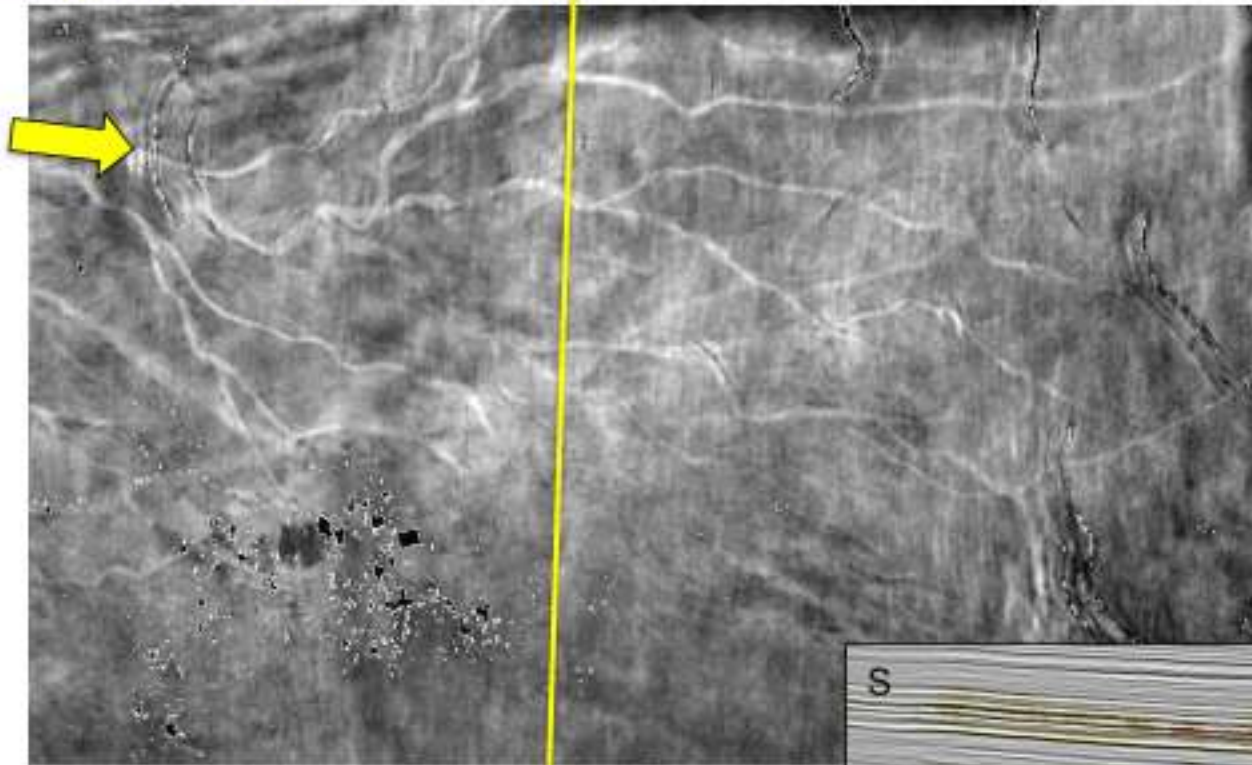


Deep-water Turbidites – Black Sea

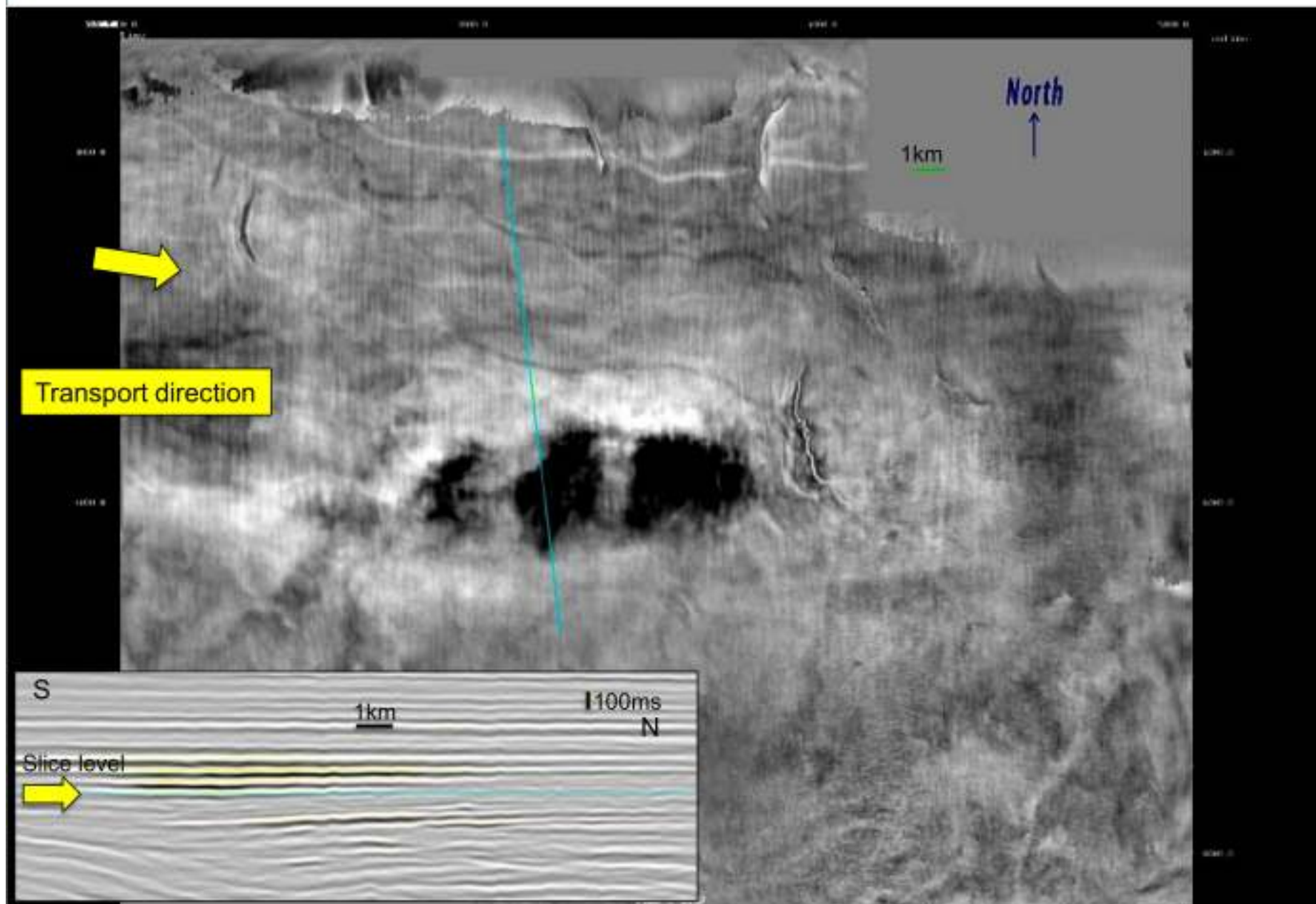


Deep-water Turbidites – Black Sea

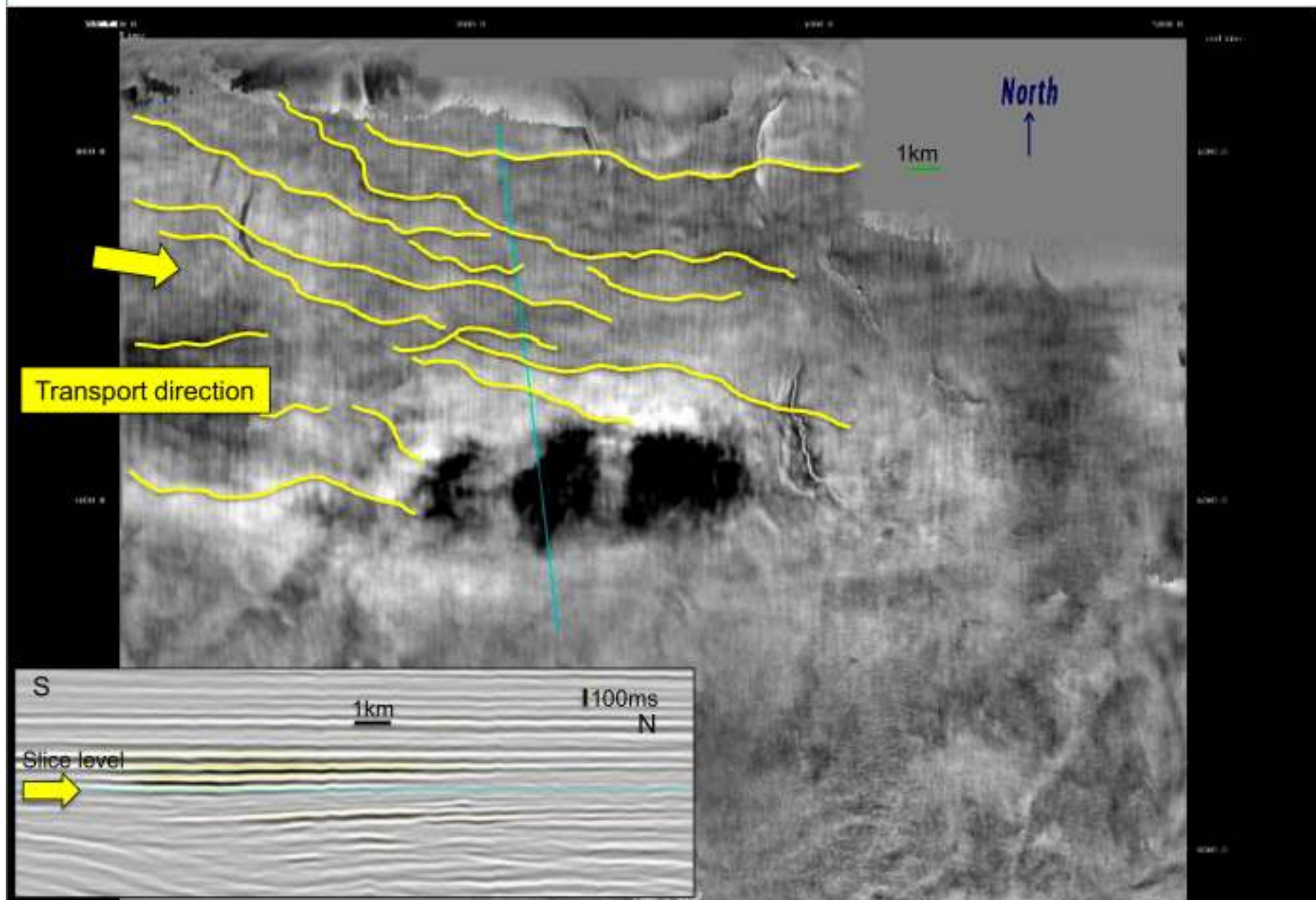
Transport direction



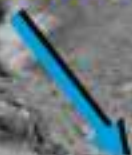
Flat Time 6352



Flat Time 6352

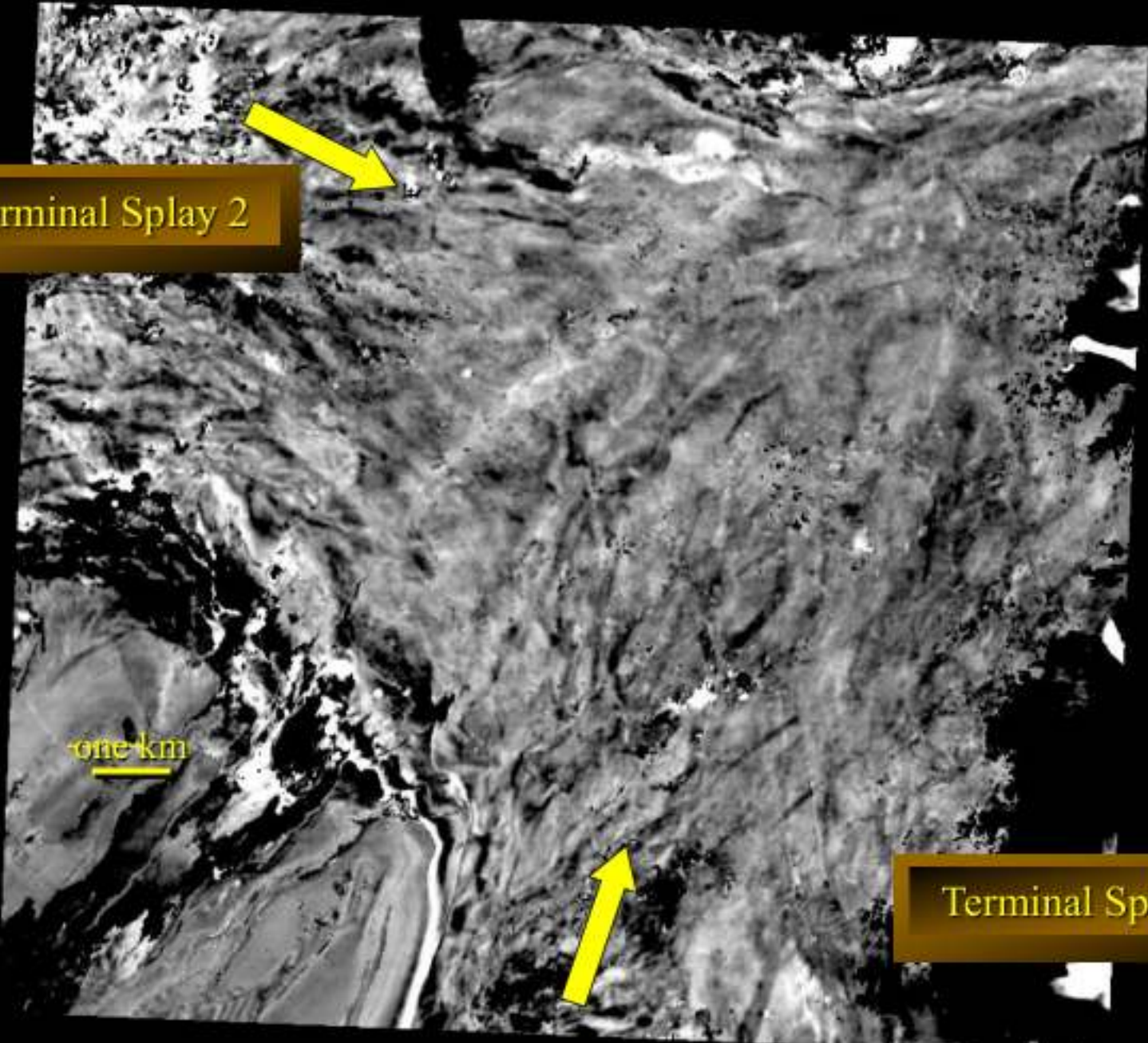


Transition Point



Transition Point



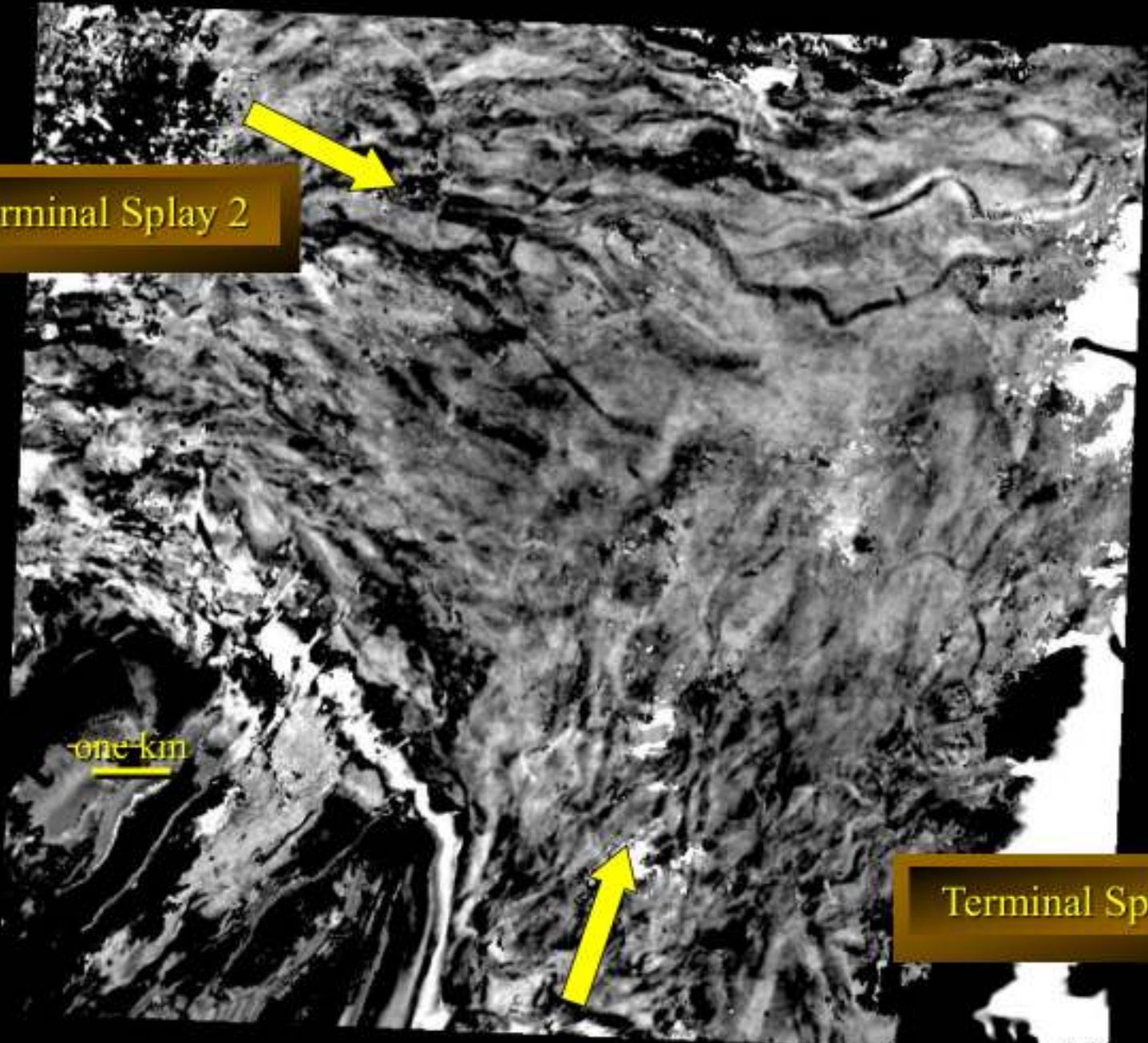


A satellite image of a river delta system. The main river channel enters from the bottom left and branches out into a complex network of distributaries. Two specific areas are highlighted with yellow arrows and labels: 'Terminal Splay 2' in the upper left and 'Terminal Splay 1' in the lower right. A scale bar labeled 'one km' is located in the lower left quadrant. The terrain shows varying shades of gray, indicating different sediment types or vegetation cover.

Terminal Splay 2

one km

Terminal Splay 1

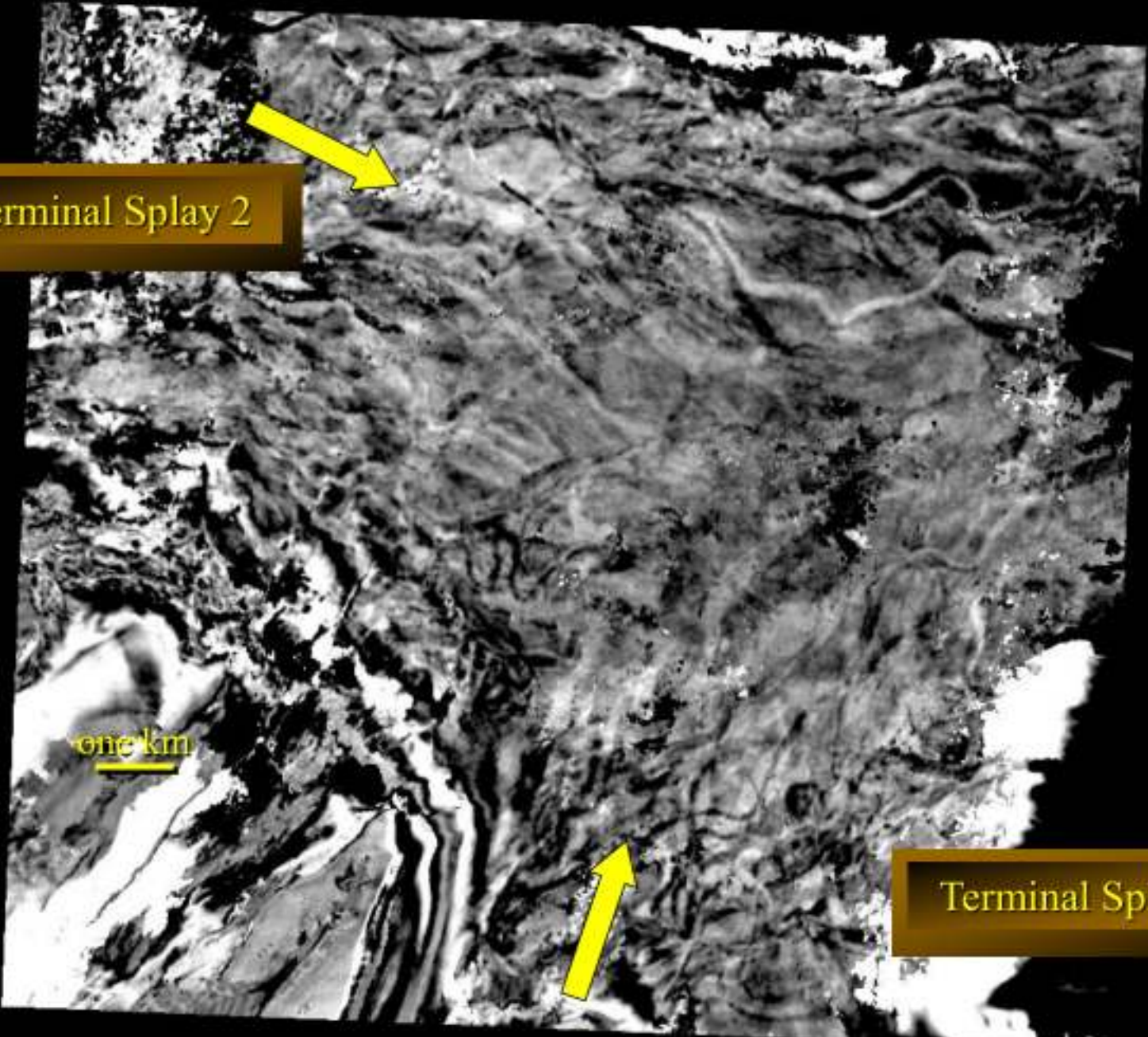


A satellite image of a river delta system. The main river channel enters from the bottom left and branches out into a complex network of distributaries. Two specific areas are highlighted with yellow arrows and labels: 'Terminal Splay 2' in the upper left and 'Terminal Splay 1' in the lower right. A scale bar labeled 'one km' is located in the lower left quadrant.

Terminal Splay 2

one km

Terminal Splay 1

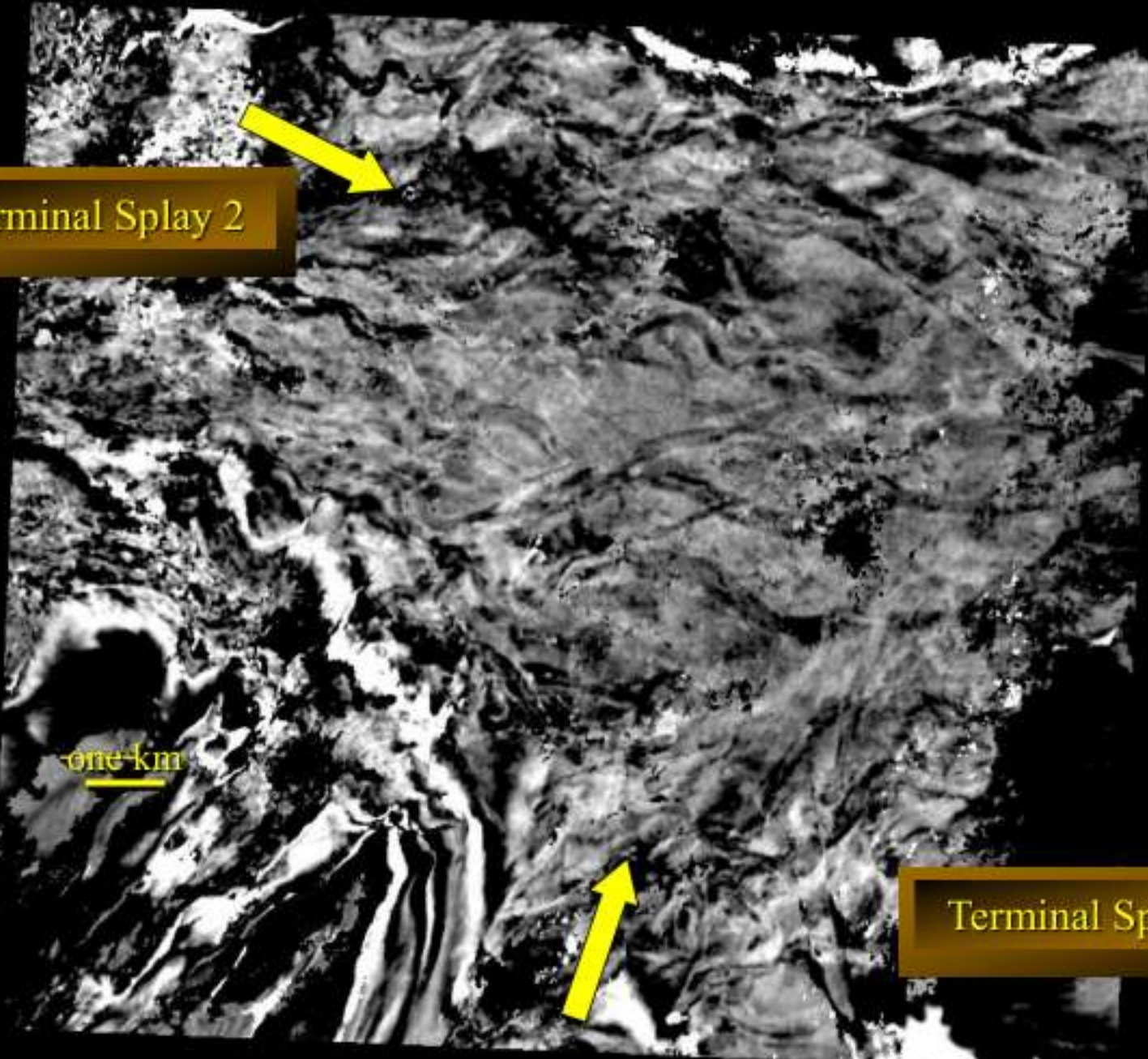


A satellite image of a river delta system. The main river channel enters from the bottom left and branches out into a complex network of distributaries. Two specific areas are highlighted with yellow arrows and labels: 'Terminal Splay 2' in the upper left and 'Terminal Splay 1' in the lower right. A scale bar labeled 'one km' is located in the lower left quadrant.

Terminal Splay 2

one km

Terminal Splay 1

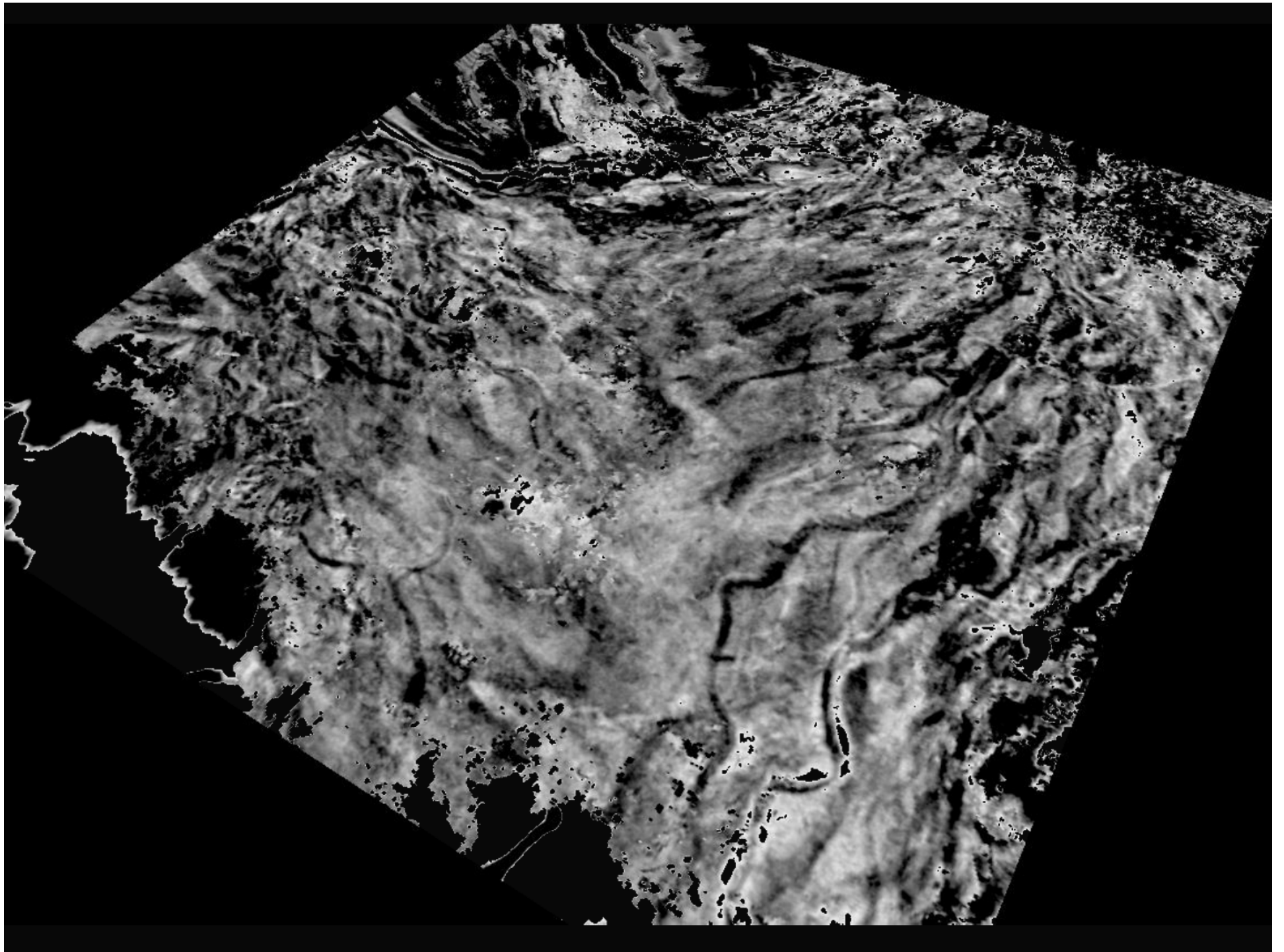


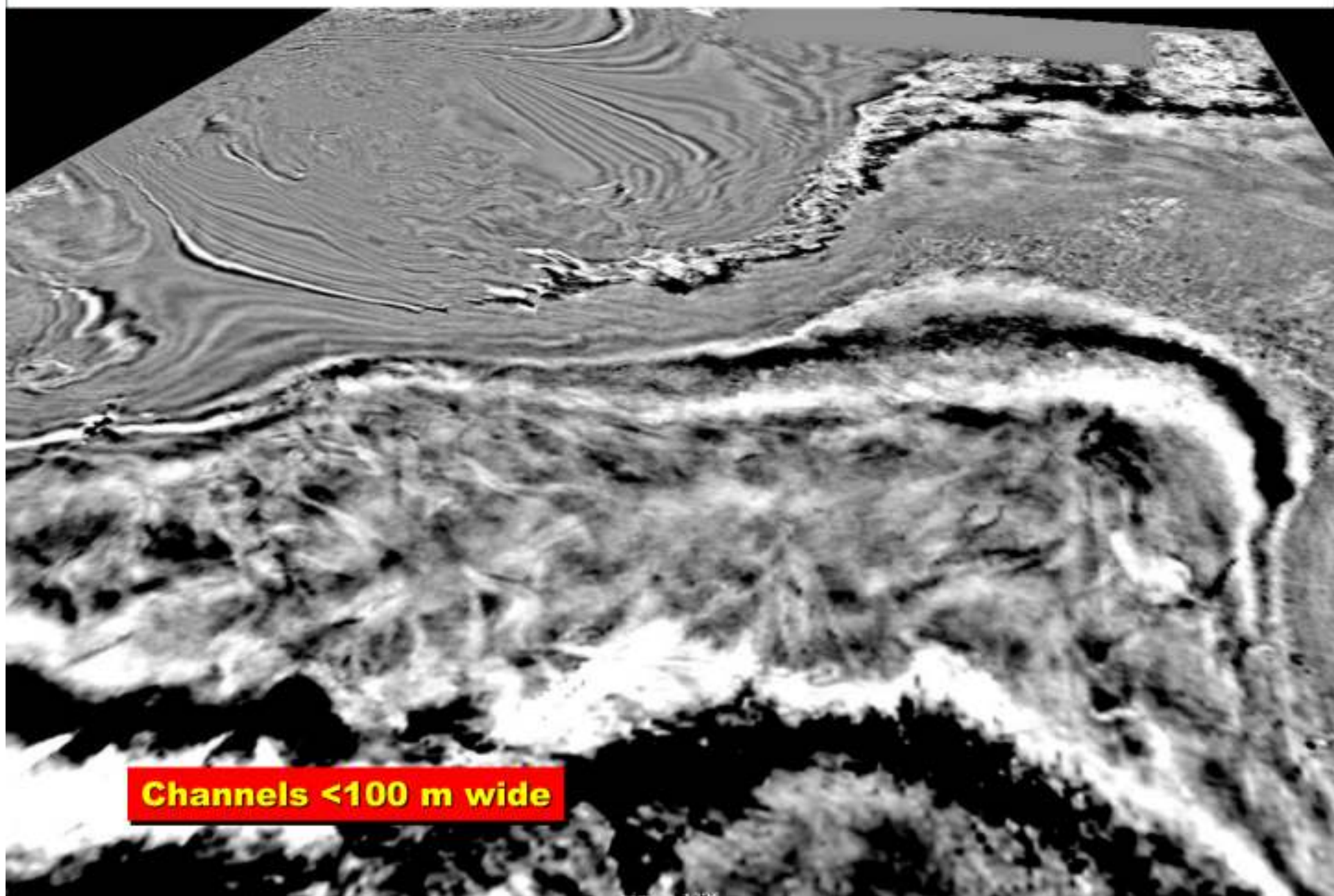
Terminal Splay 2

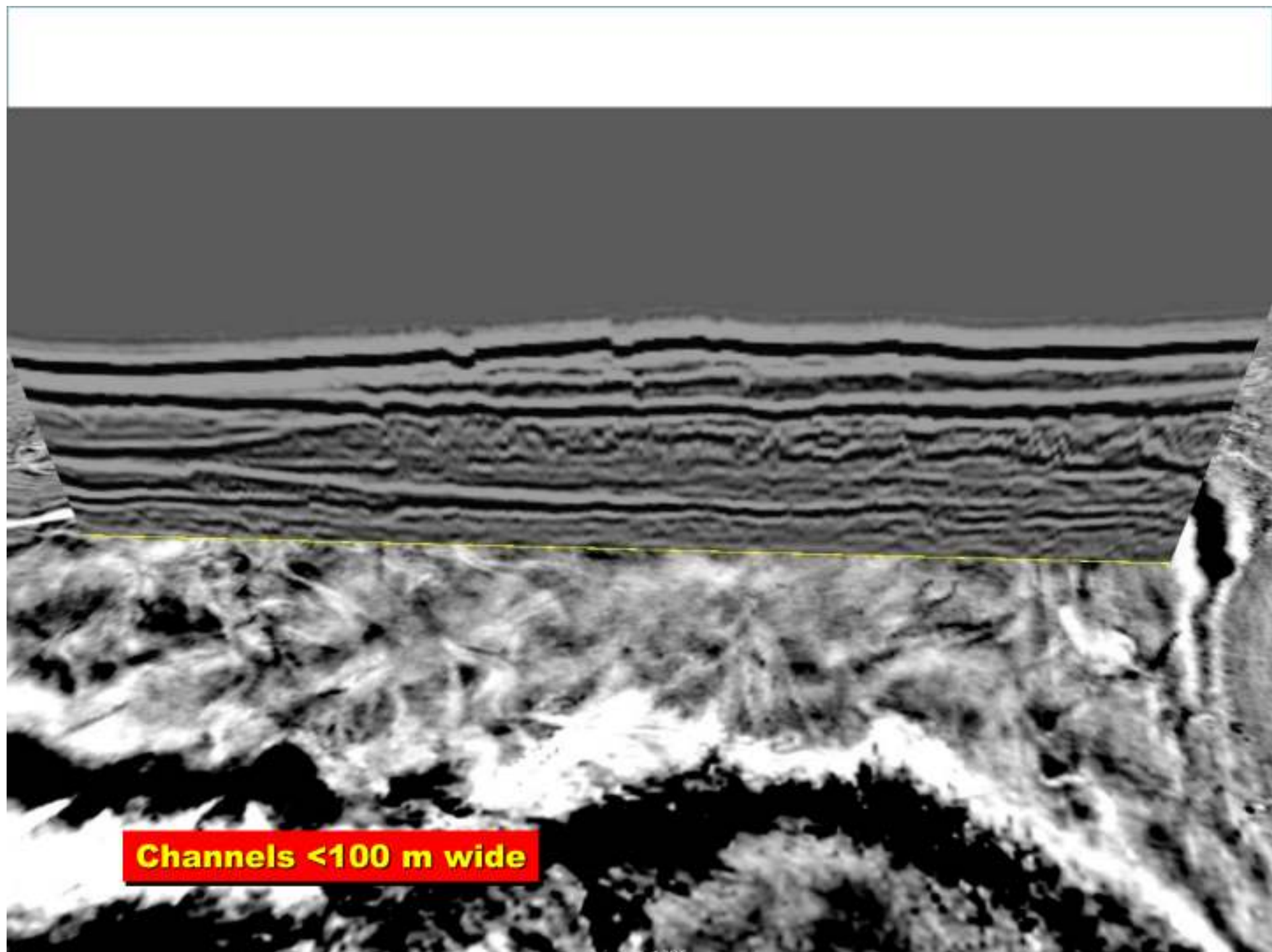
A satellite image of a river delta system. The main river channel enters from the top left and branches out into a complex network of distributaries. Two specific areas are highlighted with yellow arrows and labels: 'Terminal Splay 2' in the upper left and 'Terminal Splay 1' in the lower right. A scale bar labeled 'one km' is located in the lower left quadrant. The terrain shows varying shades of gray, indicating different sediment types or vegetation cover.

one km

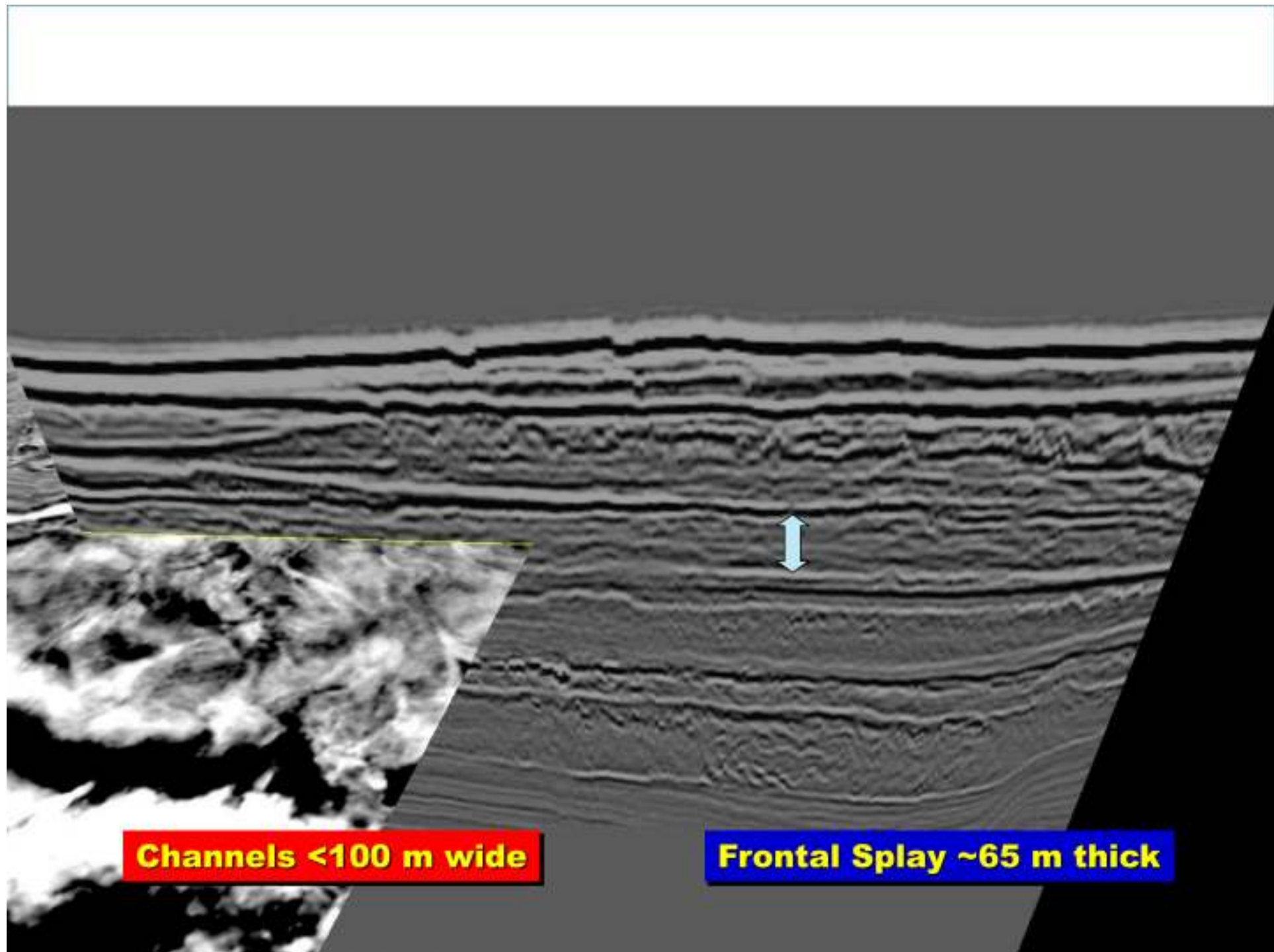
Terminal Splay 1



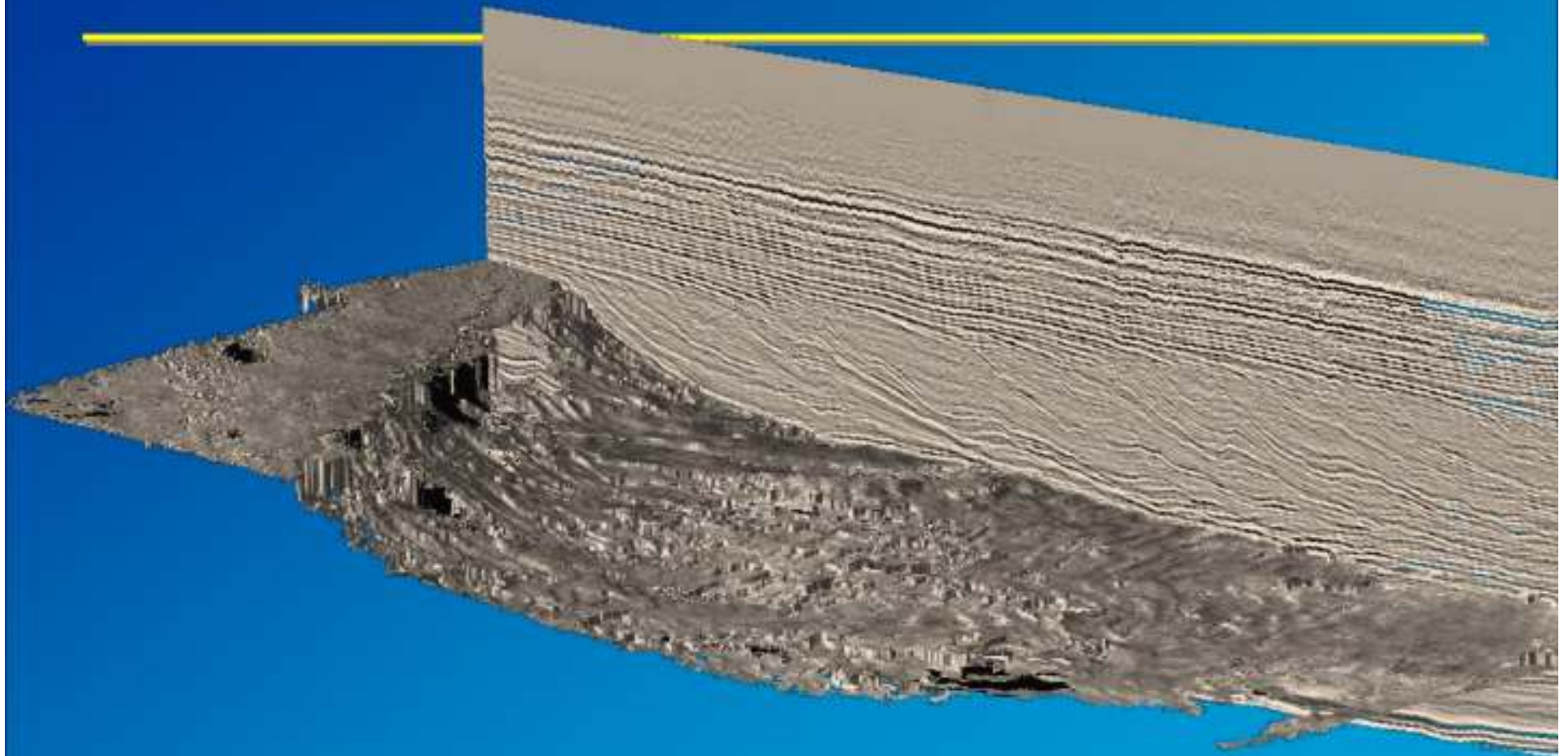




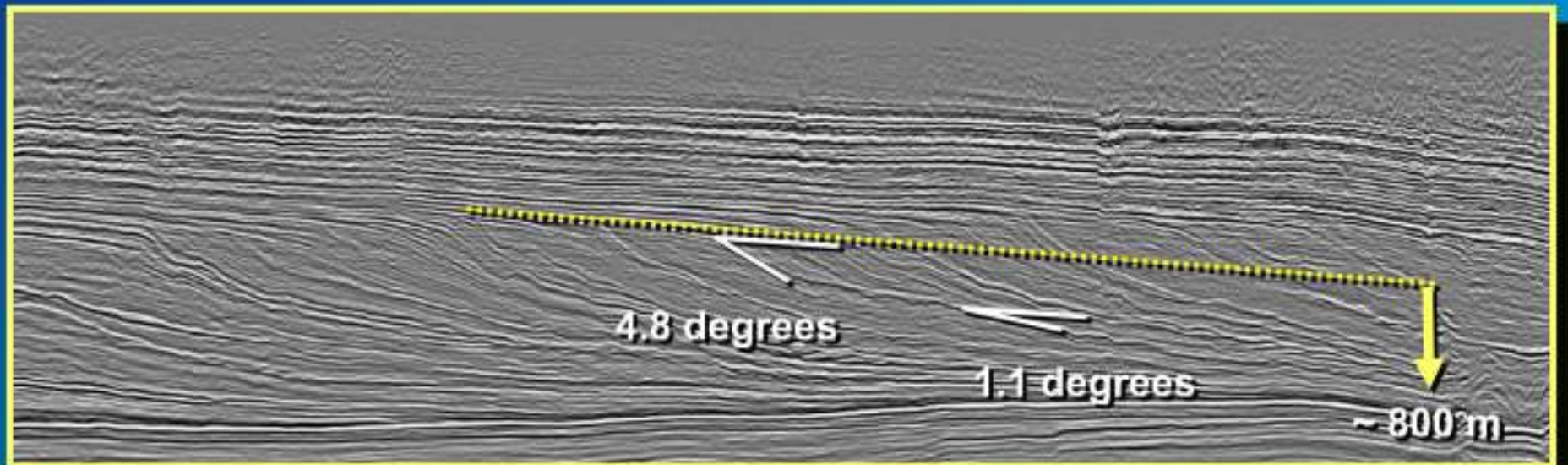
Channels <100 m wide



Cretaceous Architecture and Clinoform Geomorphology



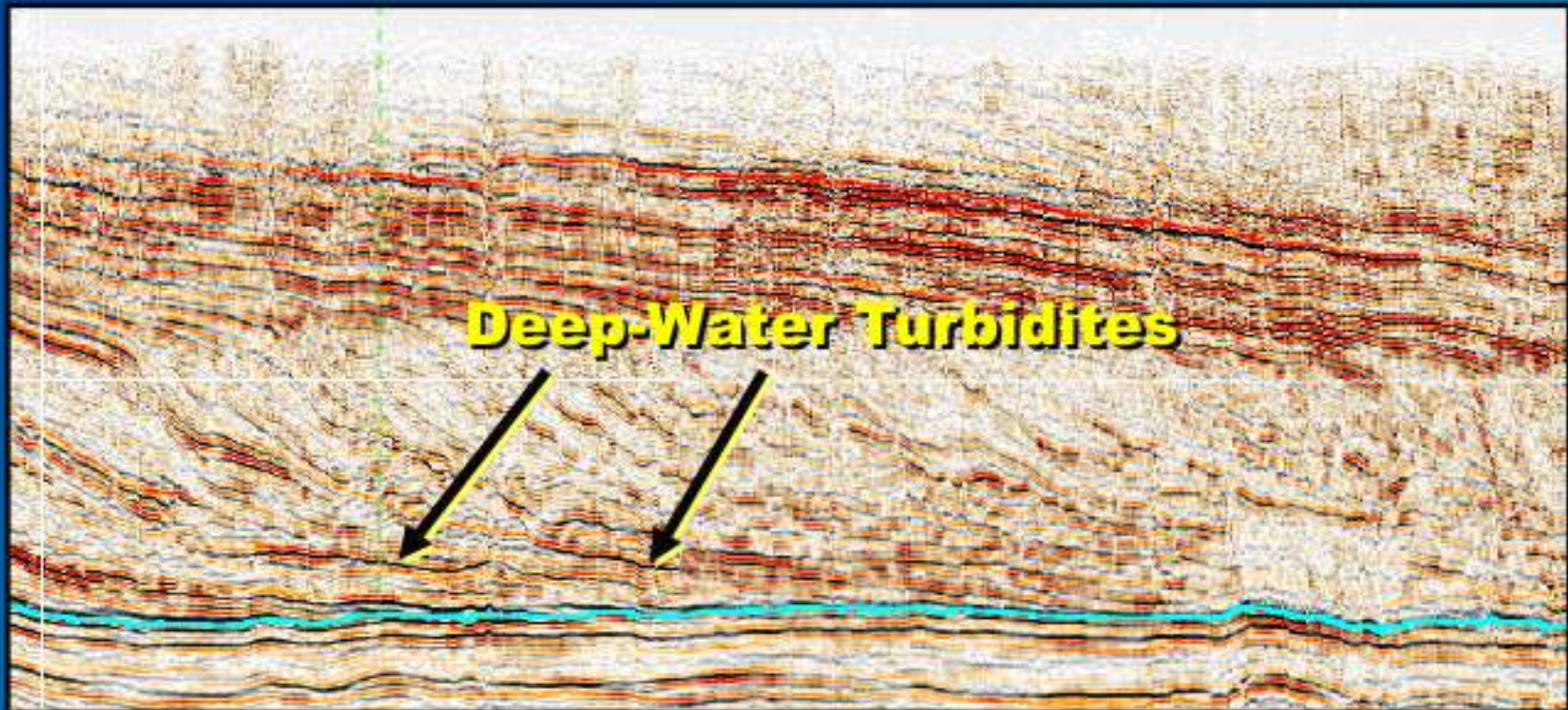
Stratigraphic Architecture



2 km

200 msec

Basin Floor Turbidites

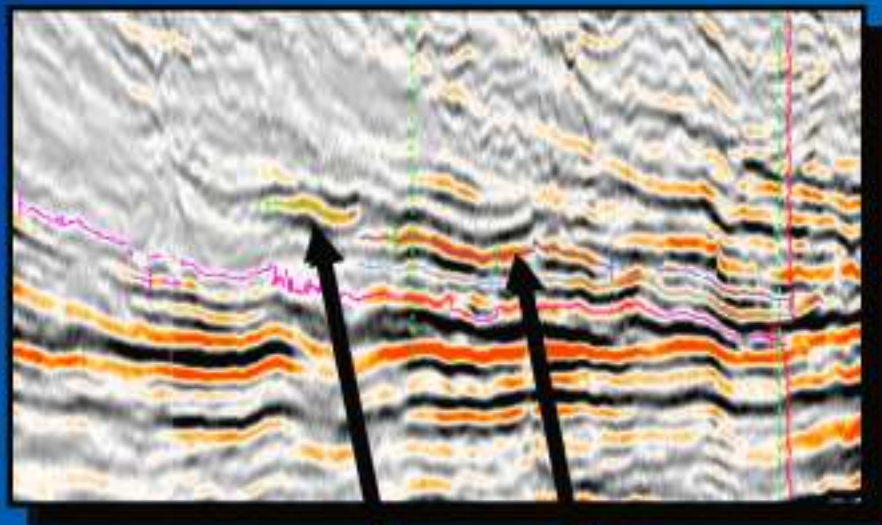


200 msec

2 km

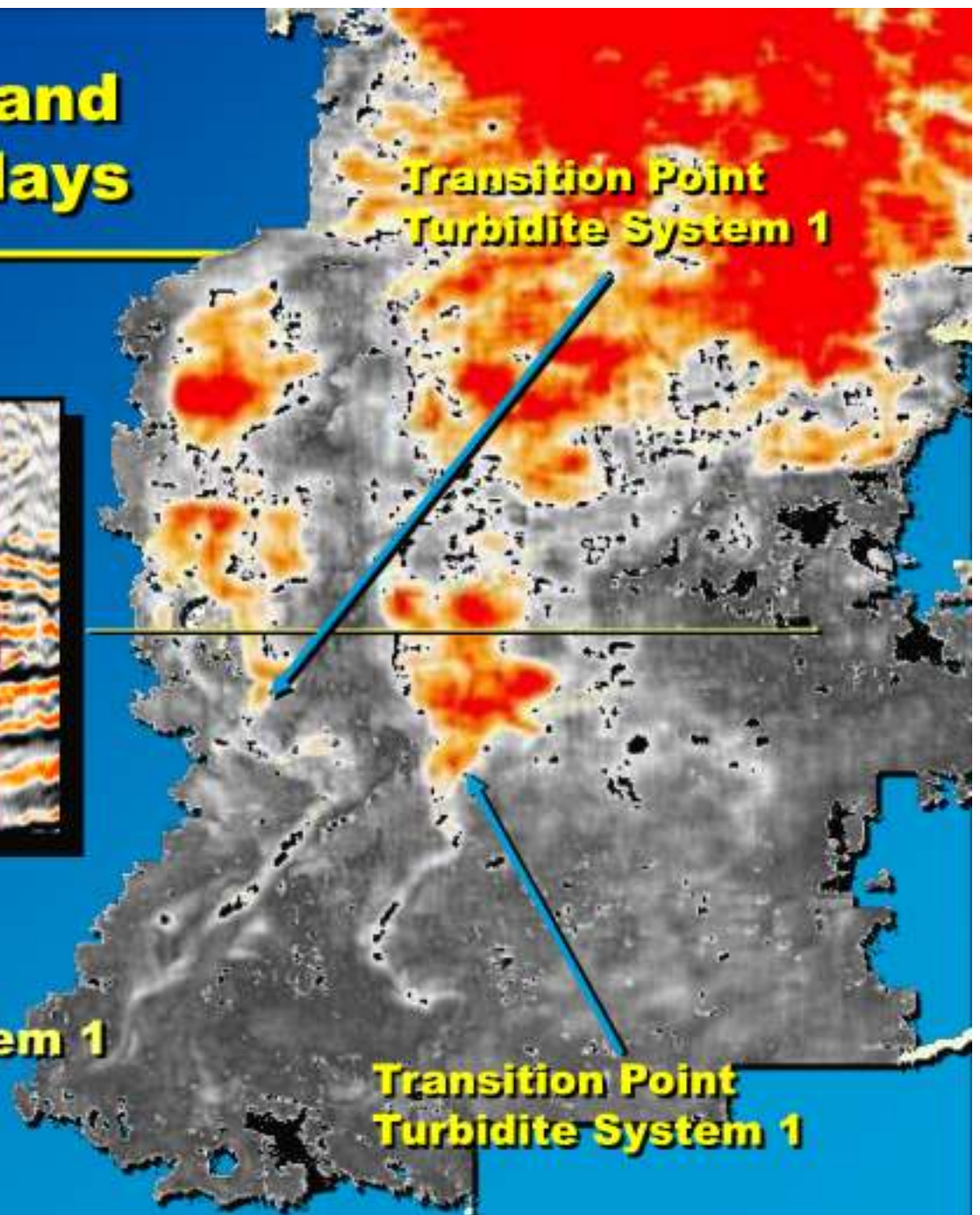


Leveed Channels and Linked Frontal Splays



Turbidite System 2

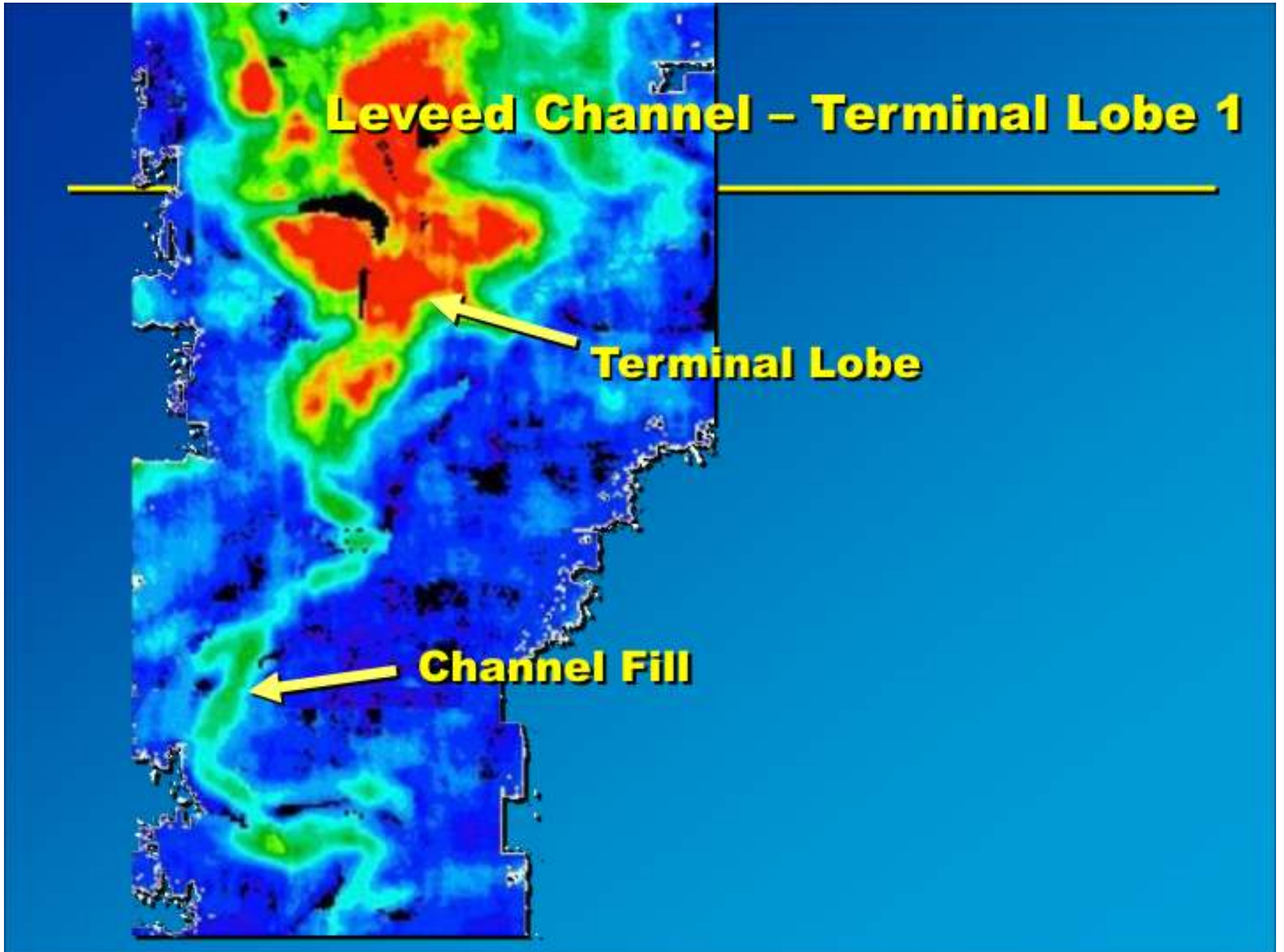
Turbidite System 1



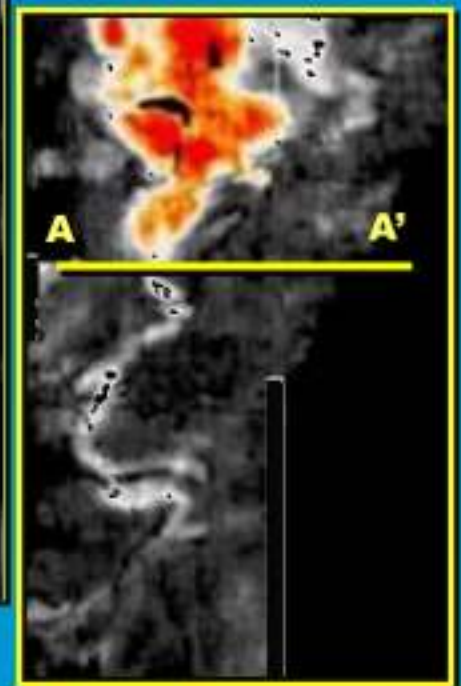
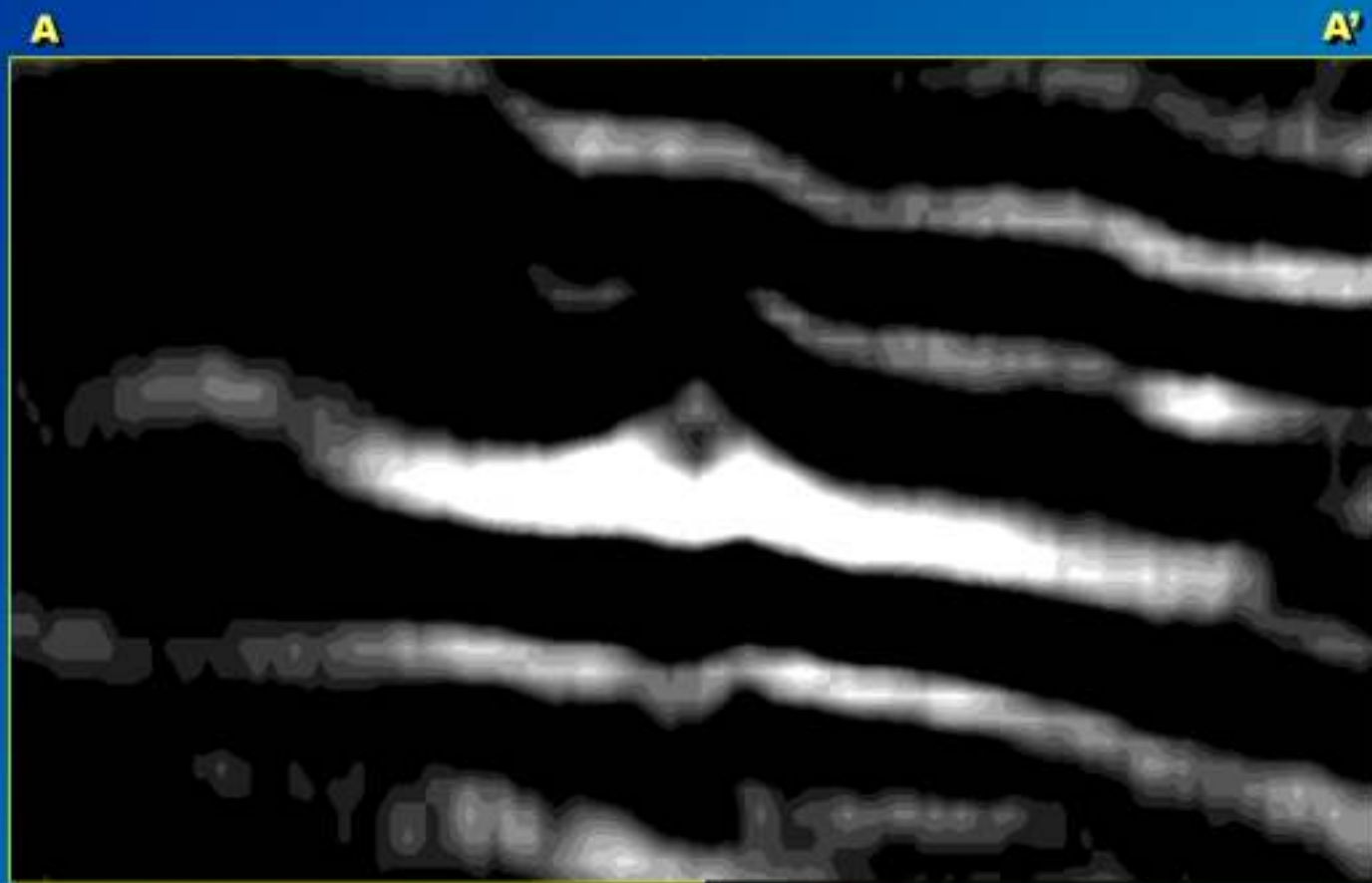
Leveed Channel – Terminal Lobe 1

Terminal Lobe

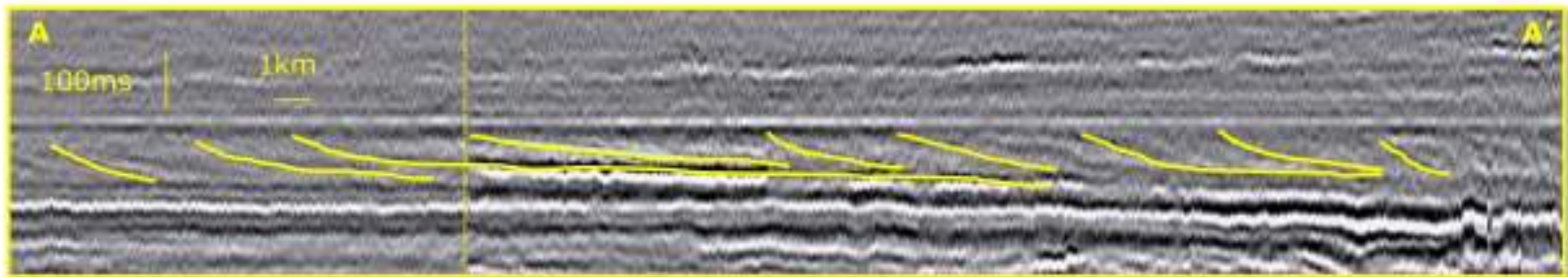
Channel Fill



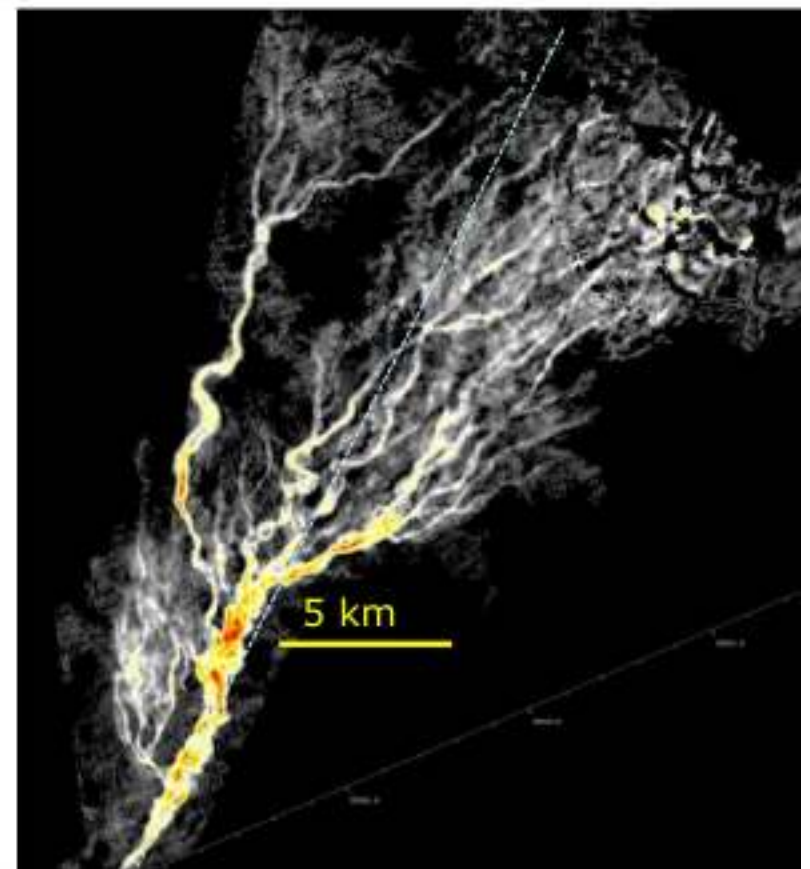
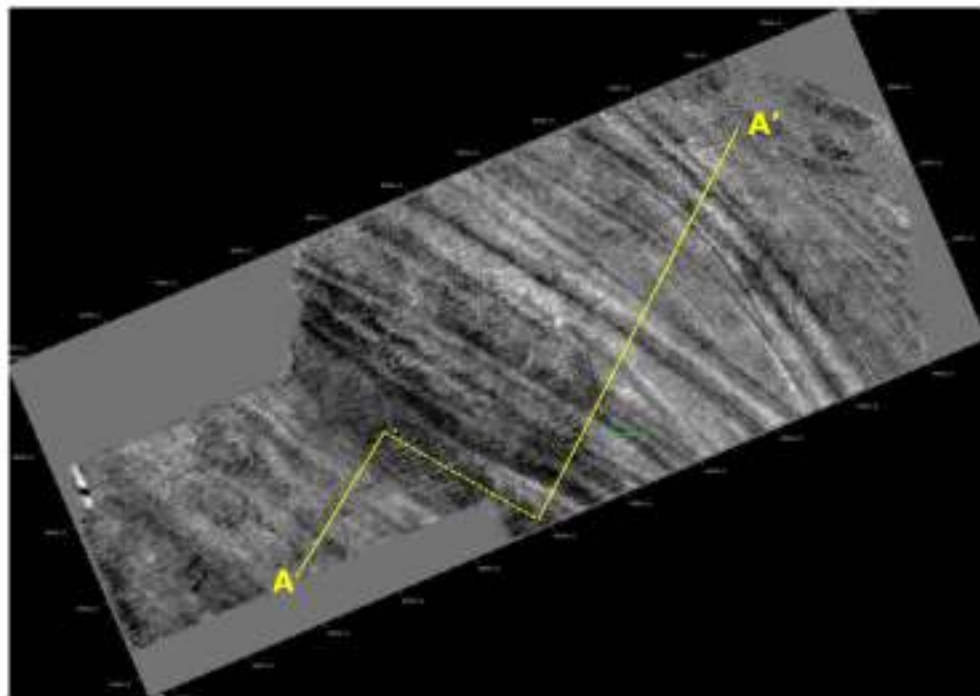
Leveed Channel 1



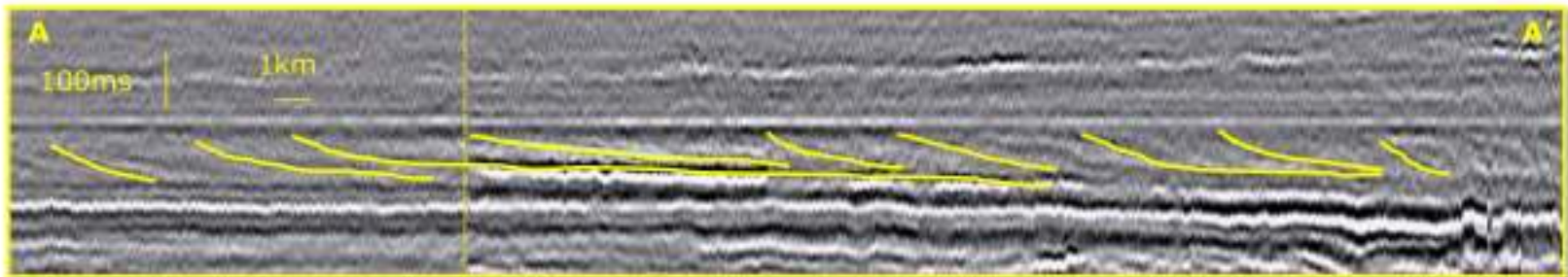
Deep-Water Turbidites – Barents Sea



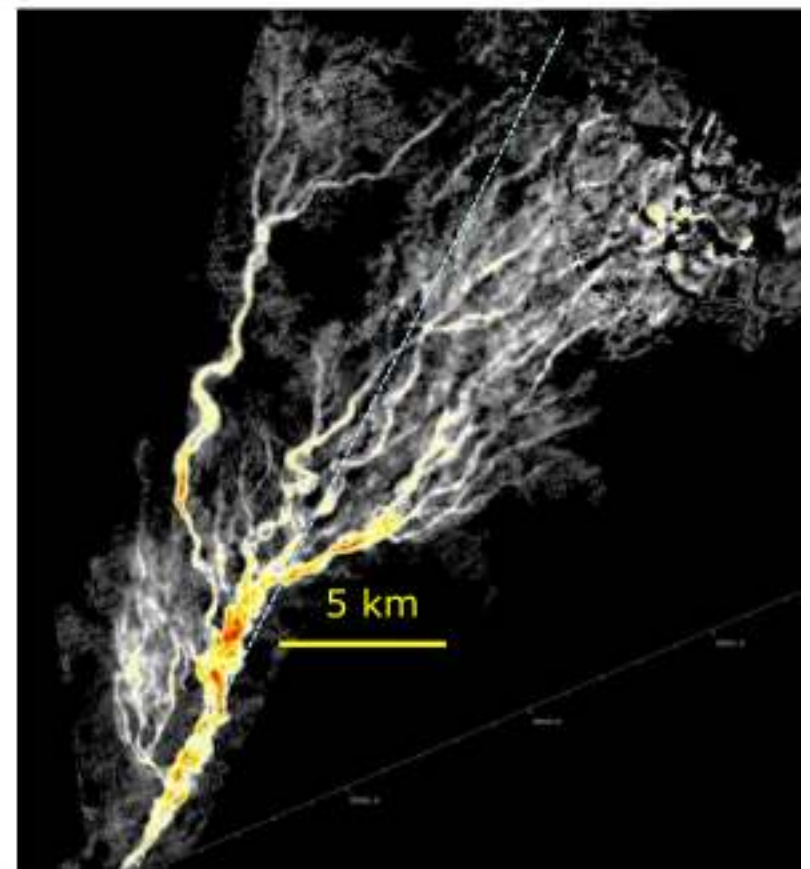
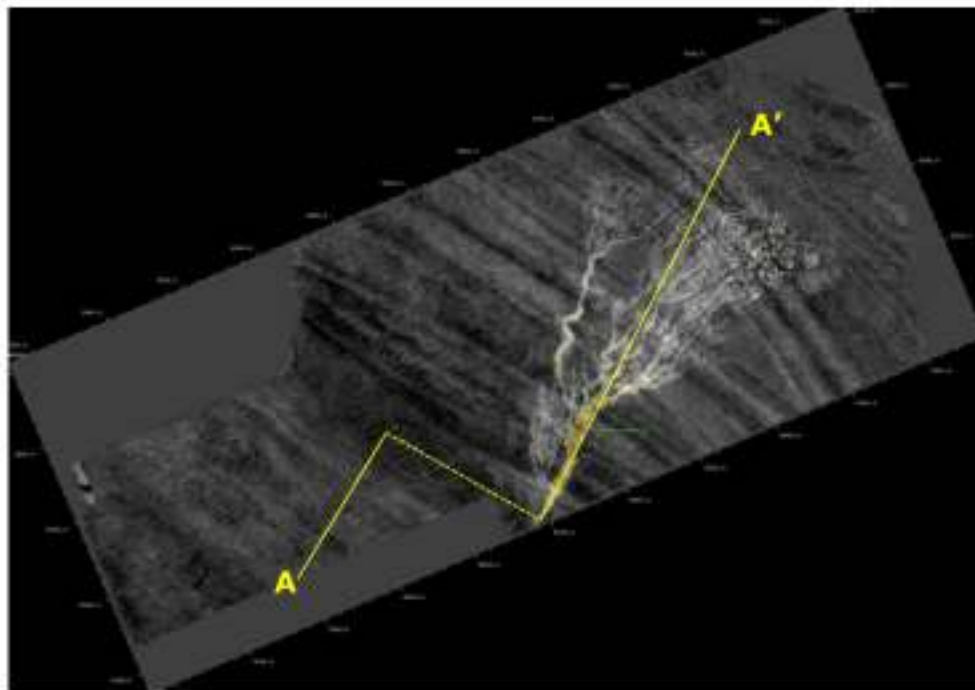
Clinof orm length = $\sim 2 - 4$ km
Clinof orm dip = $3 - 4^\circ$



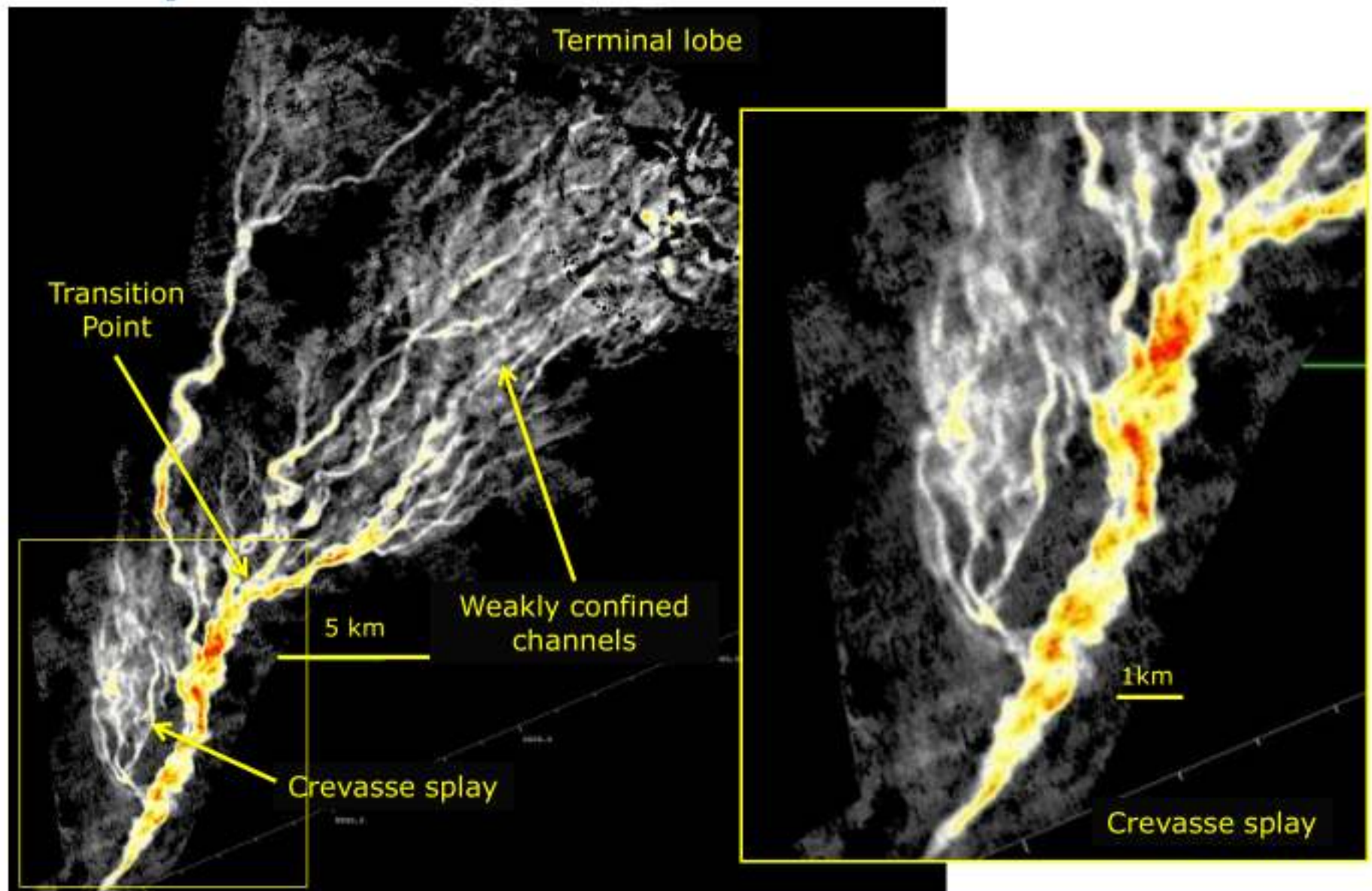
Deep-Water Turbidites – Barents Sea



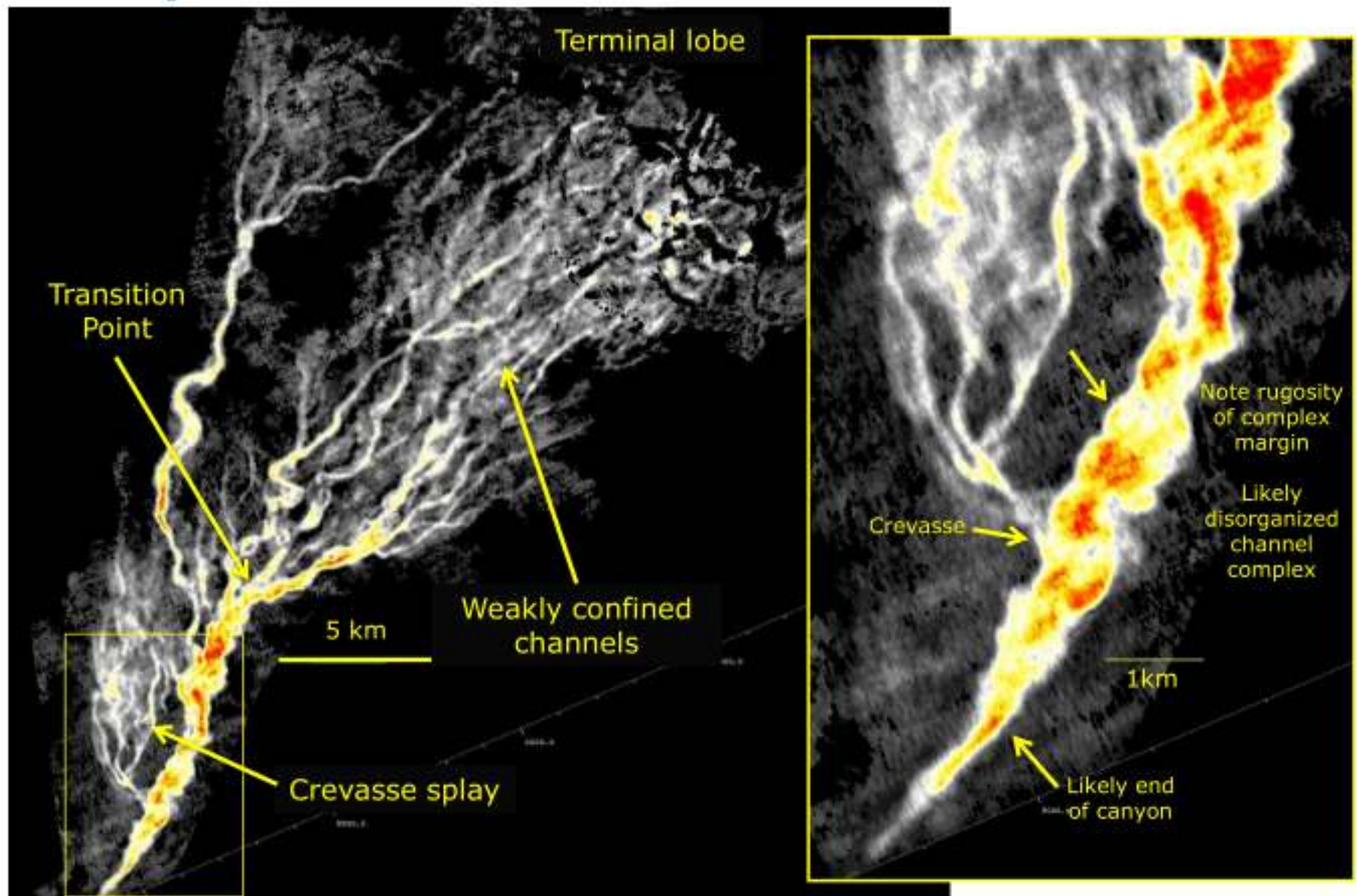
Clinofom length = $\sim 0.6 - 1.2$ km
Clinofom dip = 4°



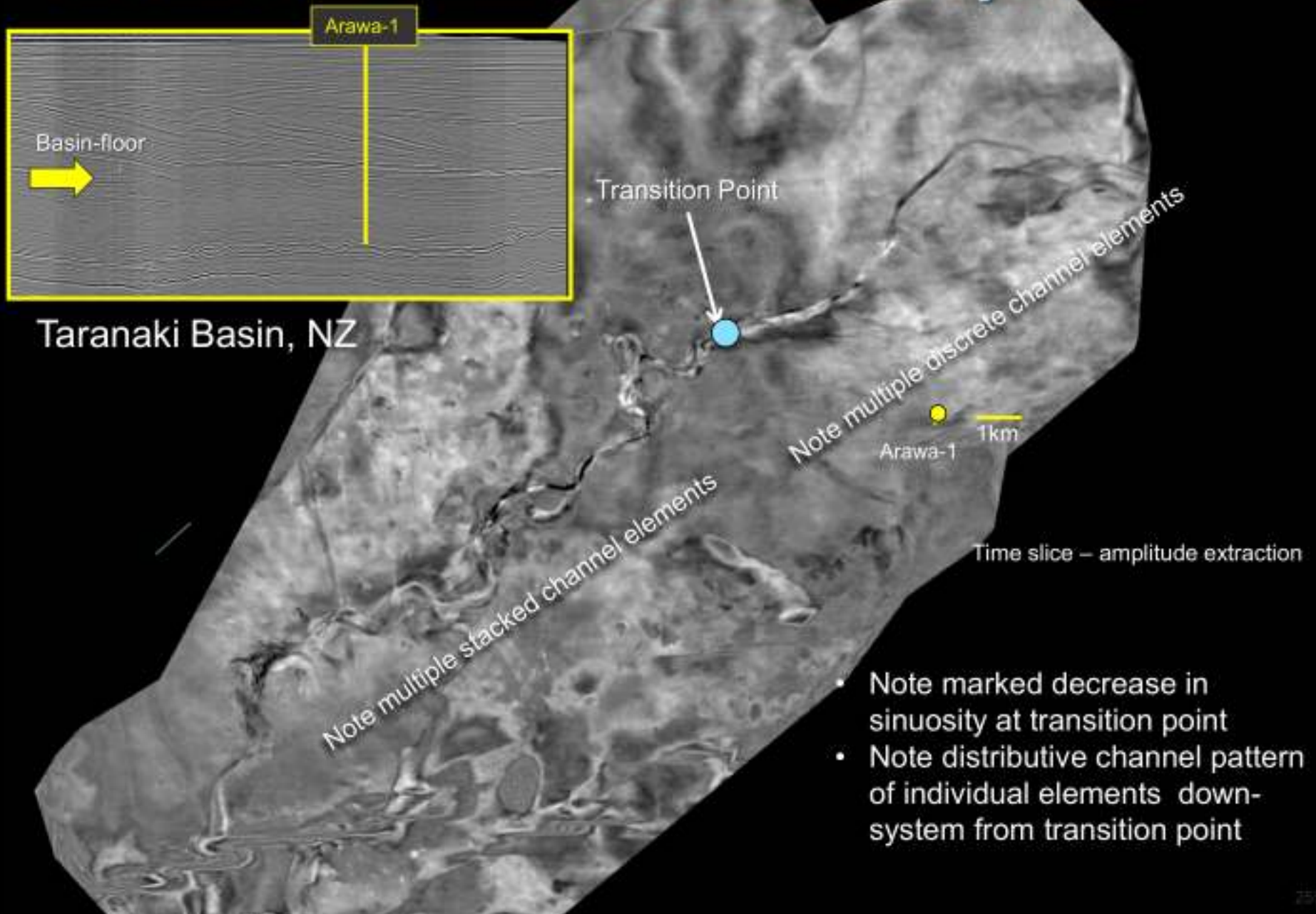
Deep-Water Turbidites – Barents Sea



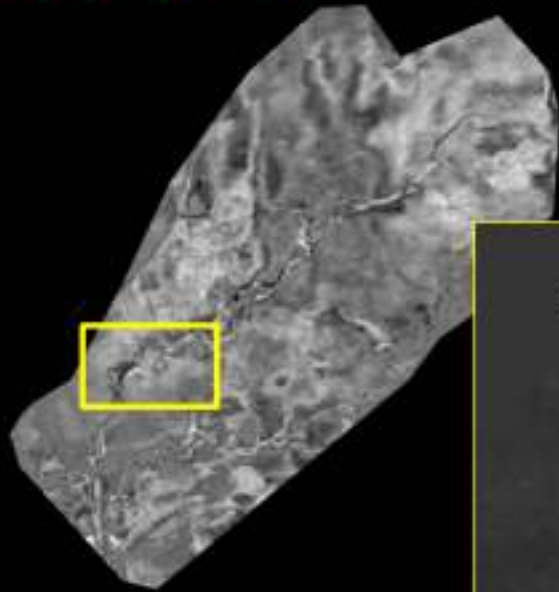
Deep-Water Turbidites – Barents Sea



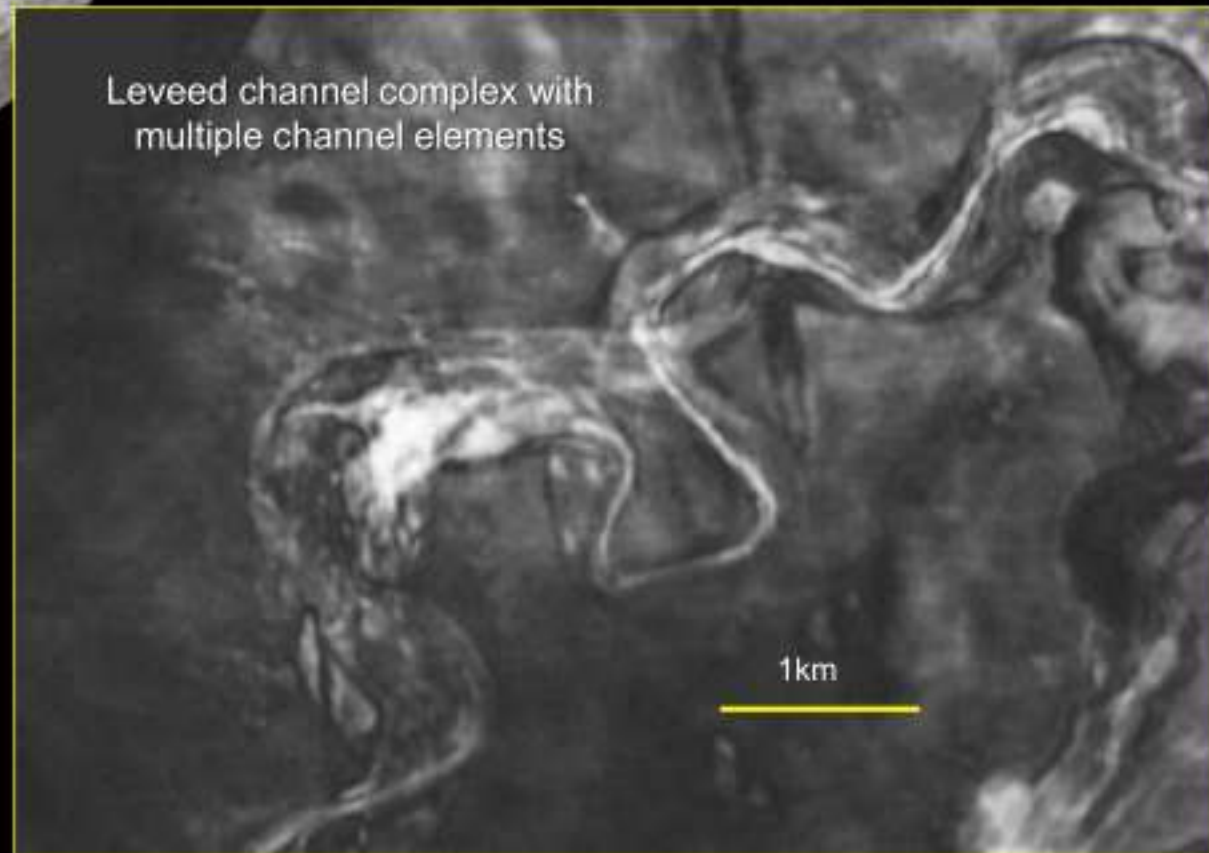
Mid Miocene Basin-Floor Turbidite System



Mid Miocene Basin-Floor Turbidite Channel Complex



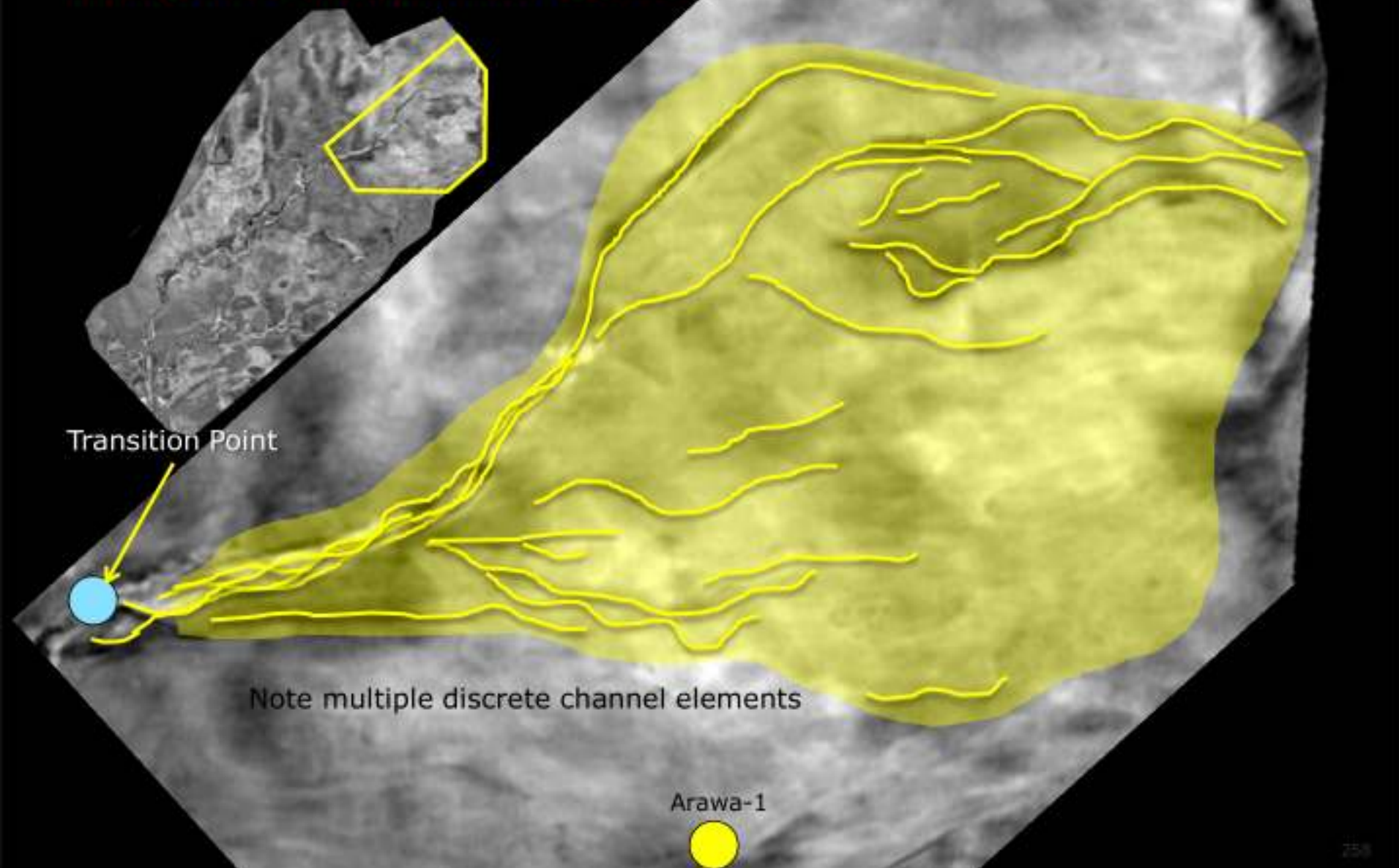
Taranaki Basin, NZ



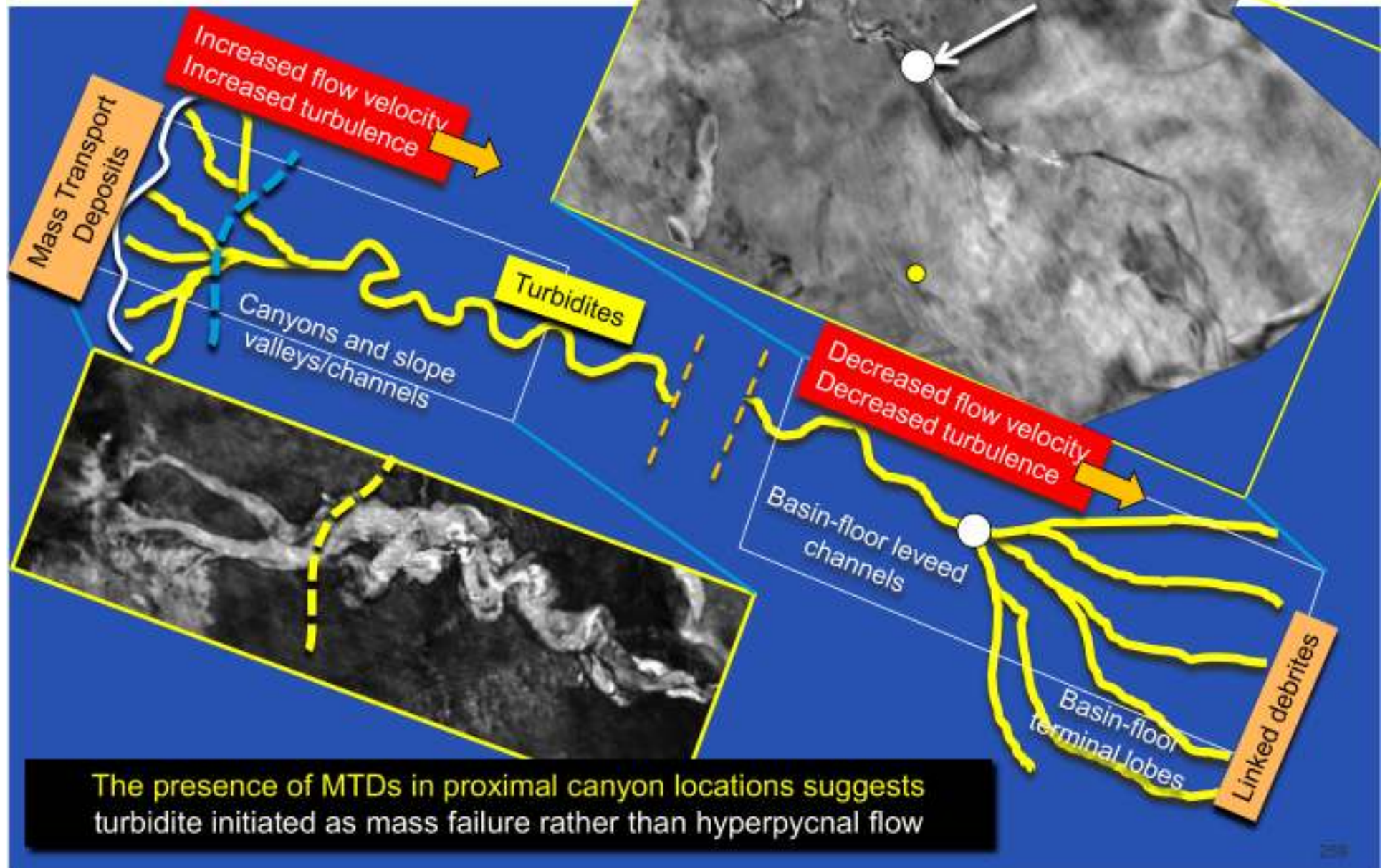
Mid Miocene Basin-Floor Turbidite Terminal Lobe



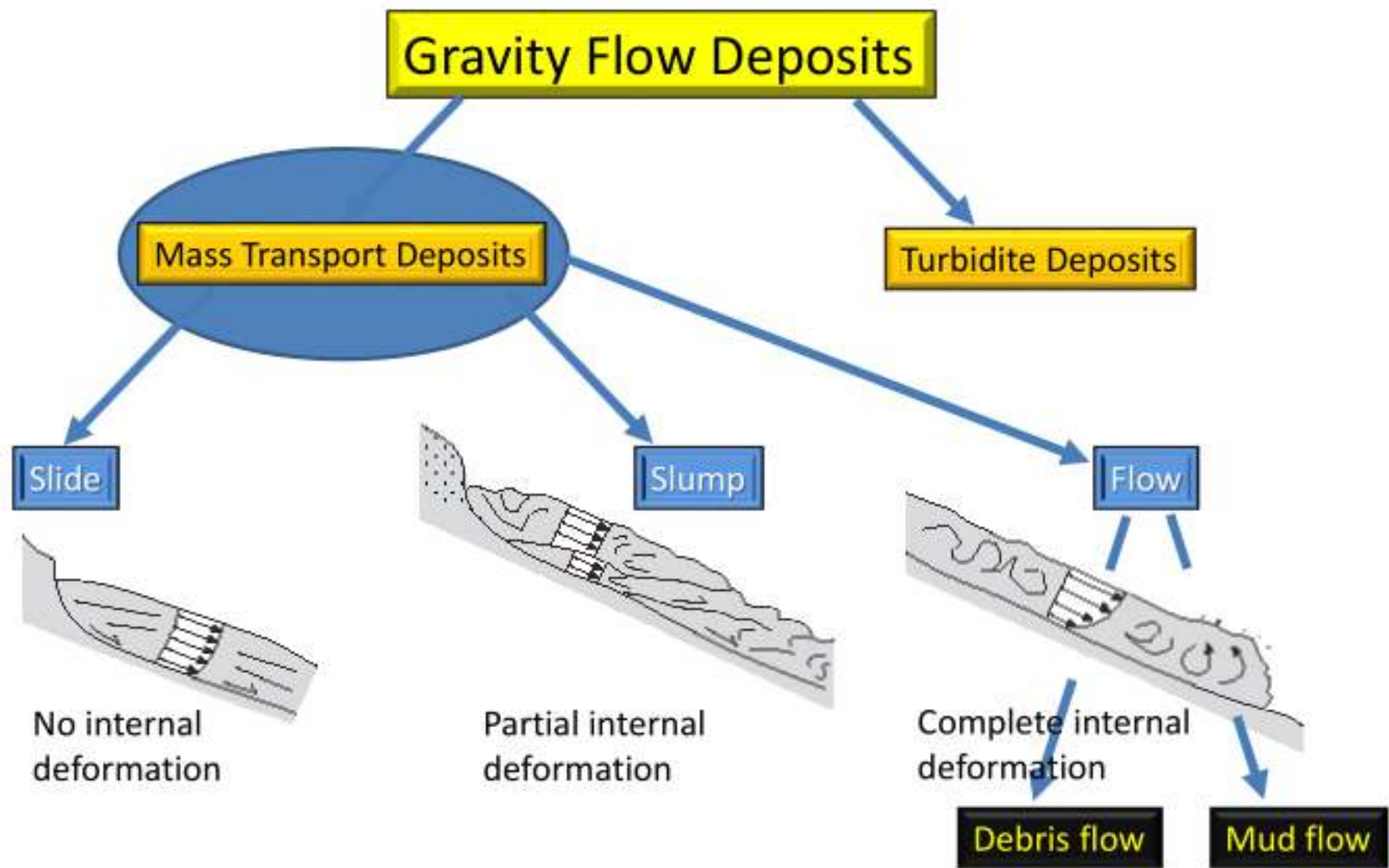
Mid Miocene Basin-Floor Turbidite Terminal Lobe



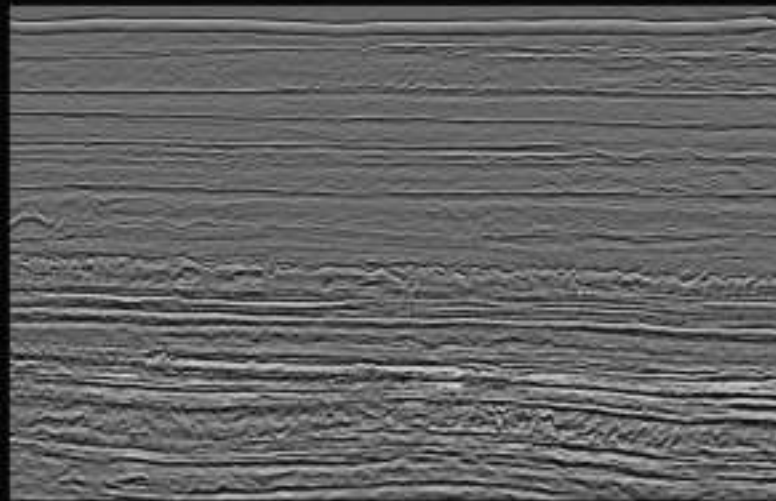
Turbidite System from Proximal to Distal



Mass Transport Deposits

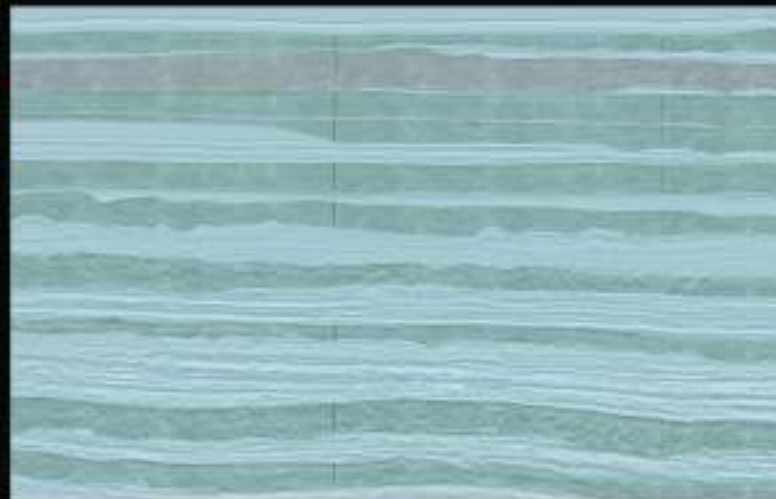


Eastern Gulf of Mexico



100 msec

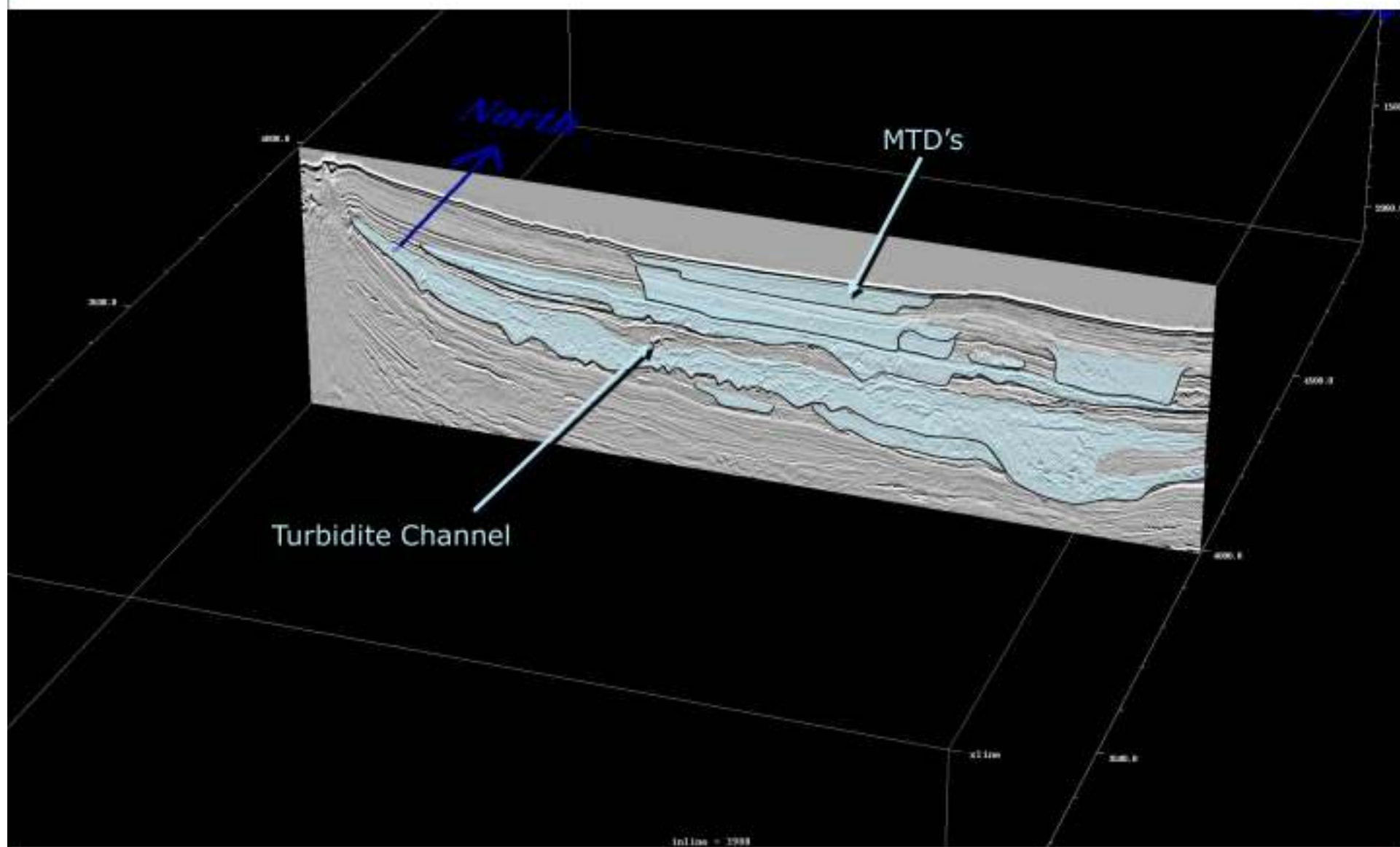
**~45% of section
Comprise MTD's**



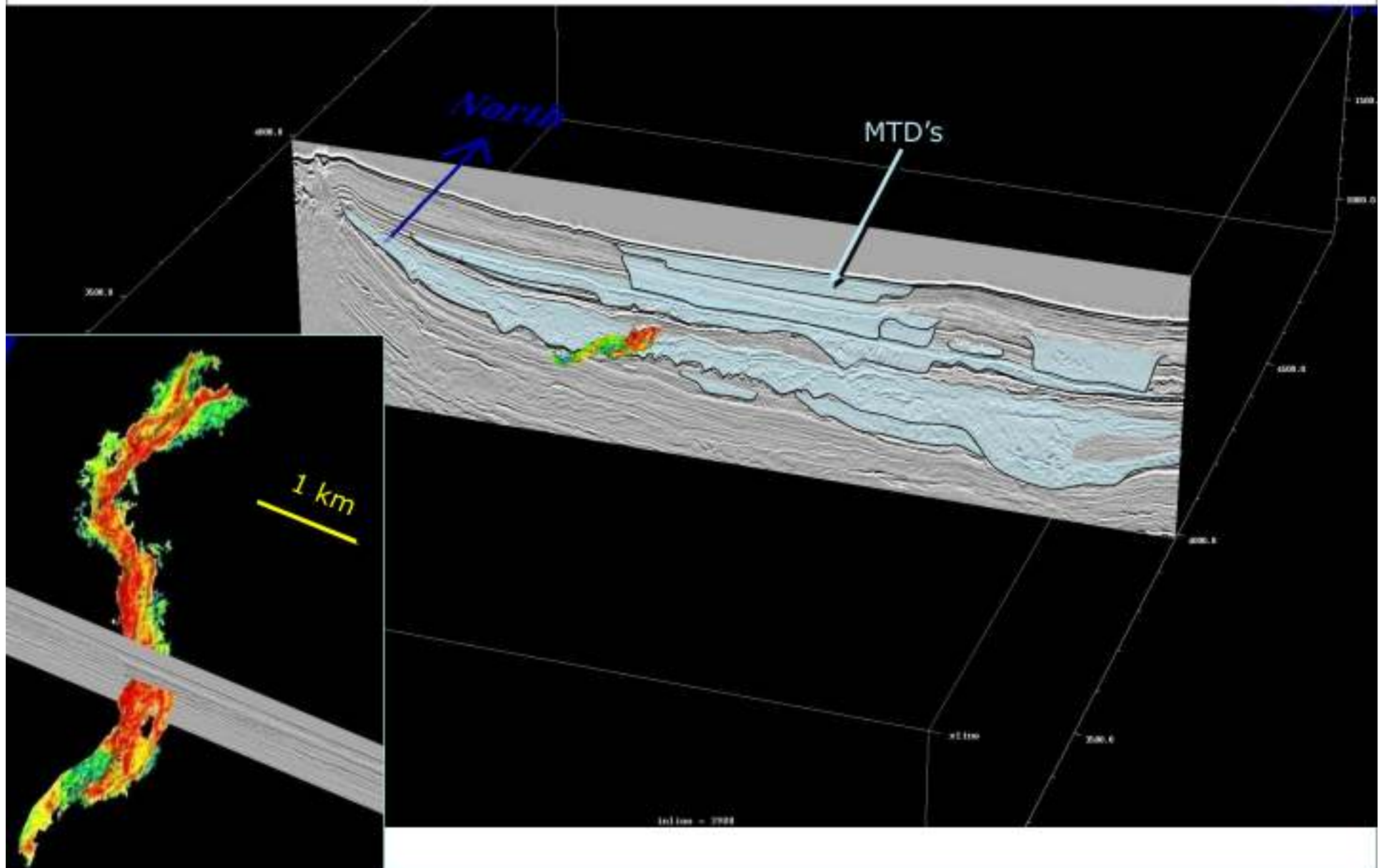
one km

Mass Transport Deposits (MTD's)

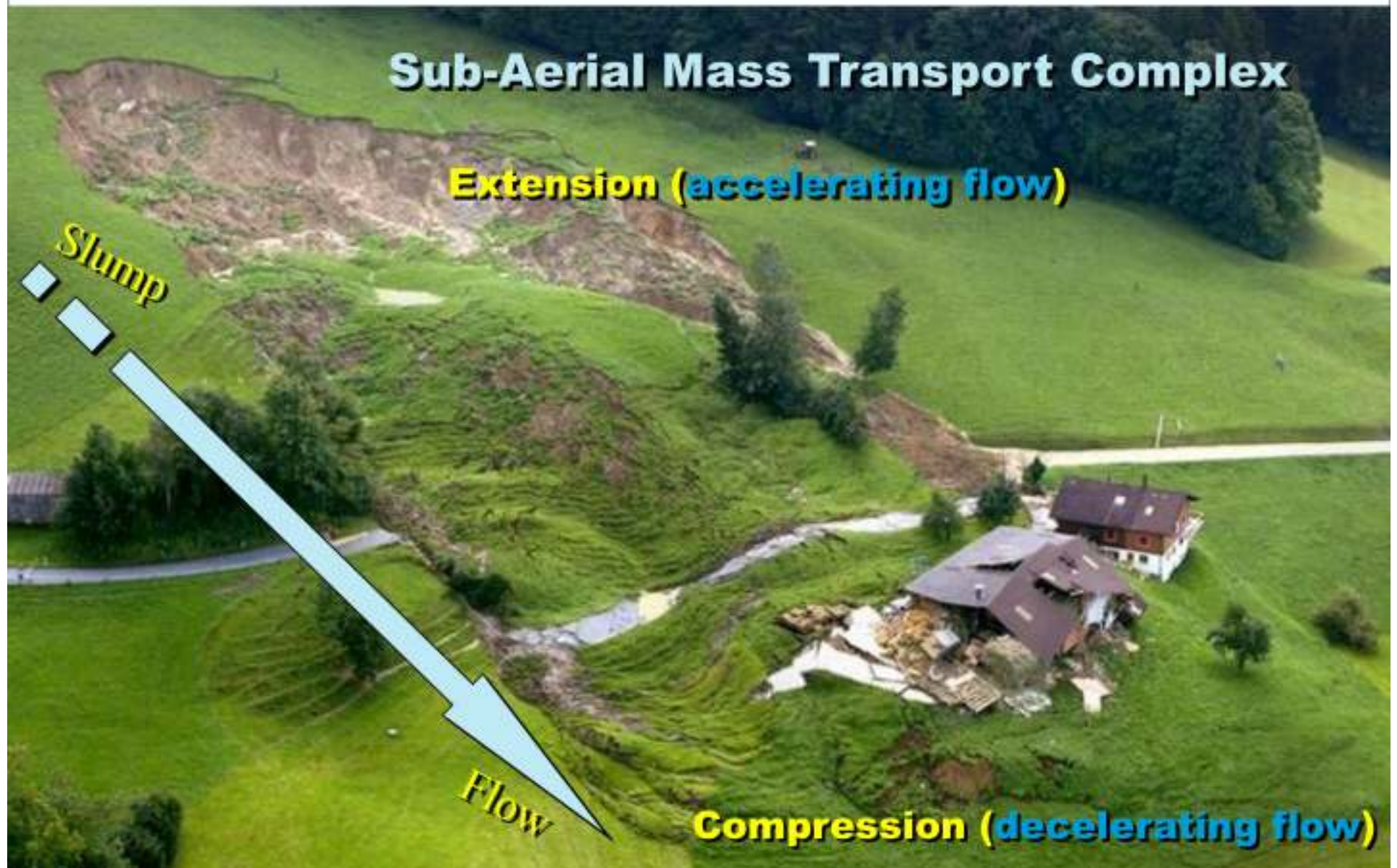
Mass Transport Deposits

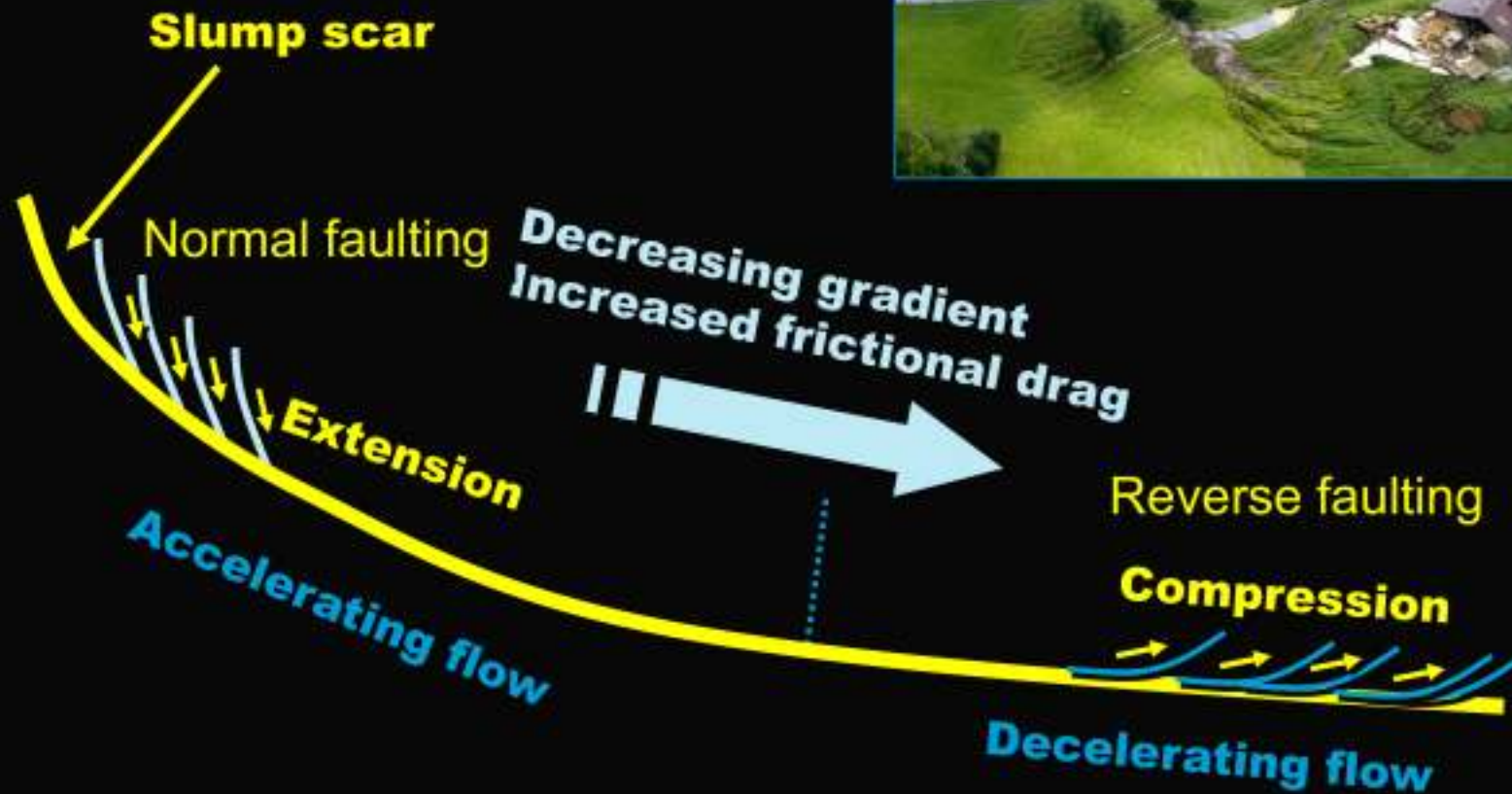


Mass Transport Deposits (with Turbidite Channel)



...what do MTD's look like?

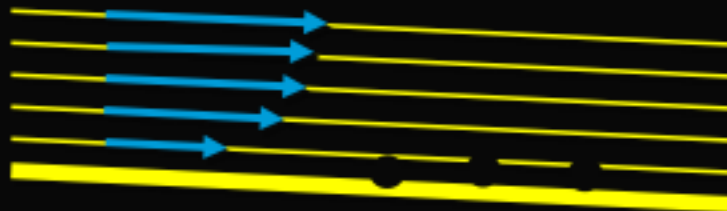




Frictional drag = f (slope gradient, internal cohesion)

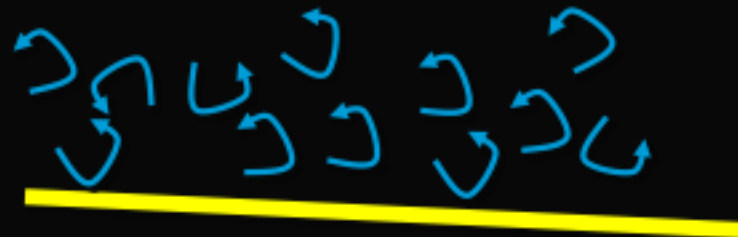
Rheology – Flow Processes

- **Laminar flow** – “tools” at flow base remain at base



Debrite

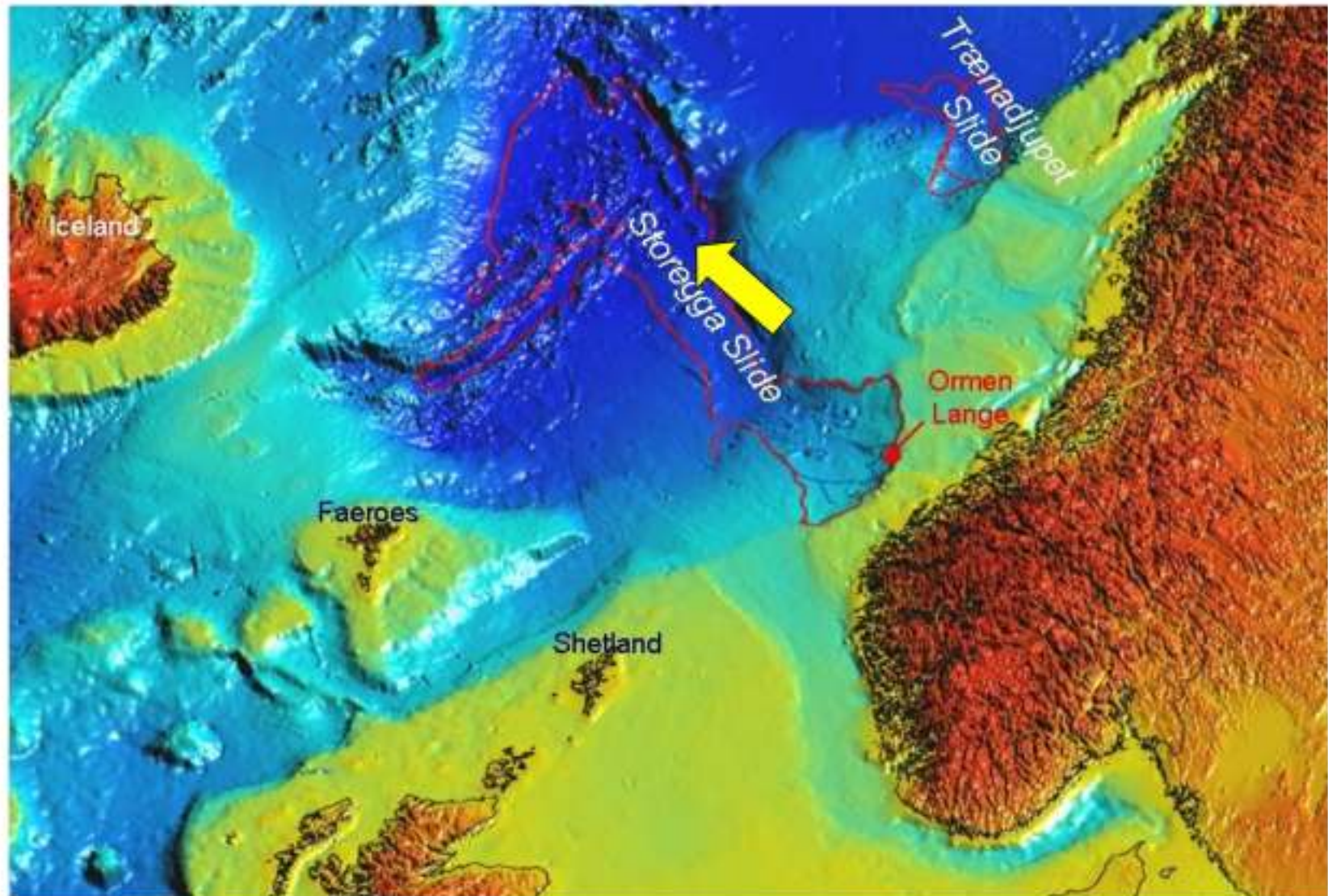
- **Grooved / striated base**



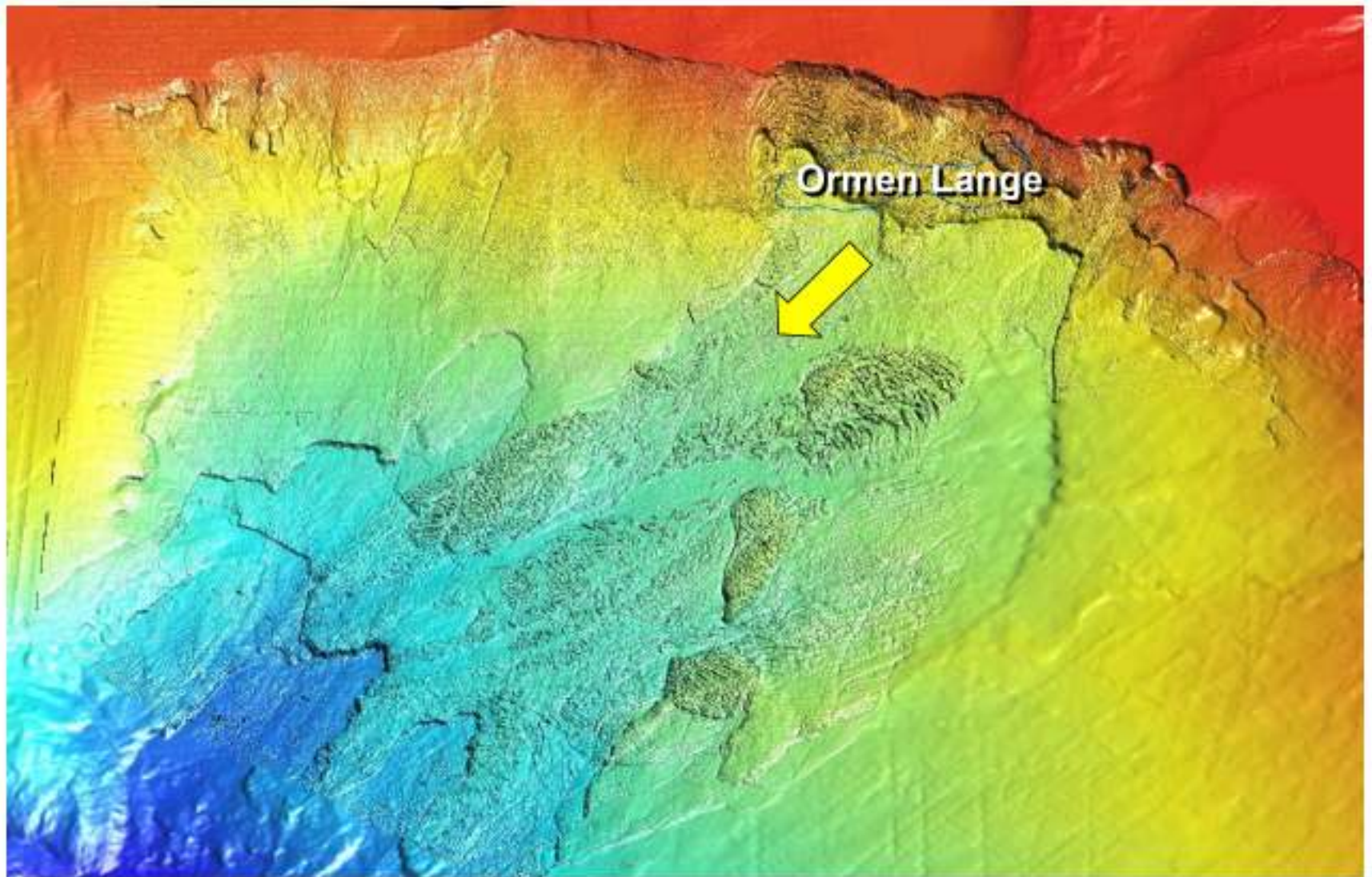
Turbidite

- **Smooth base**

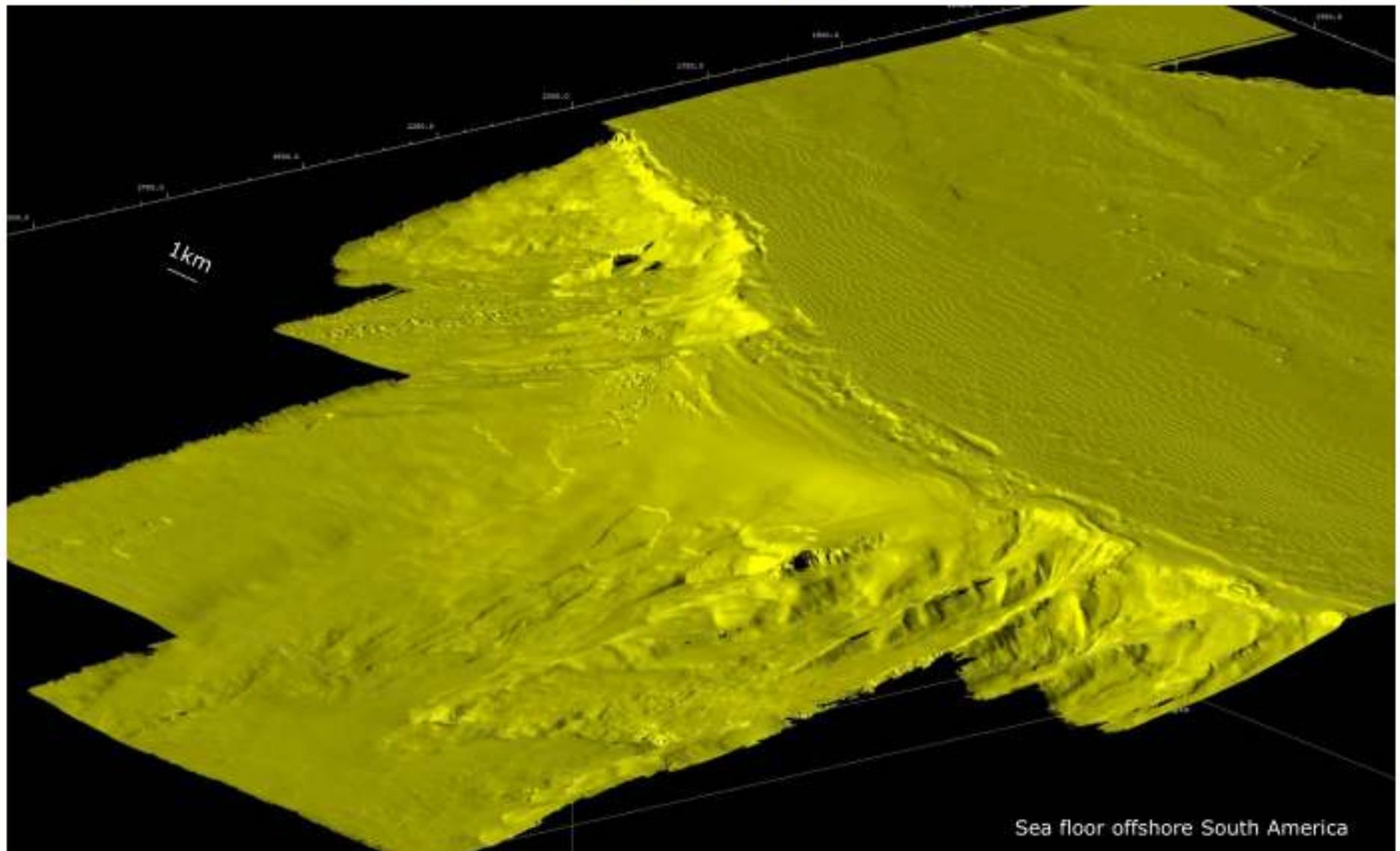
MTD's can be large...



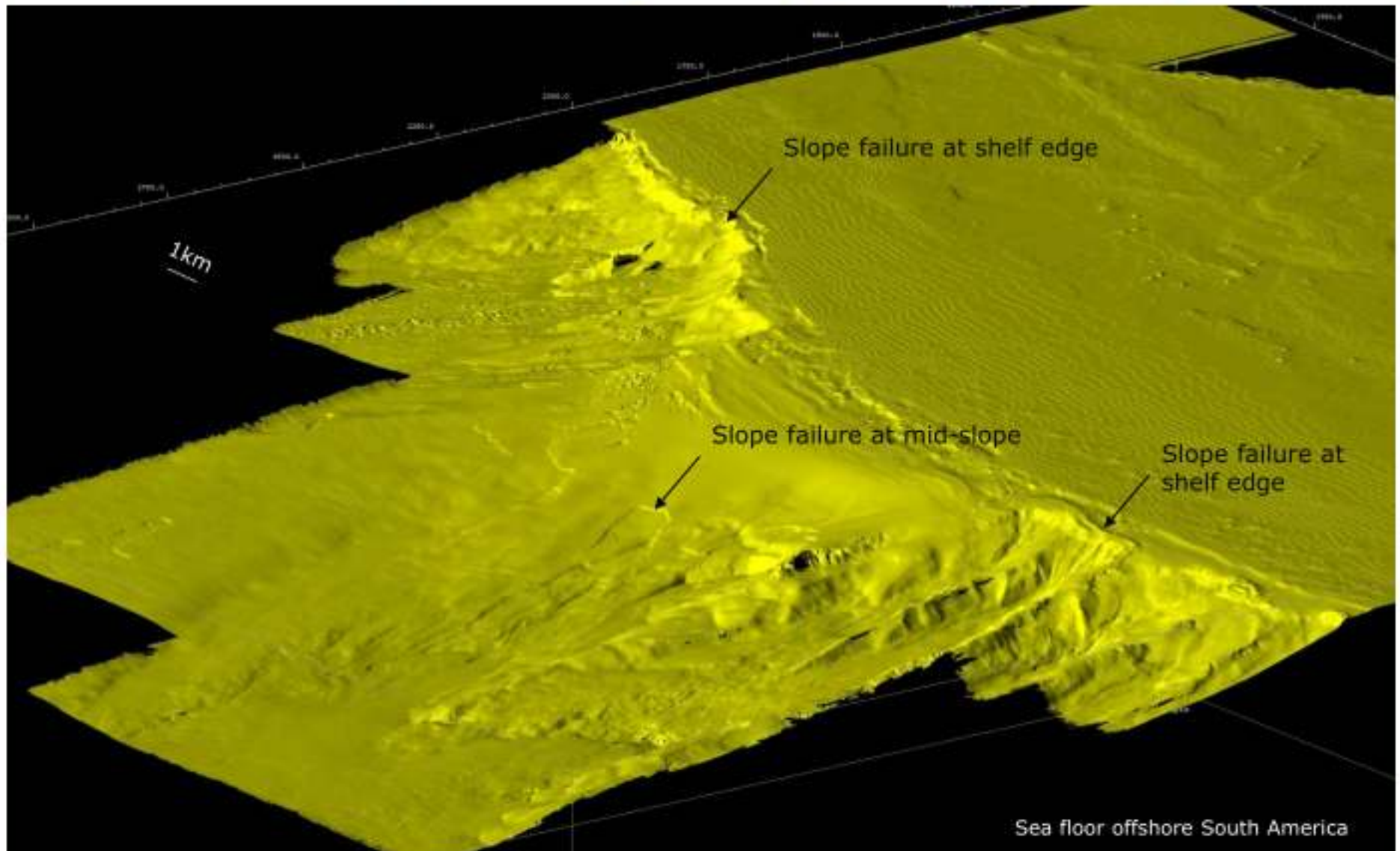
MTD's can be large...



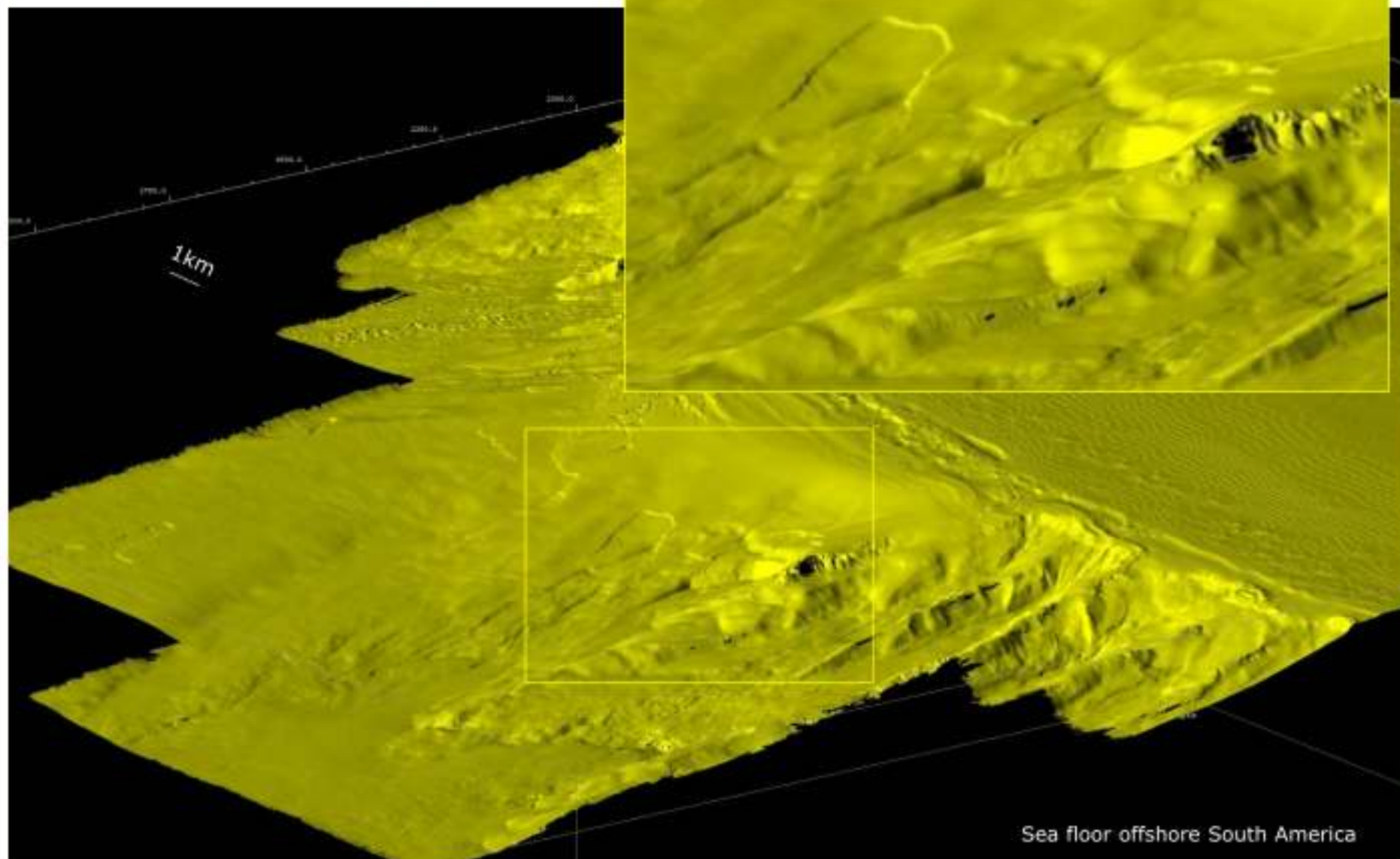
Mass Transport Originating at Upper Slope



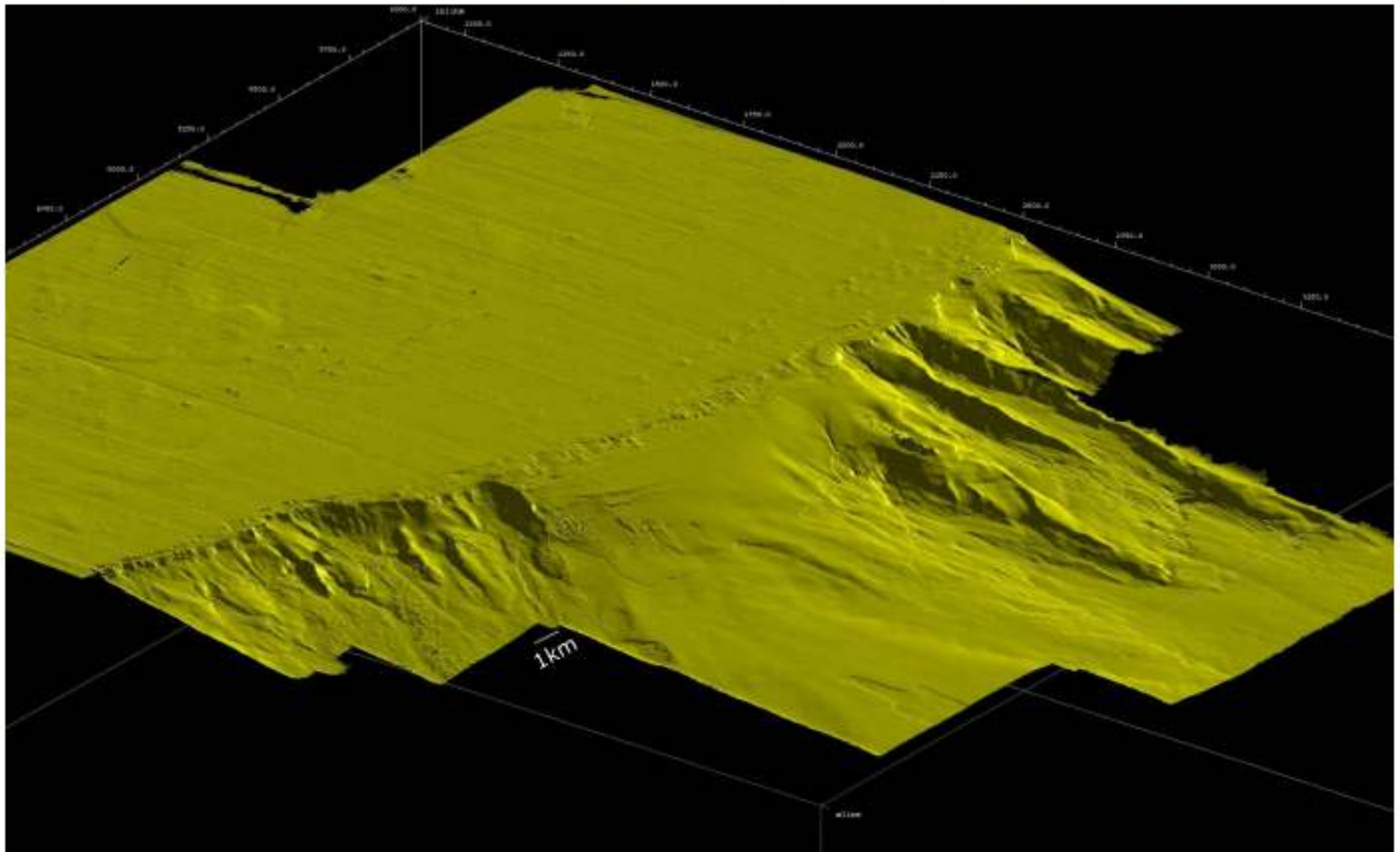
Mass Transport Originating at Upper Slope



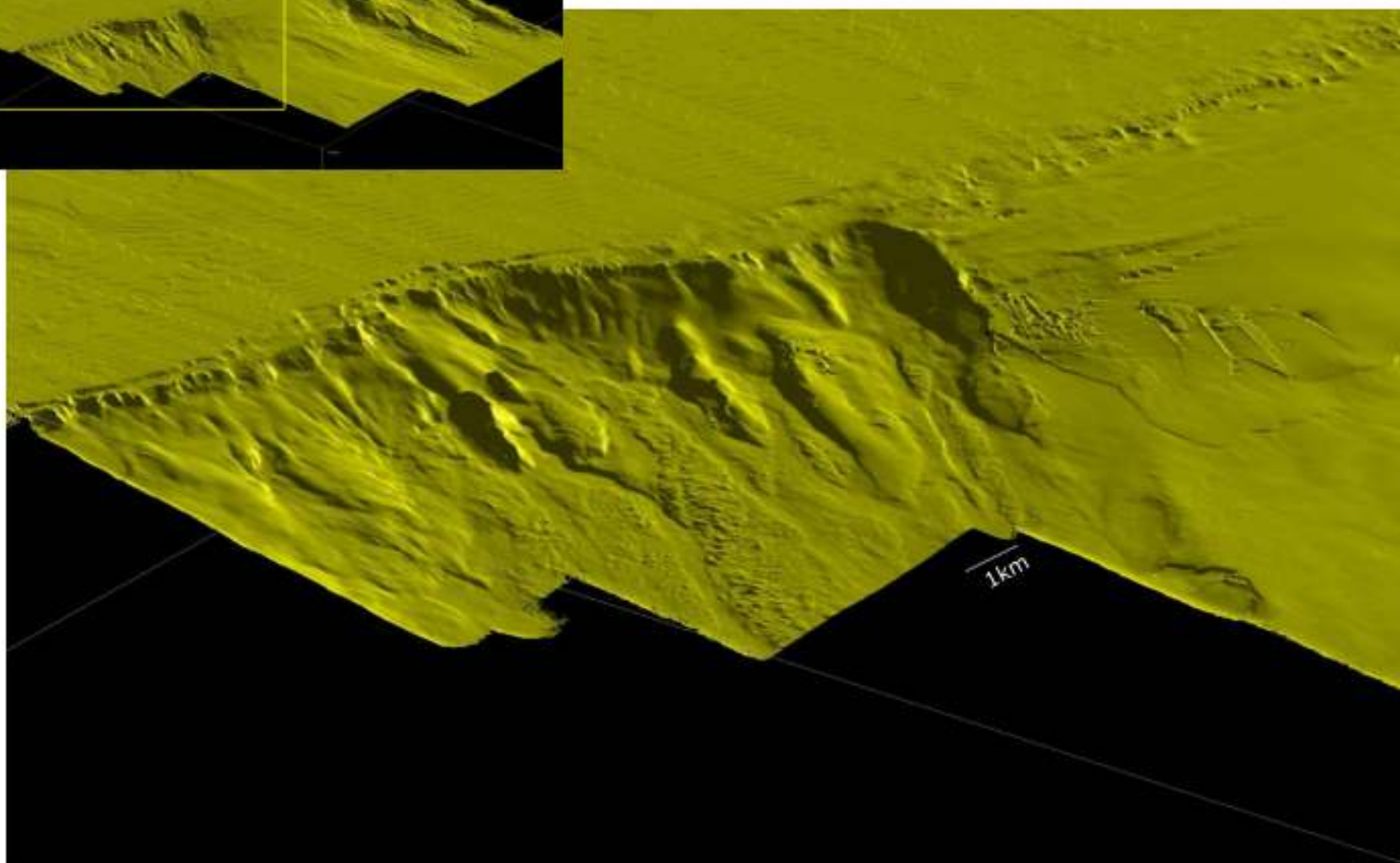
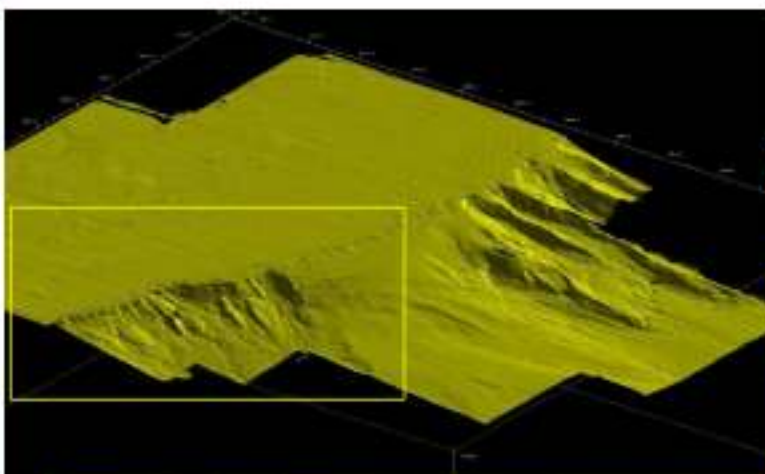
Mass Transport Ori



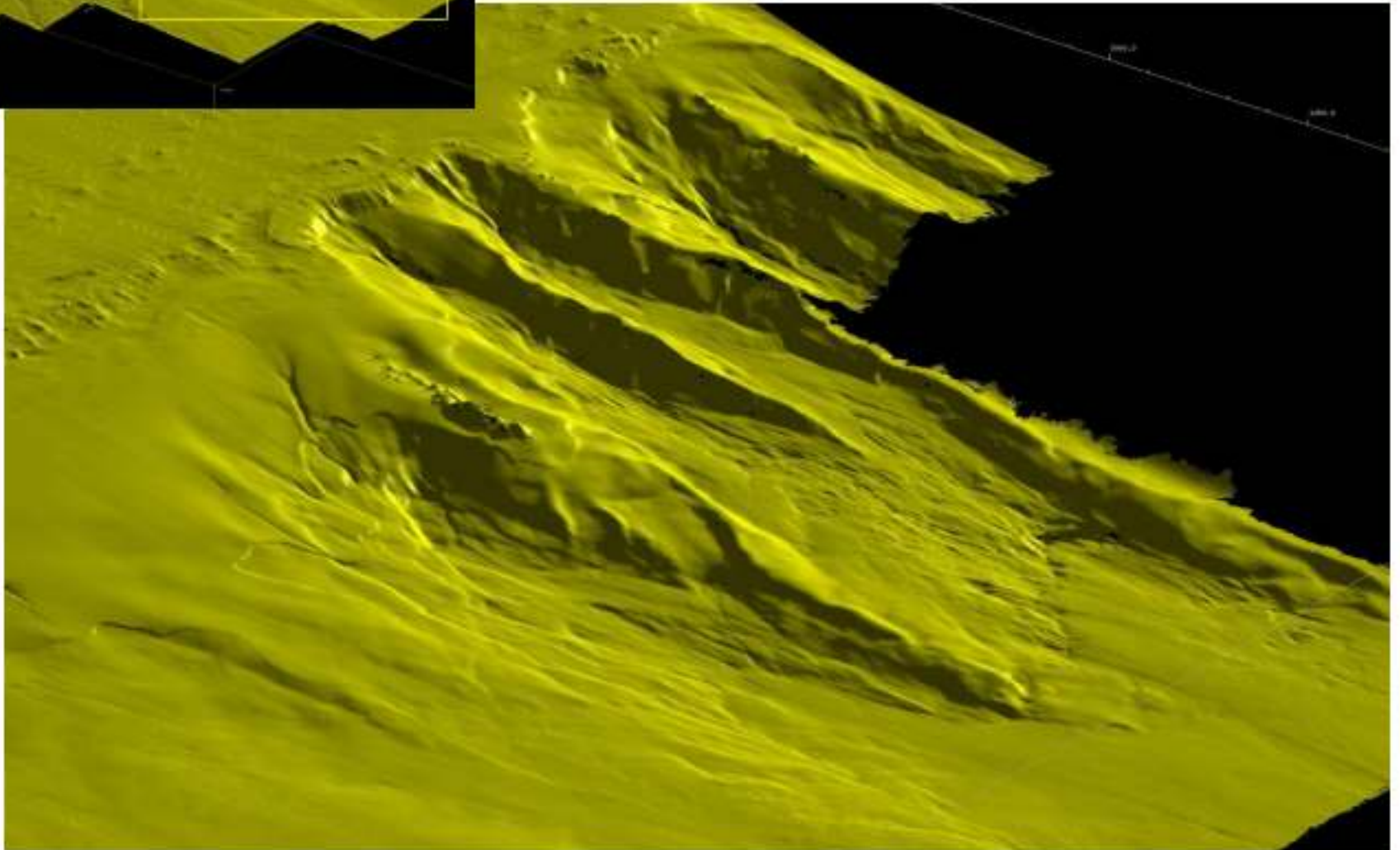
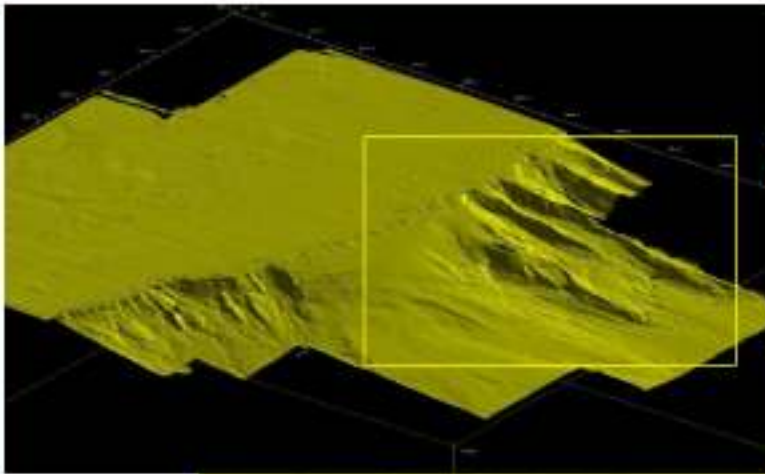
Mass Transport Originating at Upper Slope



Originating at Upper Slope



Originating at Upper Slope



MTD's can be large...

Shelf Edge

Slope Channel

Slump Scar

Basin Floor

Slump Scar

Scar Characteristics
 Relief: 45 m
 Width: ~16.4 km
 Length: ~52 km
 Area: 916 km²
 Volume: 41.2 km³

Slump Scar

Slope Channel

Basin Floor

Slump Scar

Scar Characteristics

Relief: 45 m

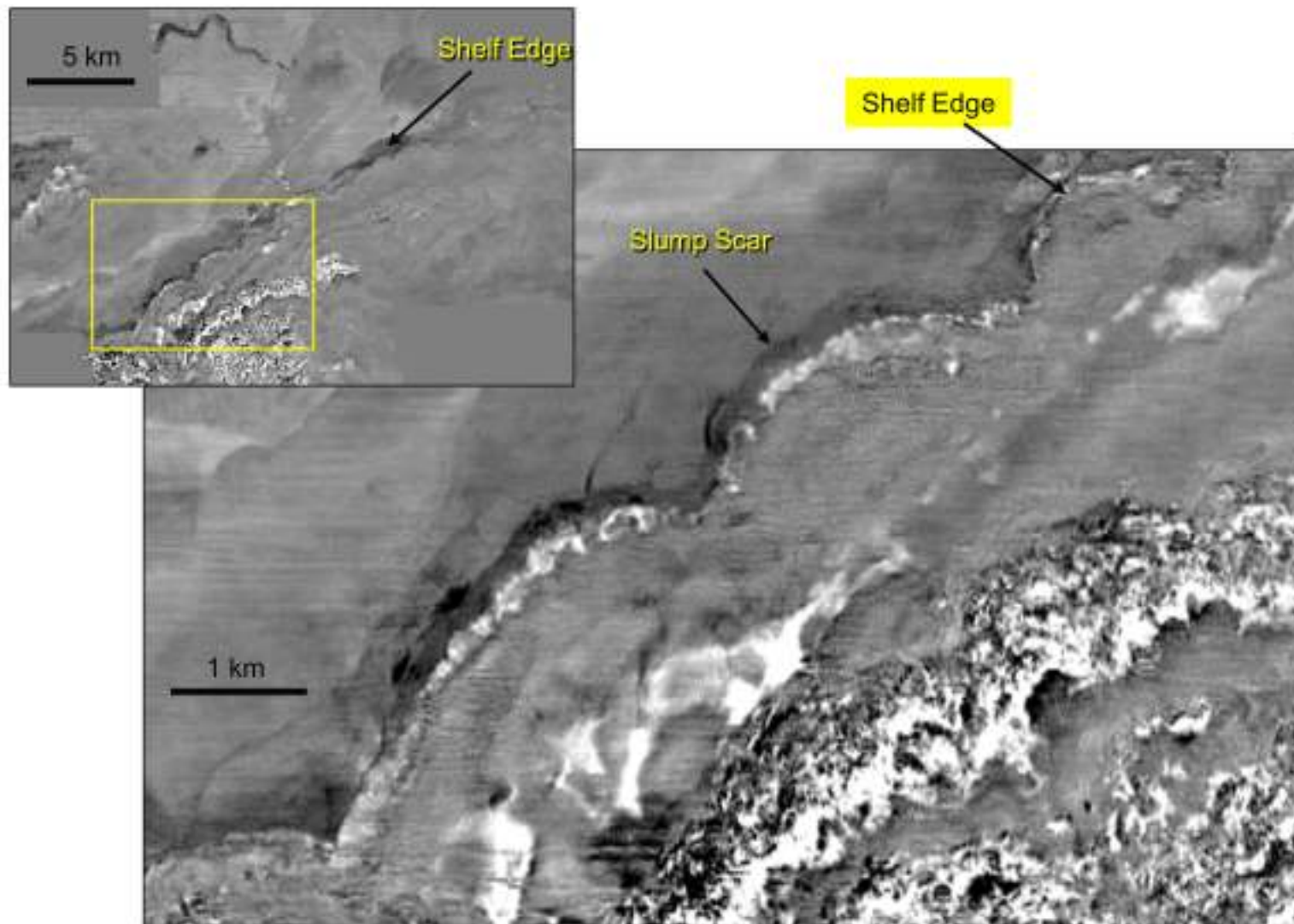
Width: ~16.4 km

Length: ~52 km

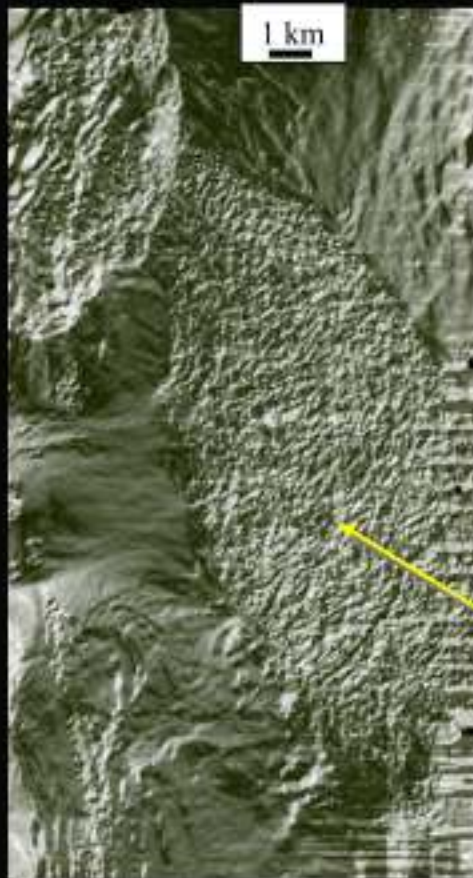
Area: 916 km²

Volume: 41.2 km³

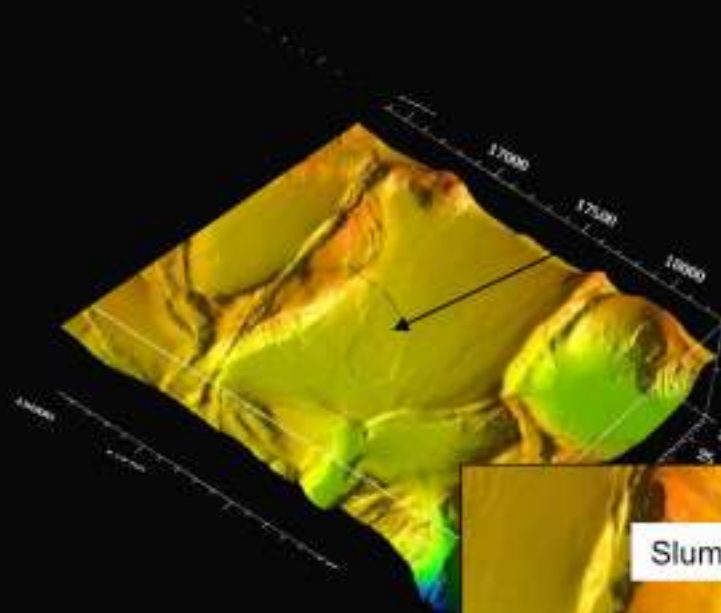
MTD's can be large...



...what do MTD's look like?



Mud volcano



Salt mini- basin

Mass transport deposit

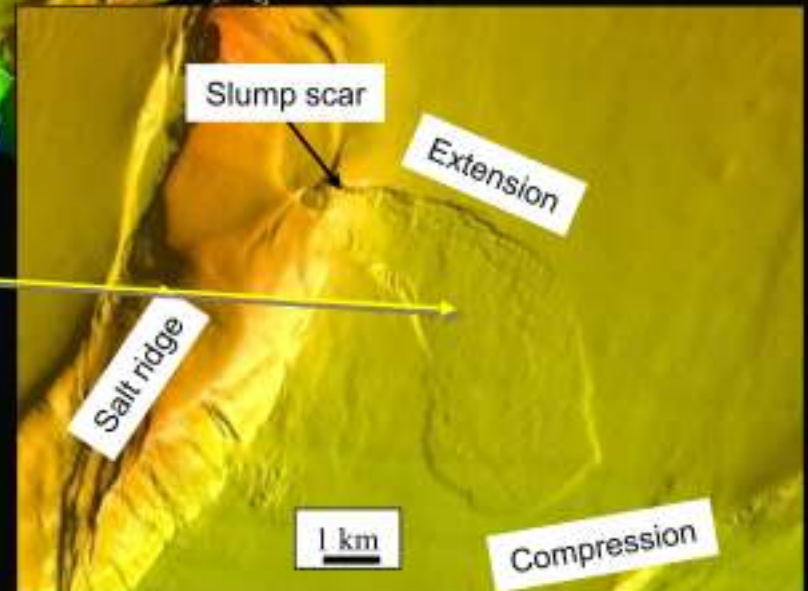


Image courtesy of JD Stephenson

MTD's can be small...



Channel-Levee Overbank

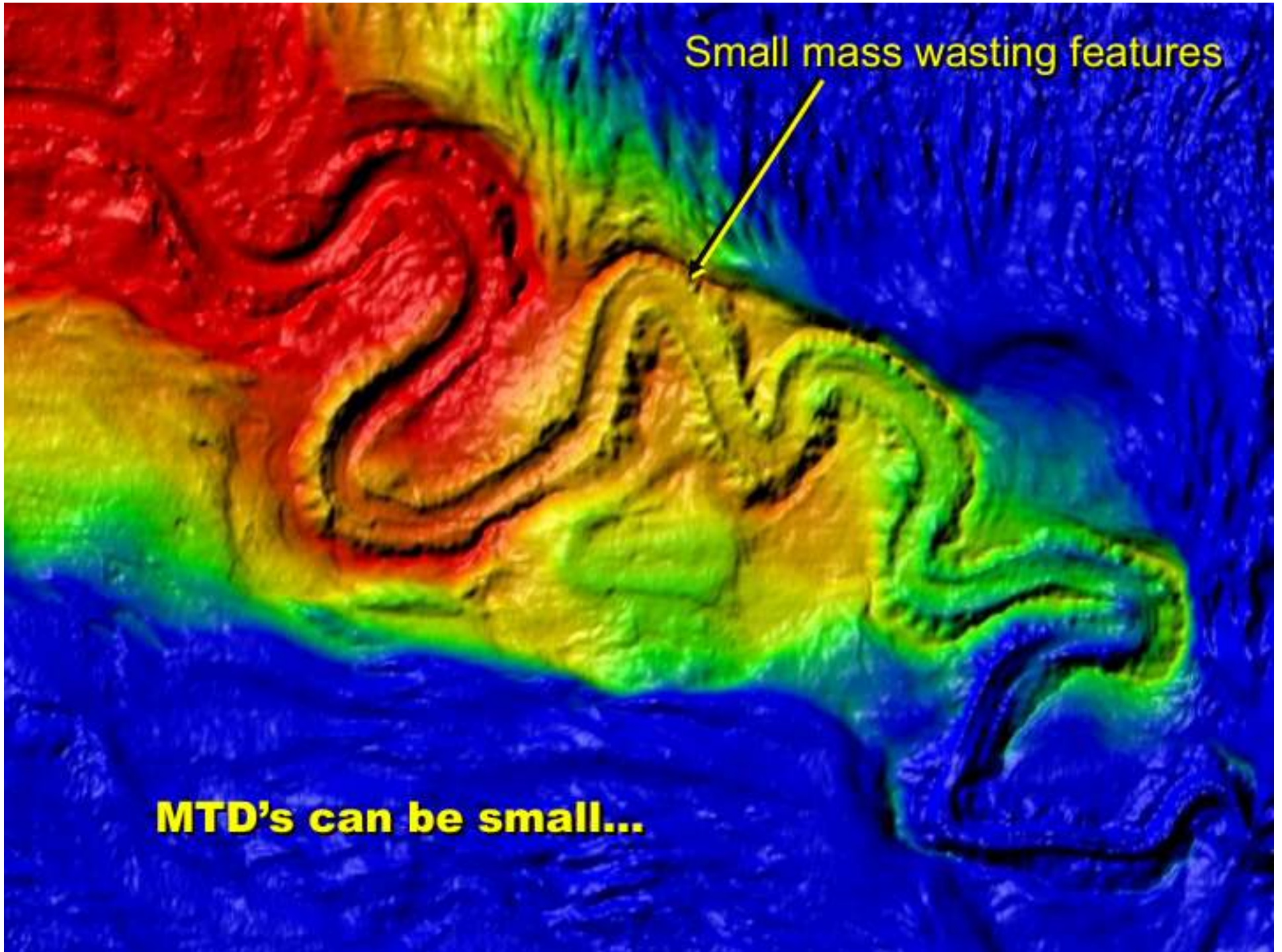
Slump Scar

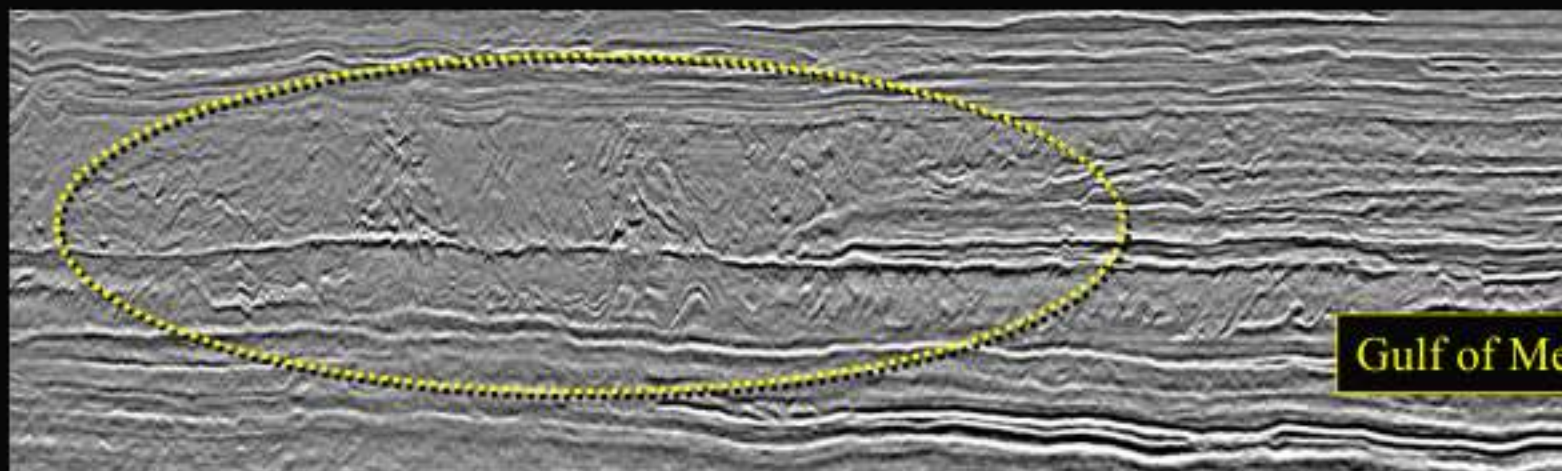
one km

Data proprietary to
WesternGeac

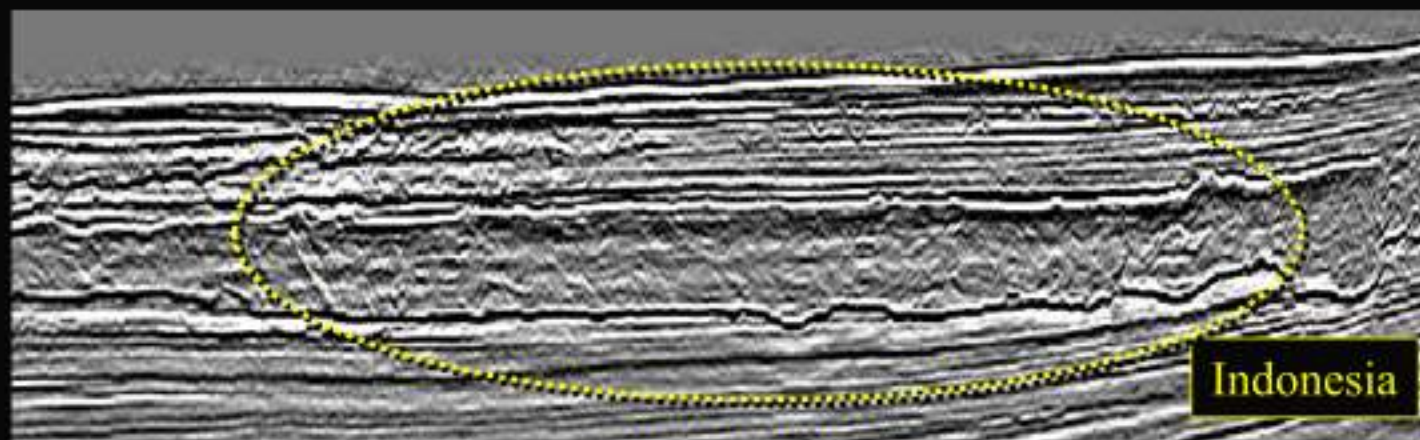
Small mass wasting features

MTD's can be small...

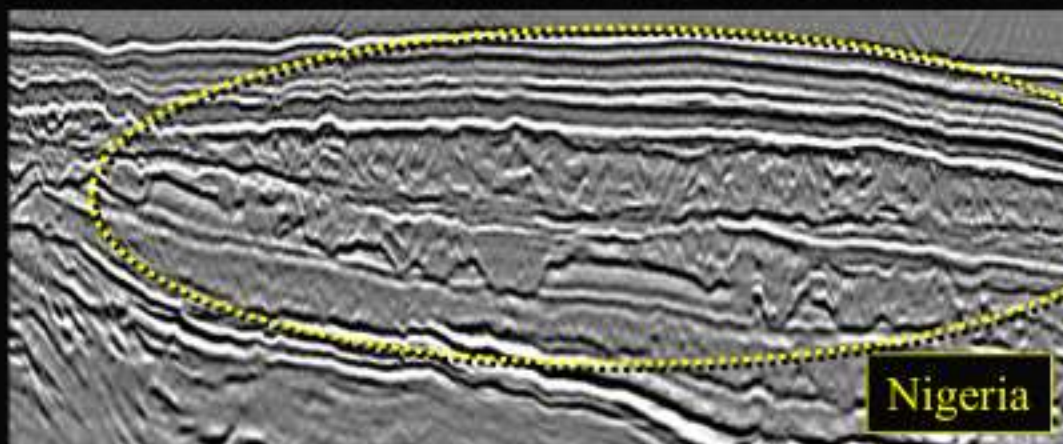




Gulf of Mexico



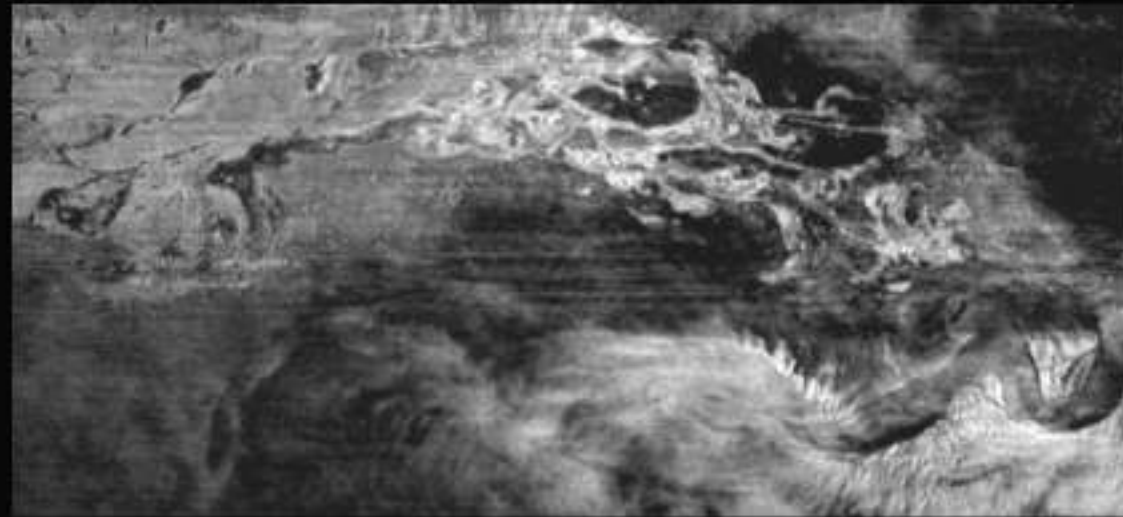
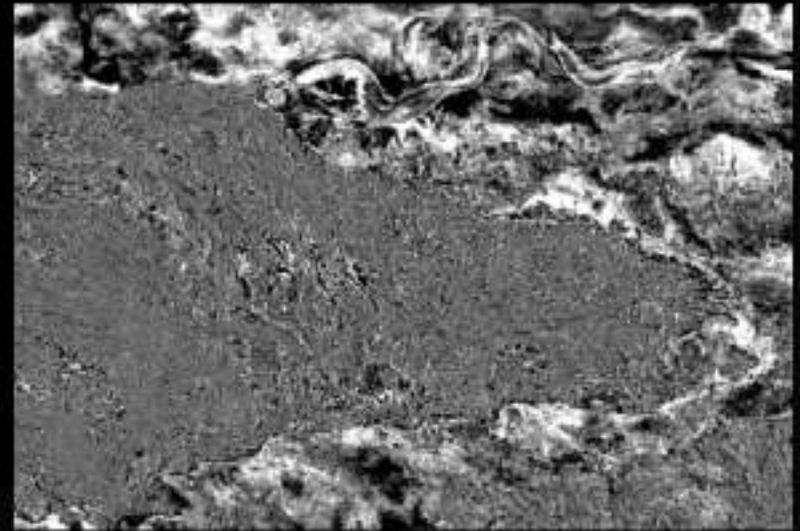
Indonesia



Nigeria

- *Contorted-chaotic to transparent*

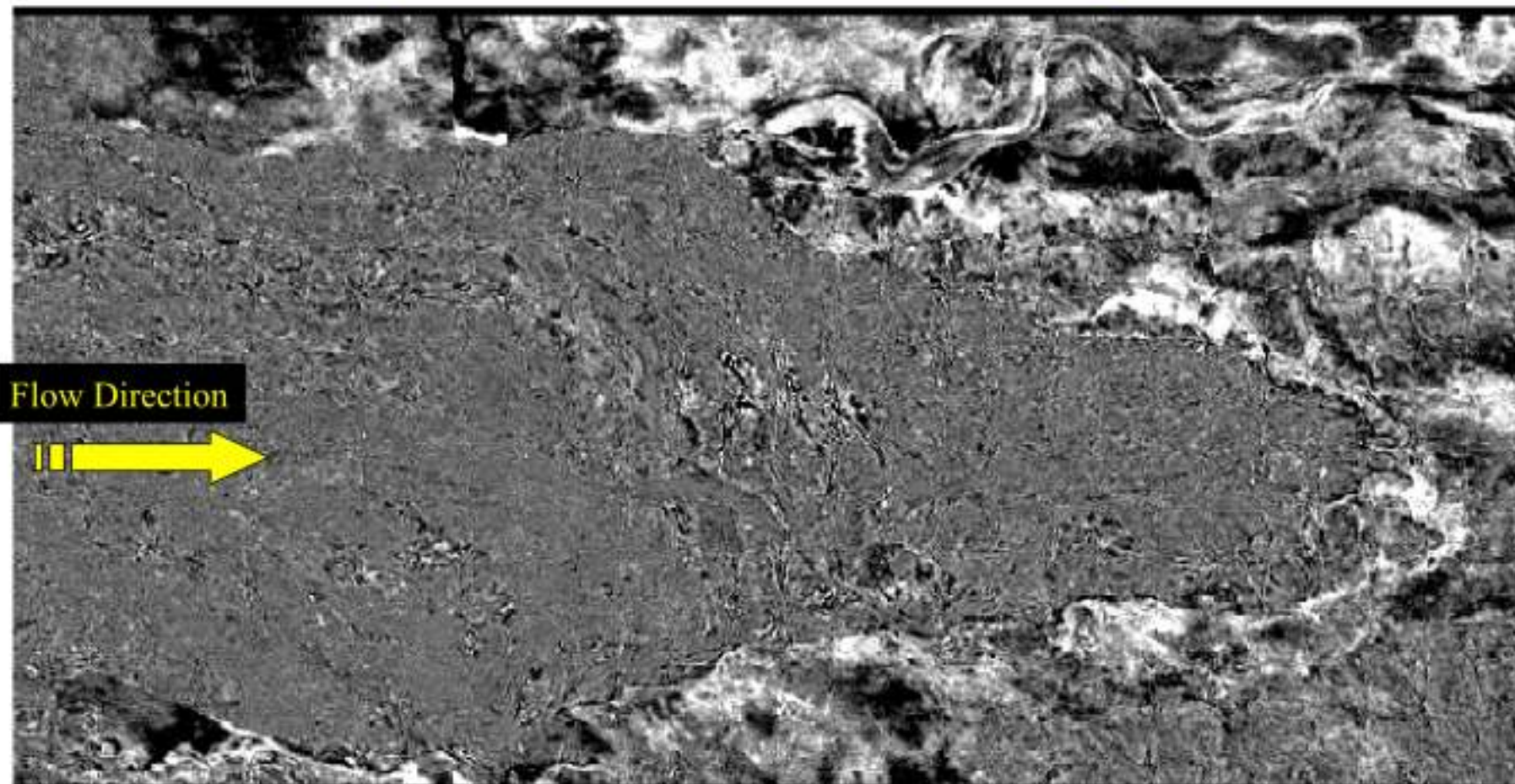
**Seismic Facies
(section view)**



Seismic Facies (map view)

- *Contorted-chaotic to convolute*

Debris Flow Deposit Gulf of Mexico



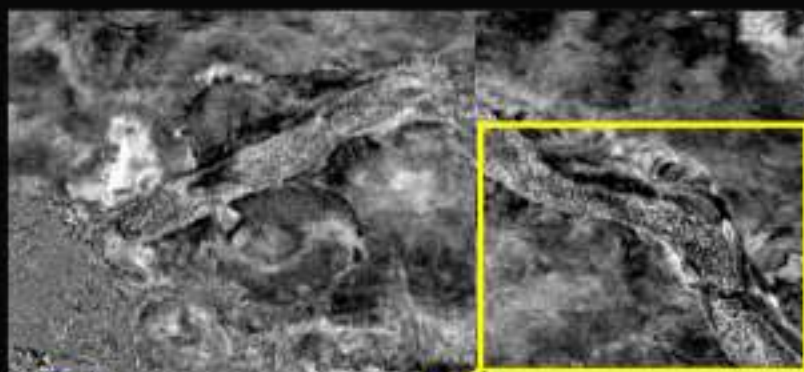
Flow Direction



five km



Horizon Slice



one km

"Opportunistic" MTD
Fill of Unfilled
Turbidite Channel

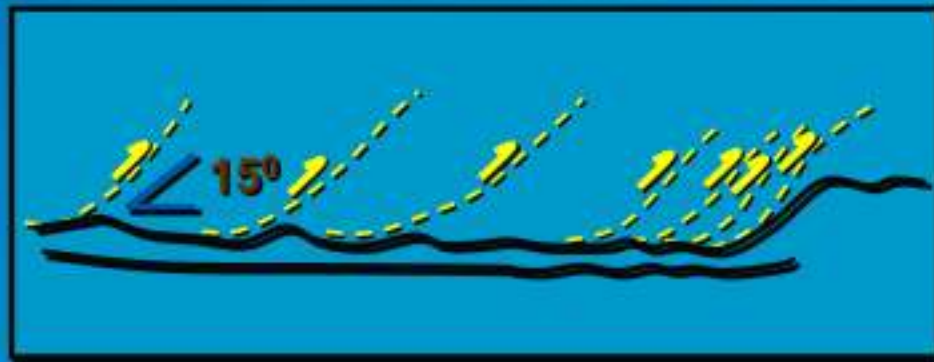
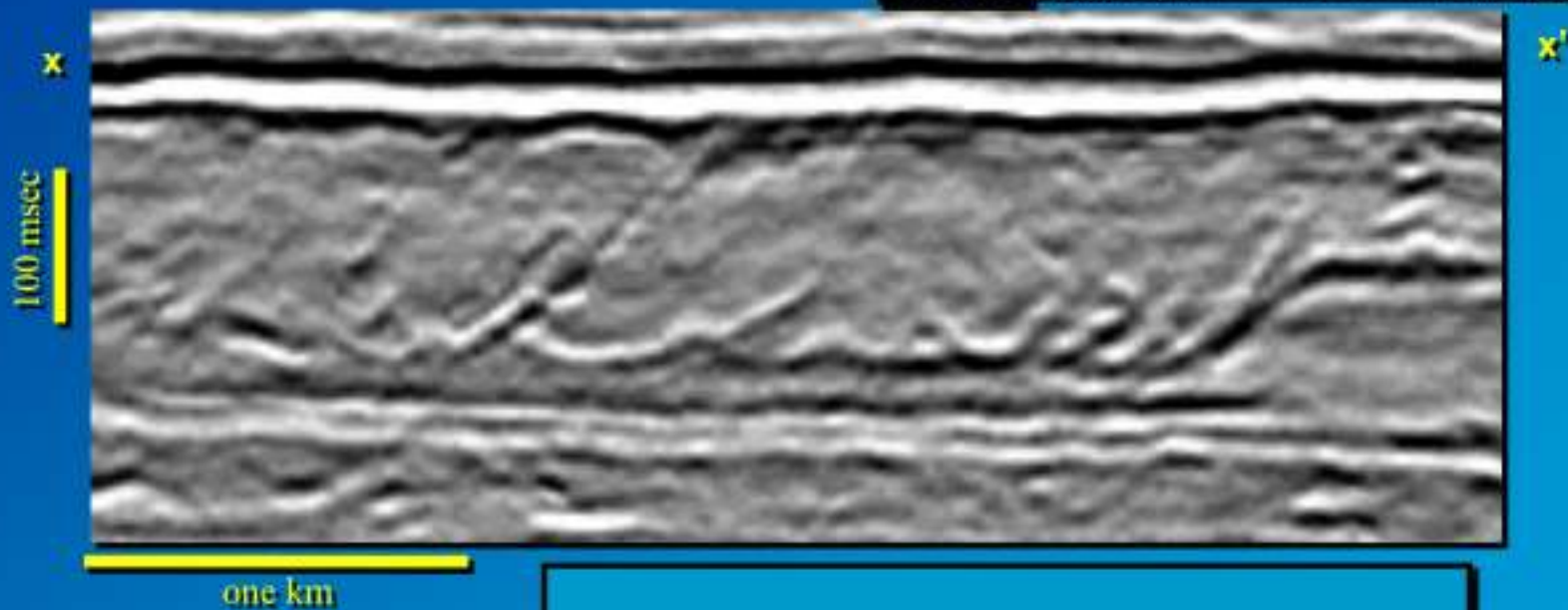
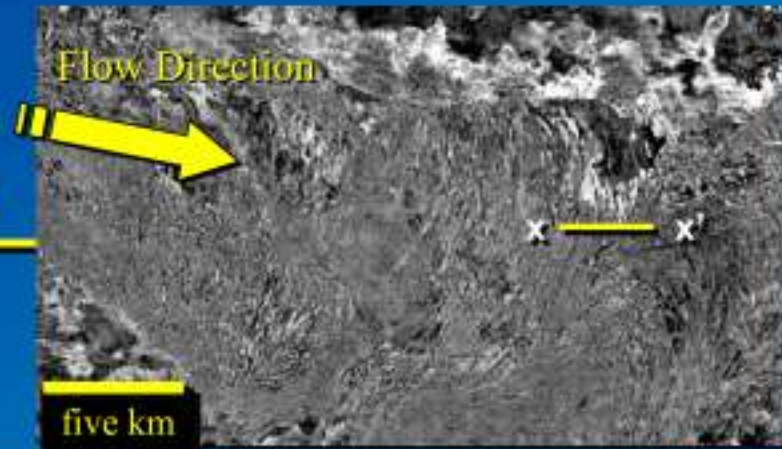


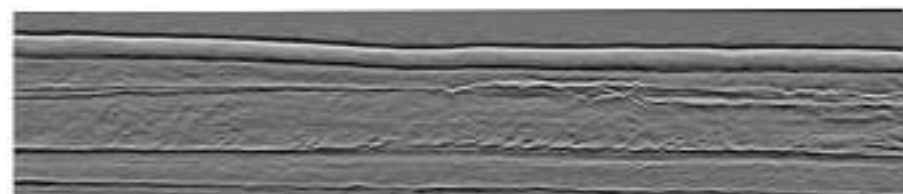
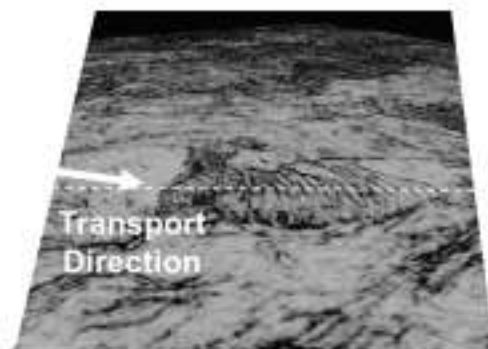
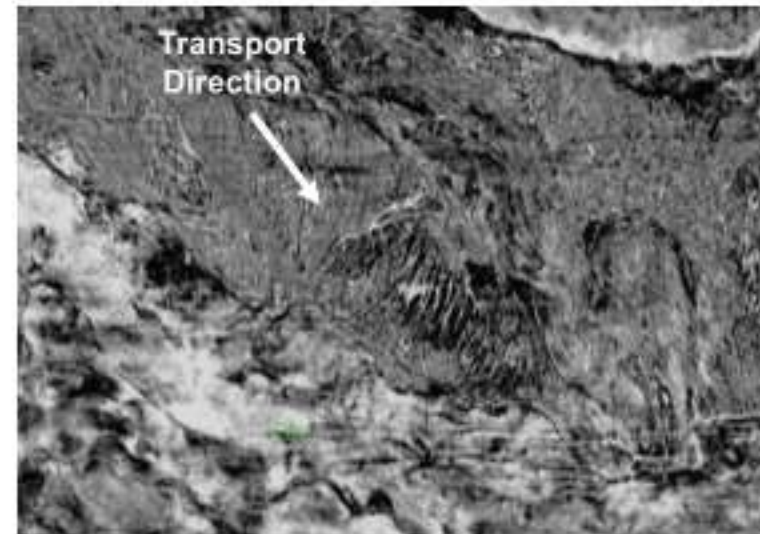
one km

Compressional Architecture

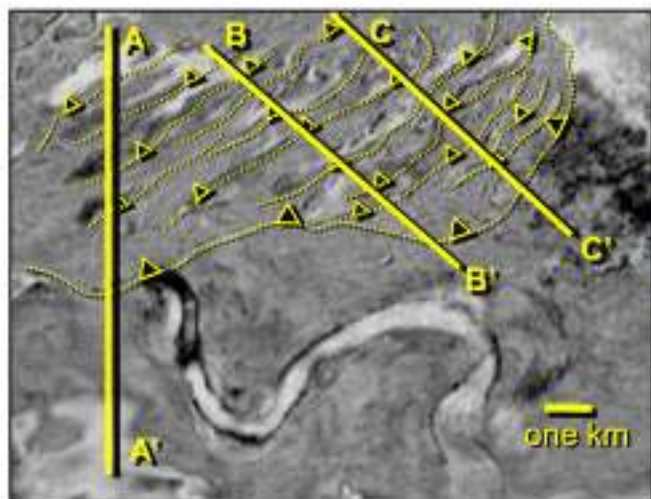


Thrust Faults within Mass Transport Complex

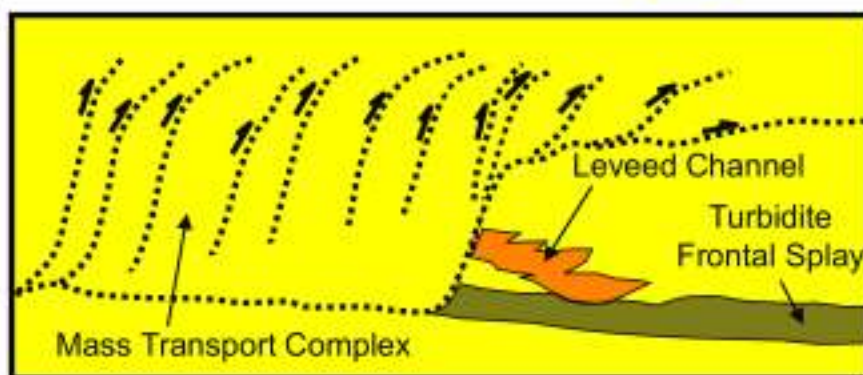
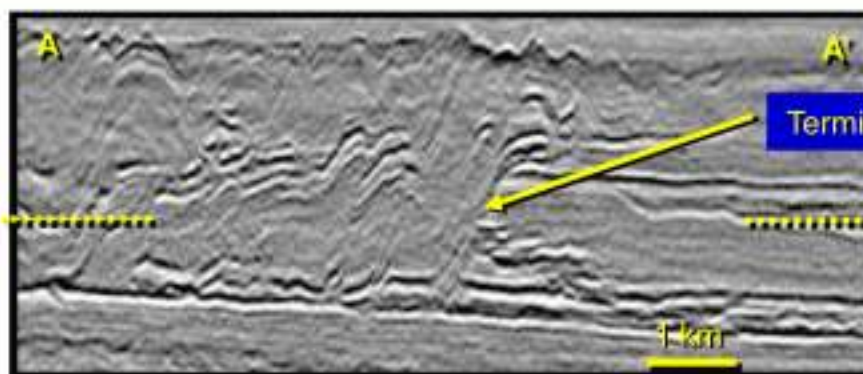




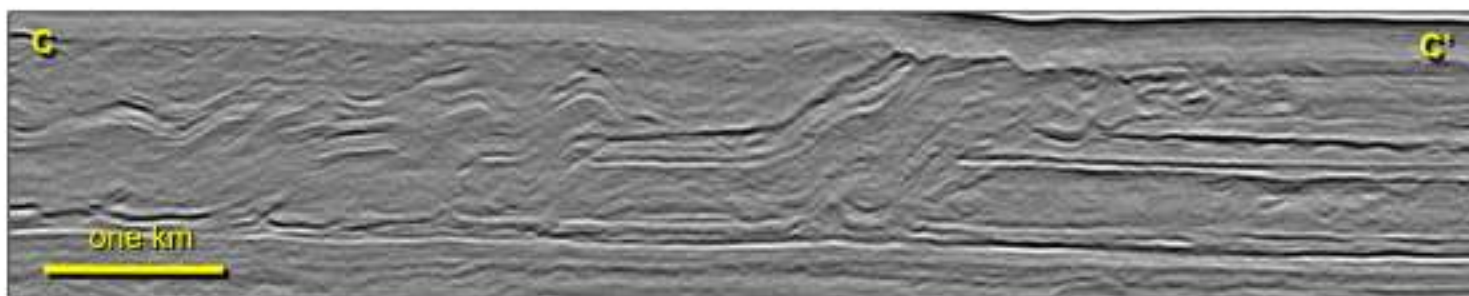
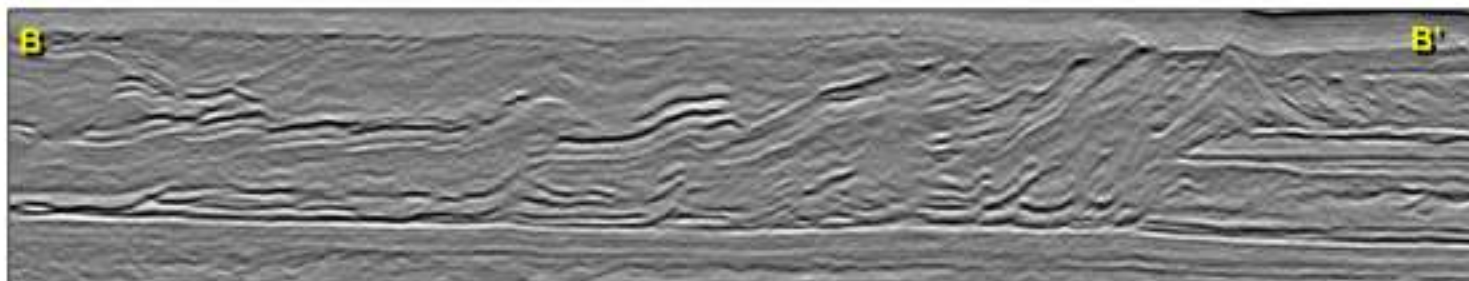
A)



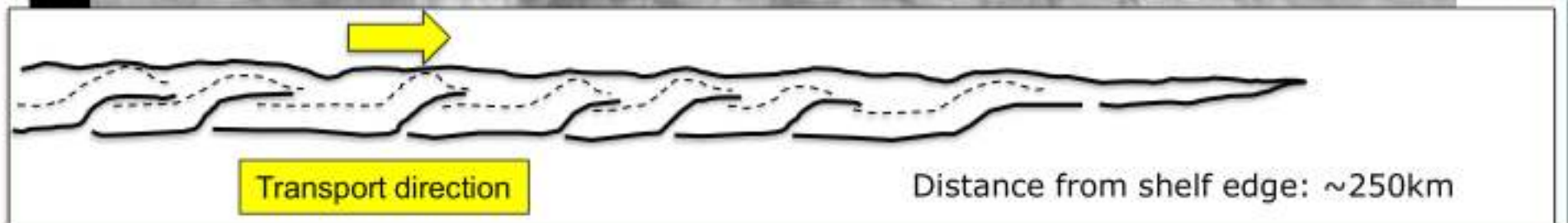
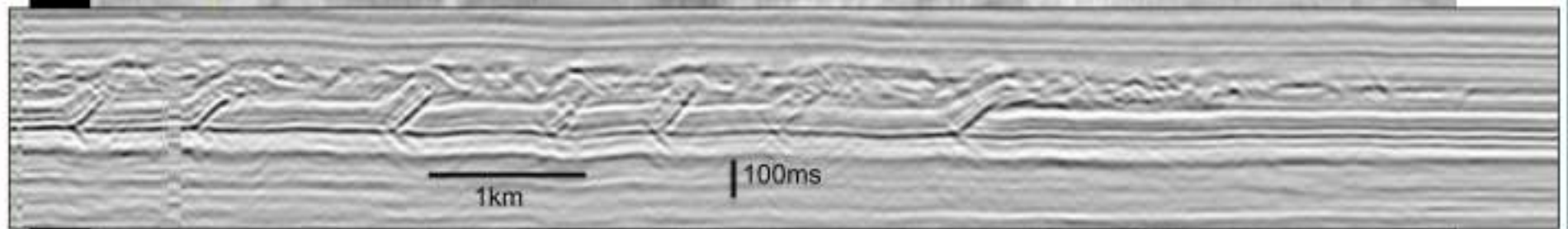
Slice Level

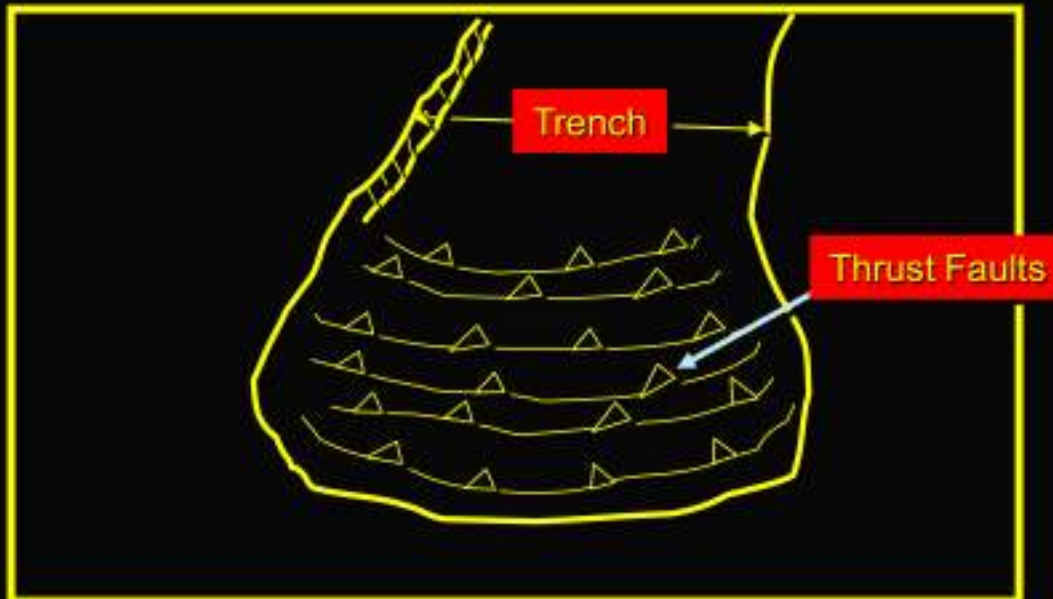


100 m

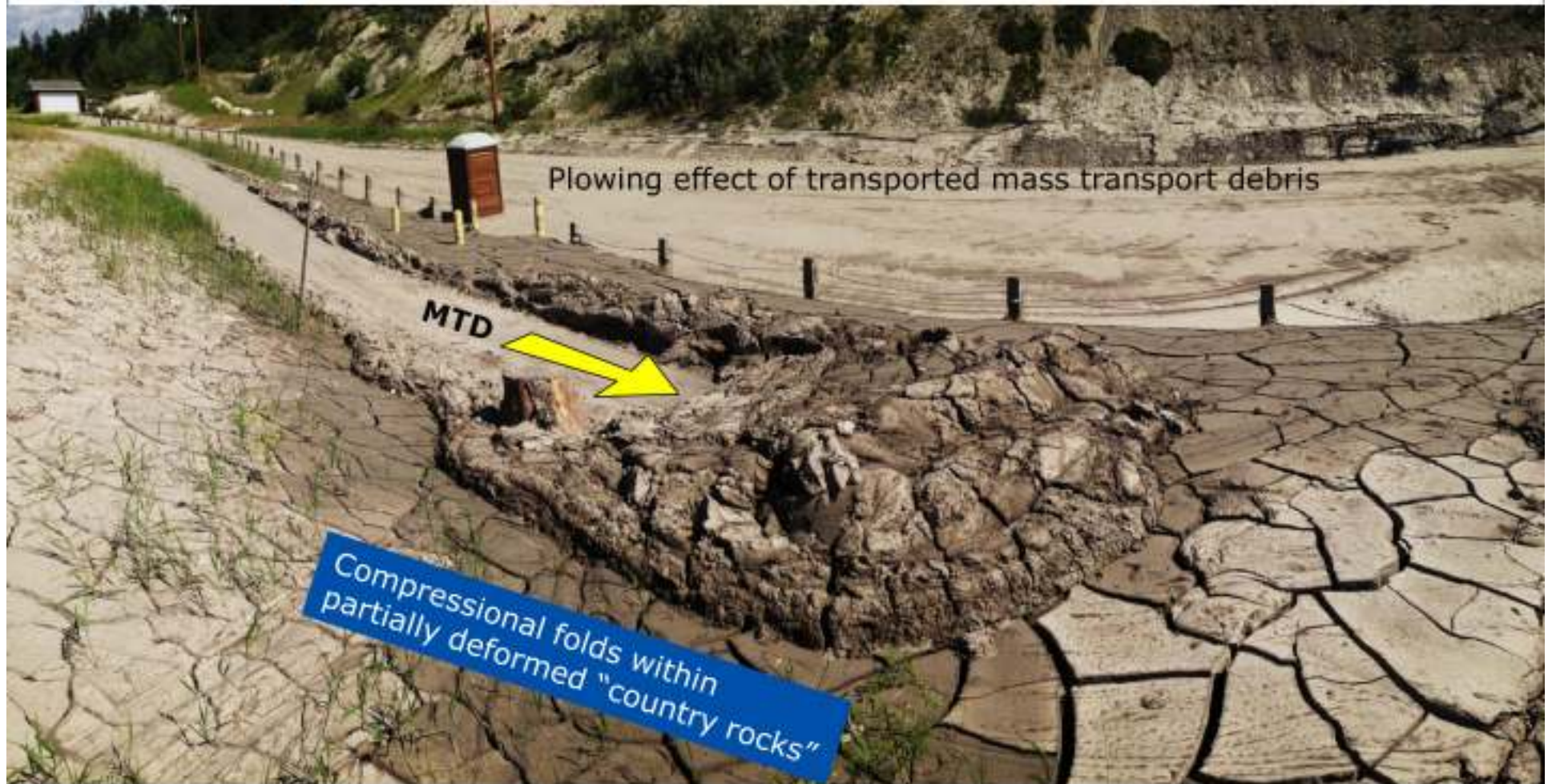


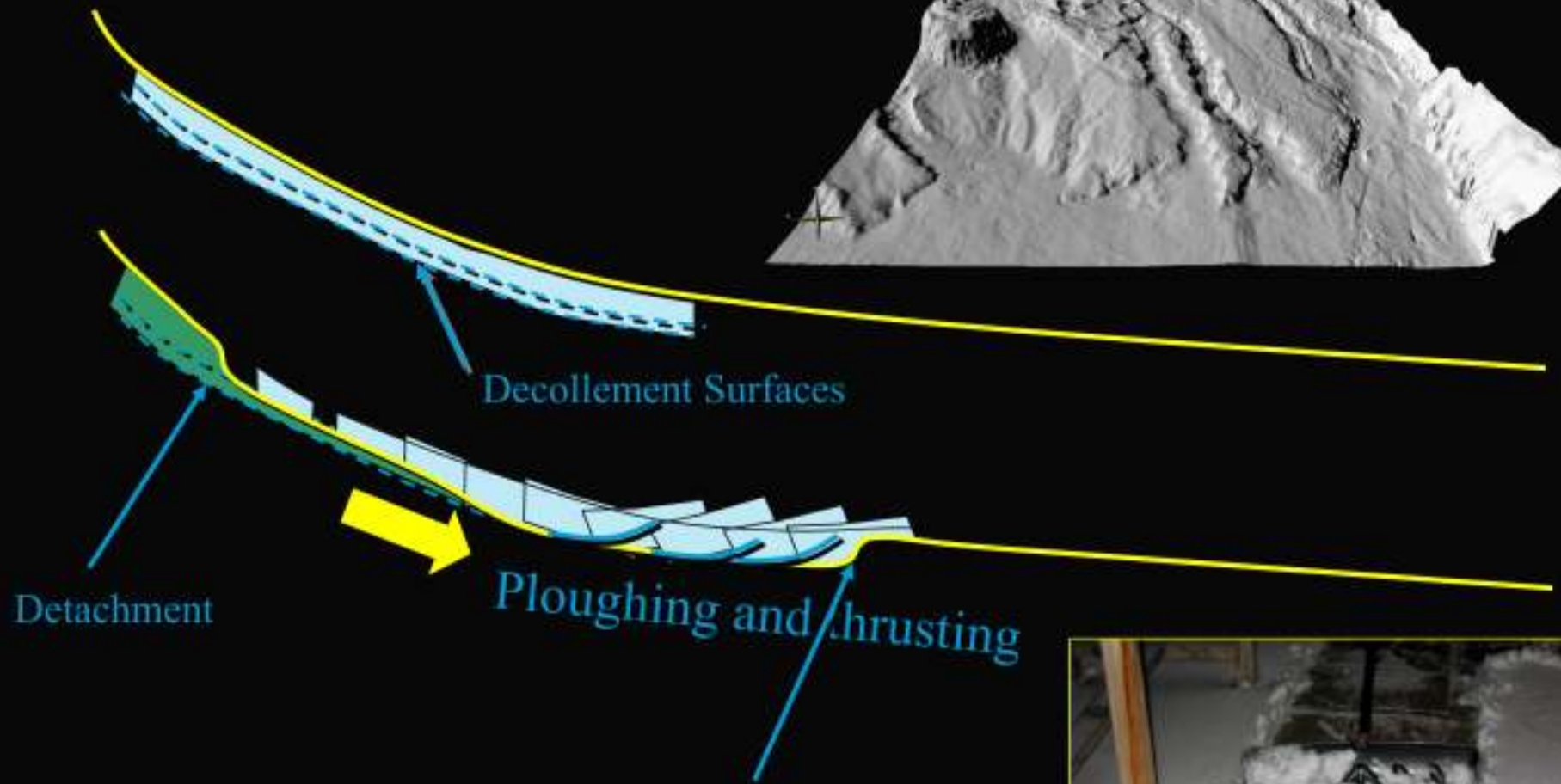
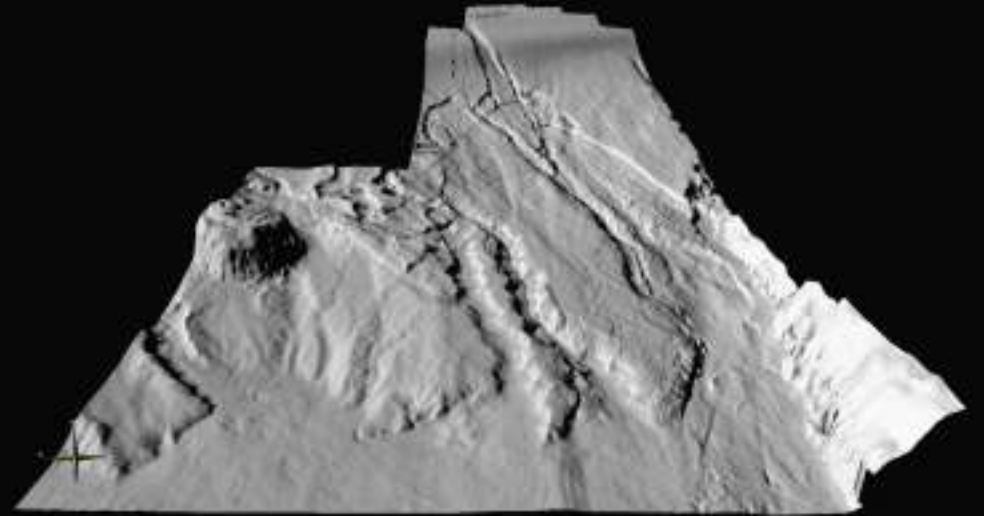
Mass Transport Deposit Derived from the NNW



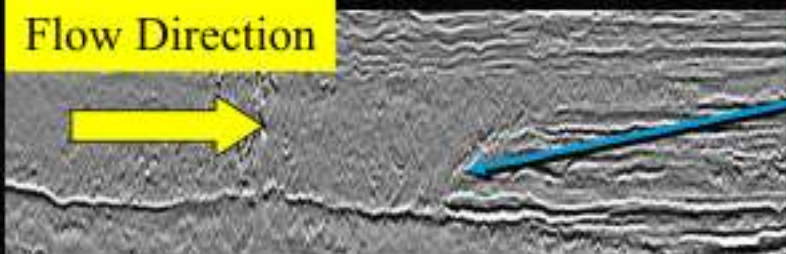


Plowing effect of transported mass transport debris





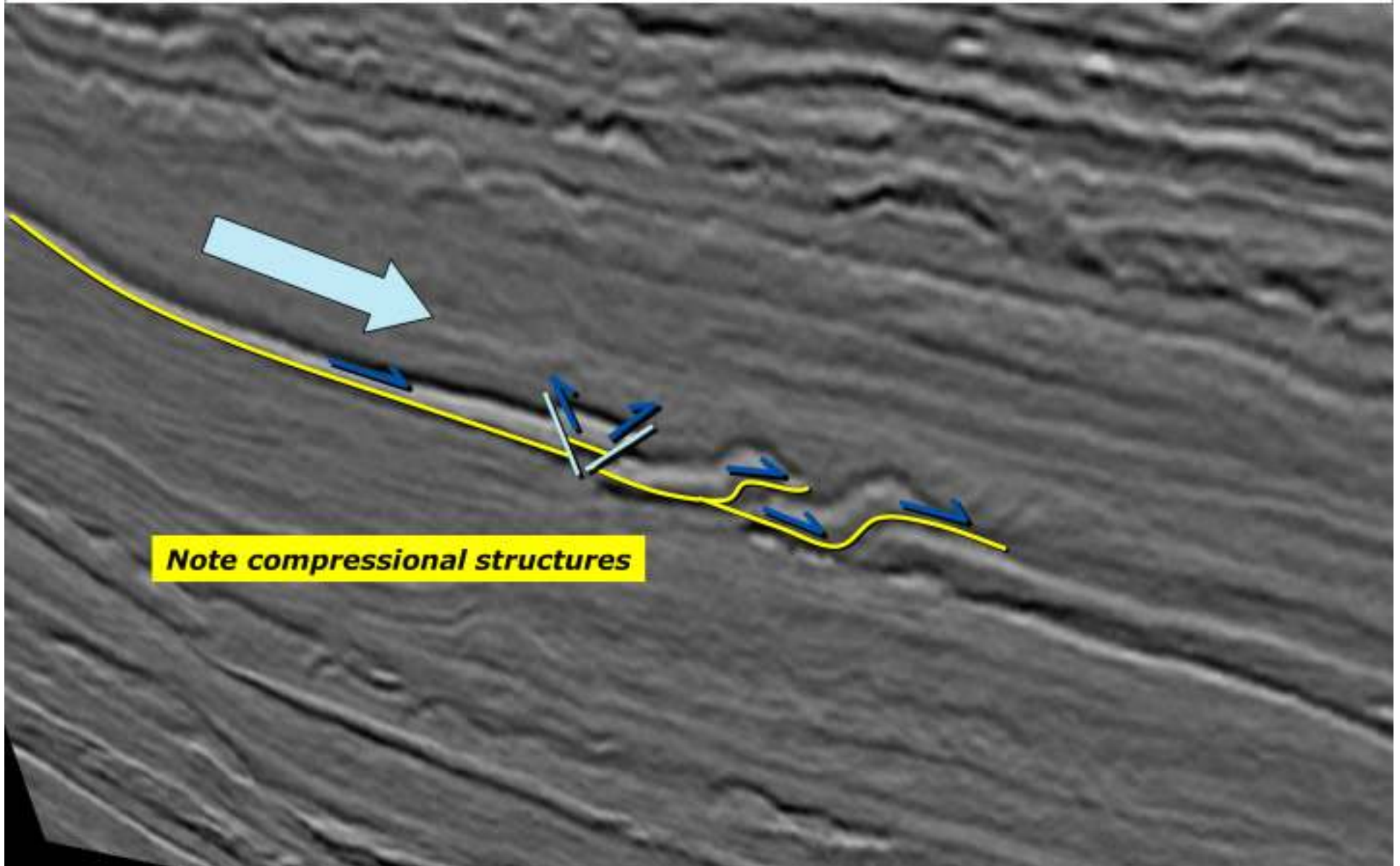
Flow Direction



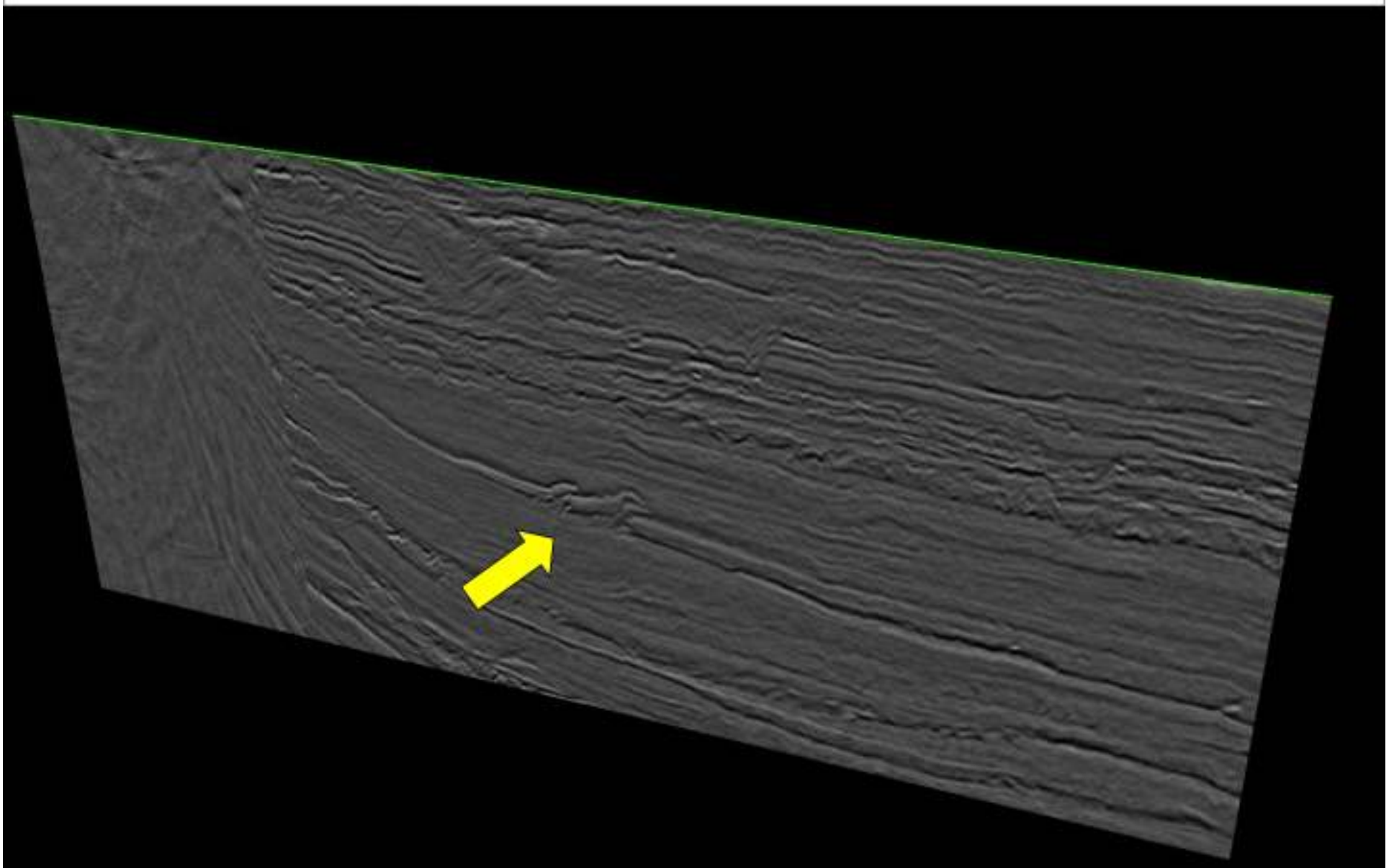
Terminal Wall



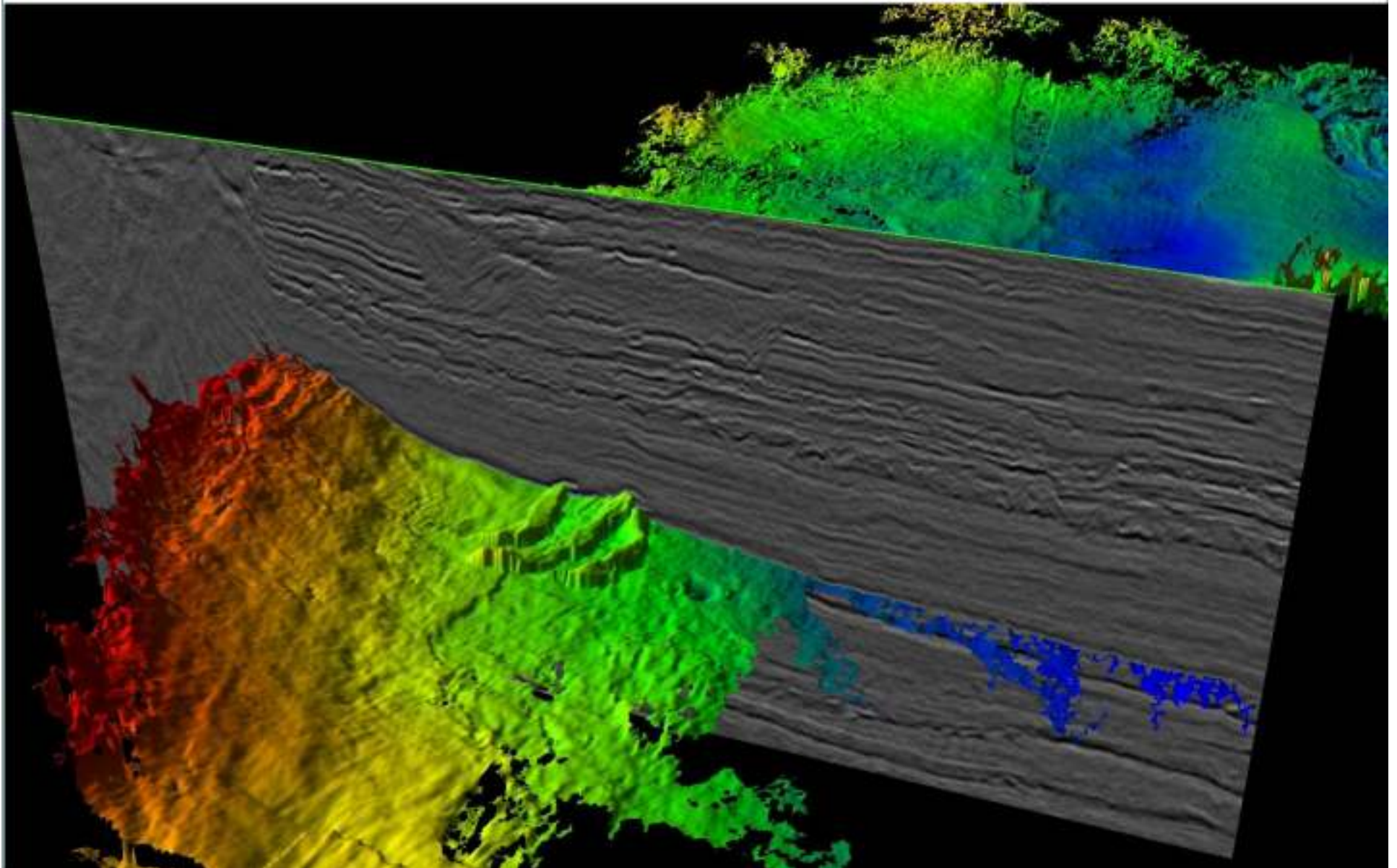
Short-Distance Mass Transport – Slide



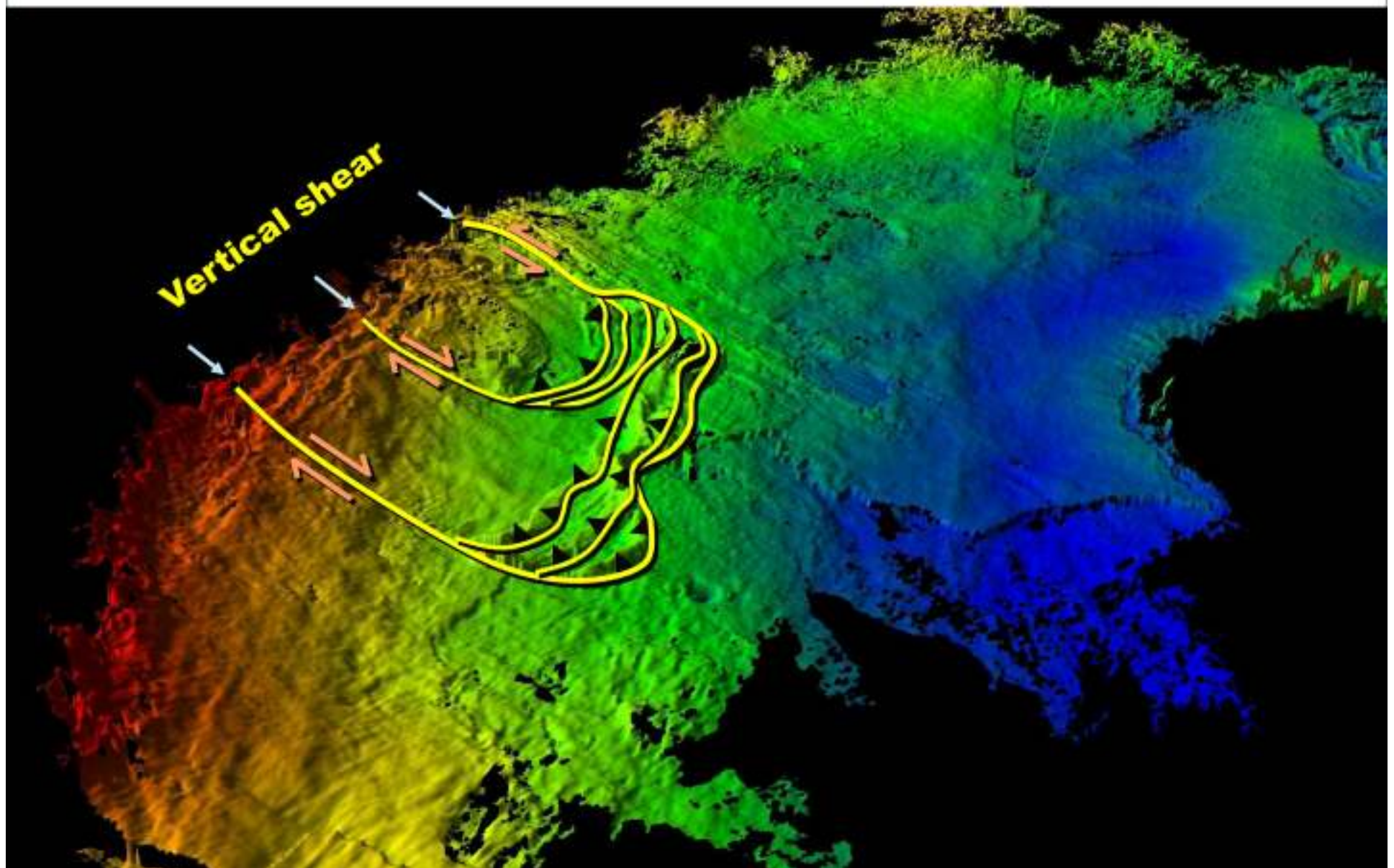
Short-Distance Mass Transport – Slide



Short-Distance Mass Transport – Slide



Short-Distance Mass Transport – Slide



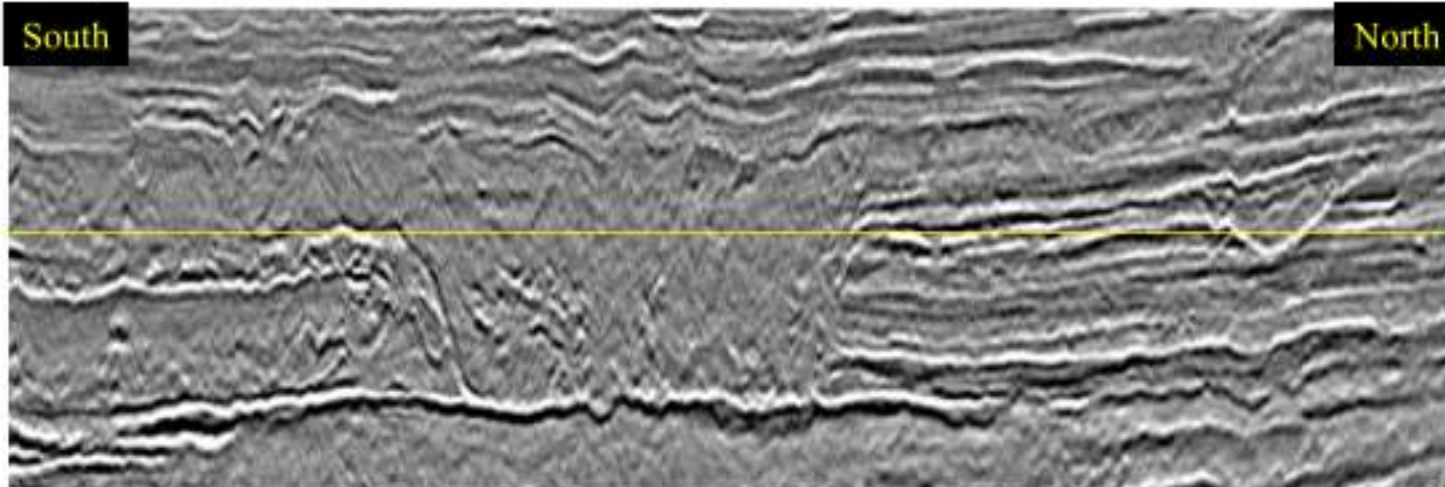
MTD Lobe/Channel

five km

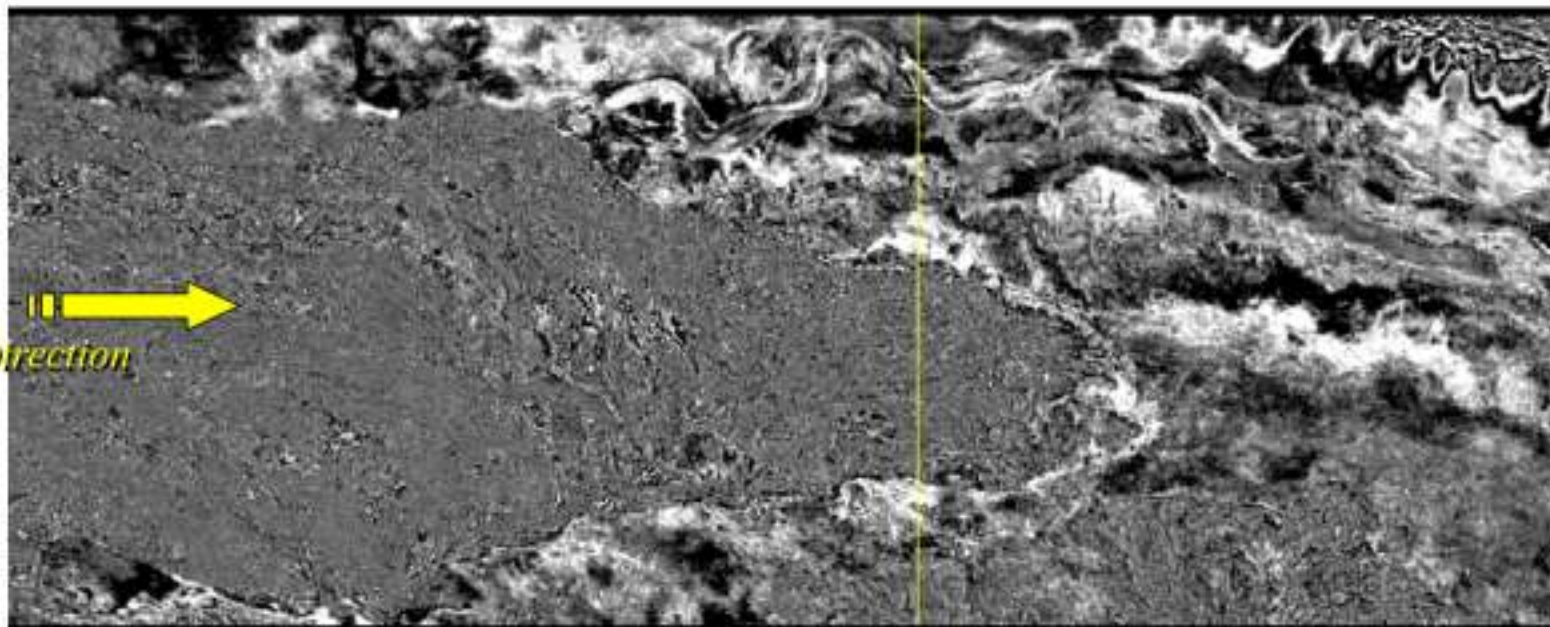
South

North

100 msec



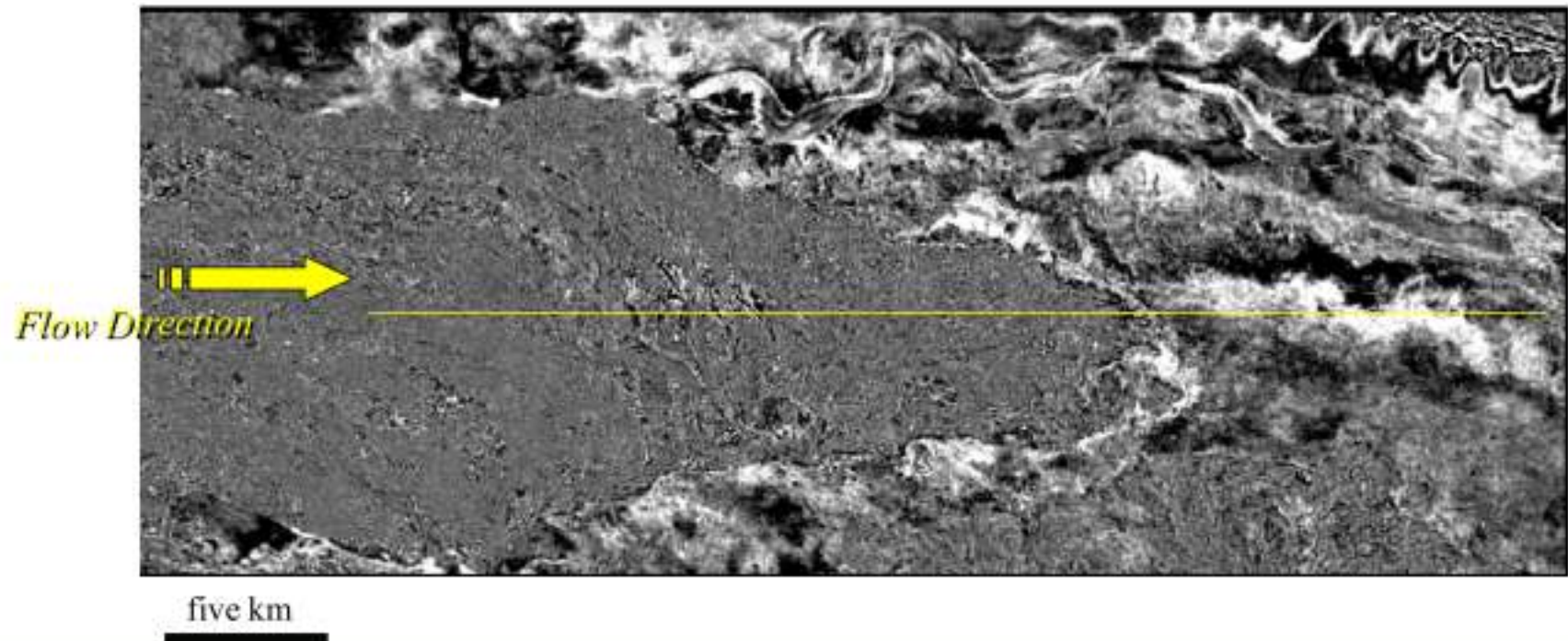
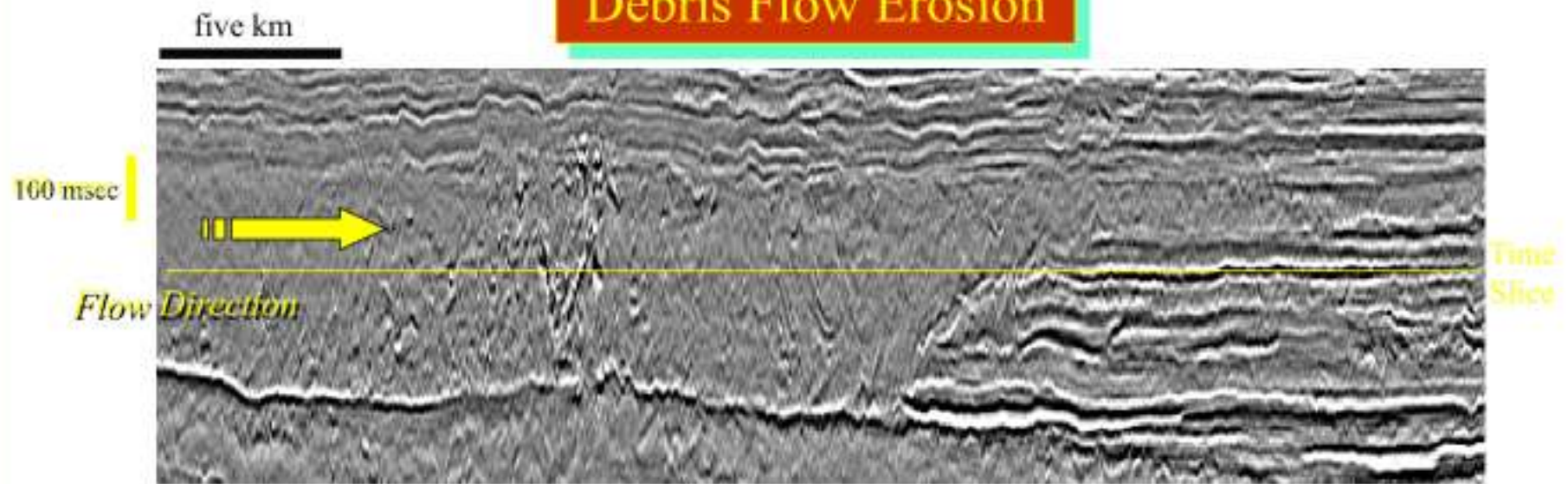
Time
Slice



Flow Direction

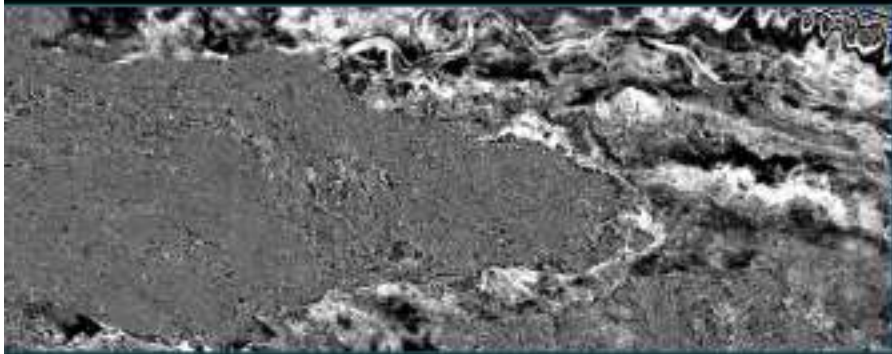
five km

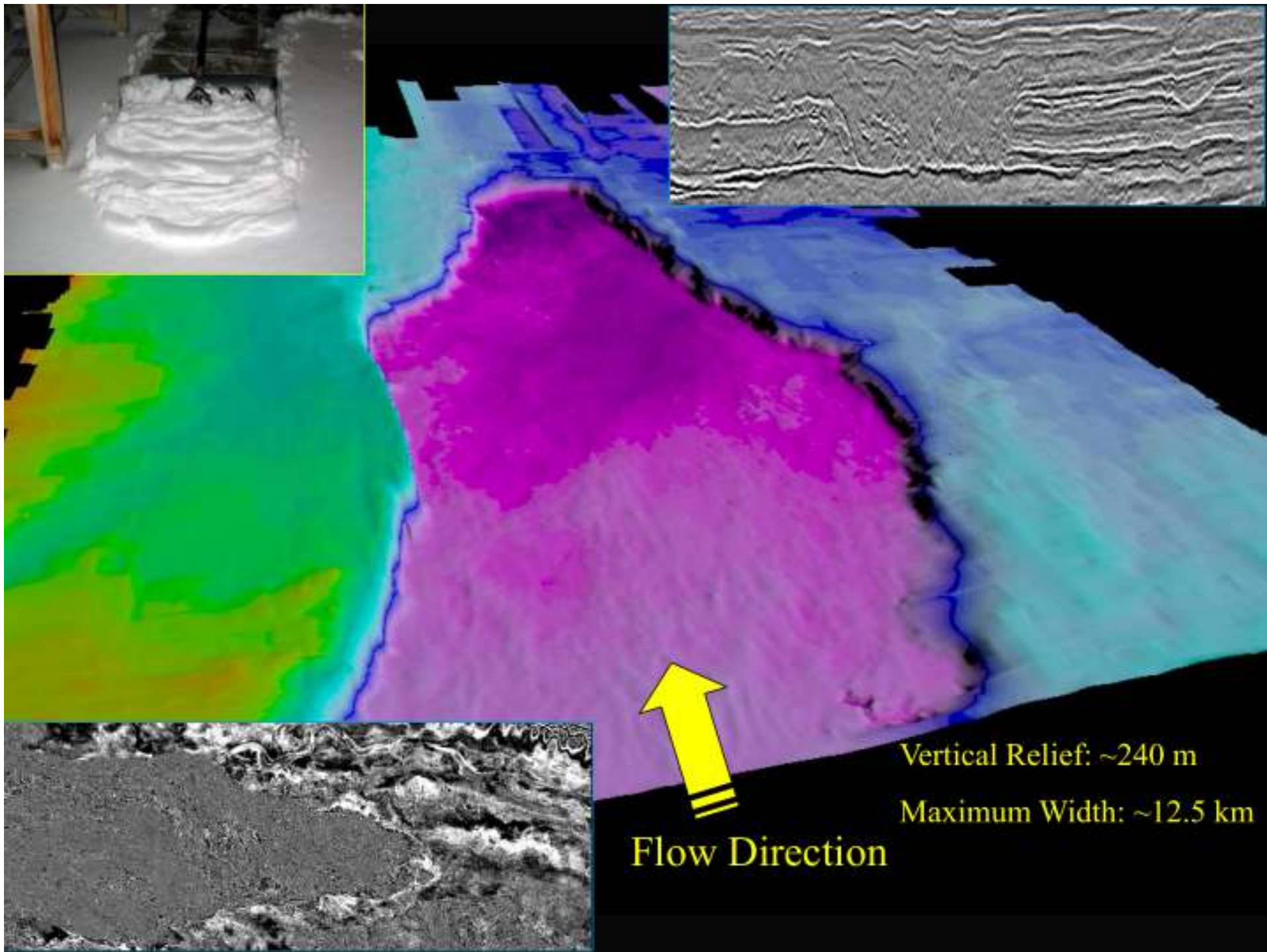
Debris Flow Erosion

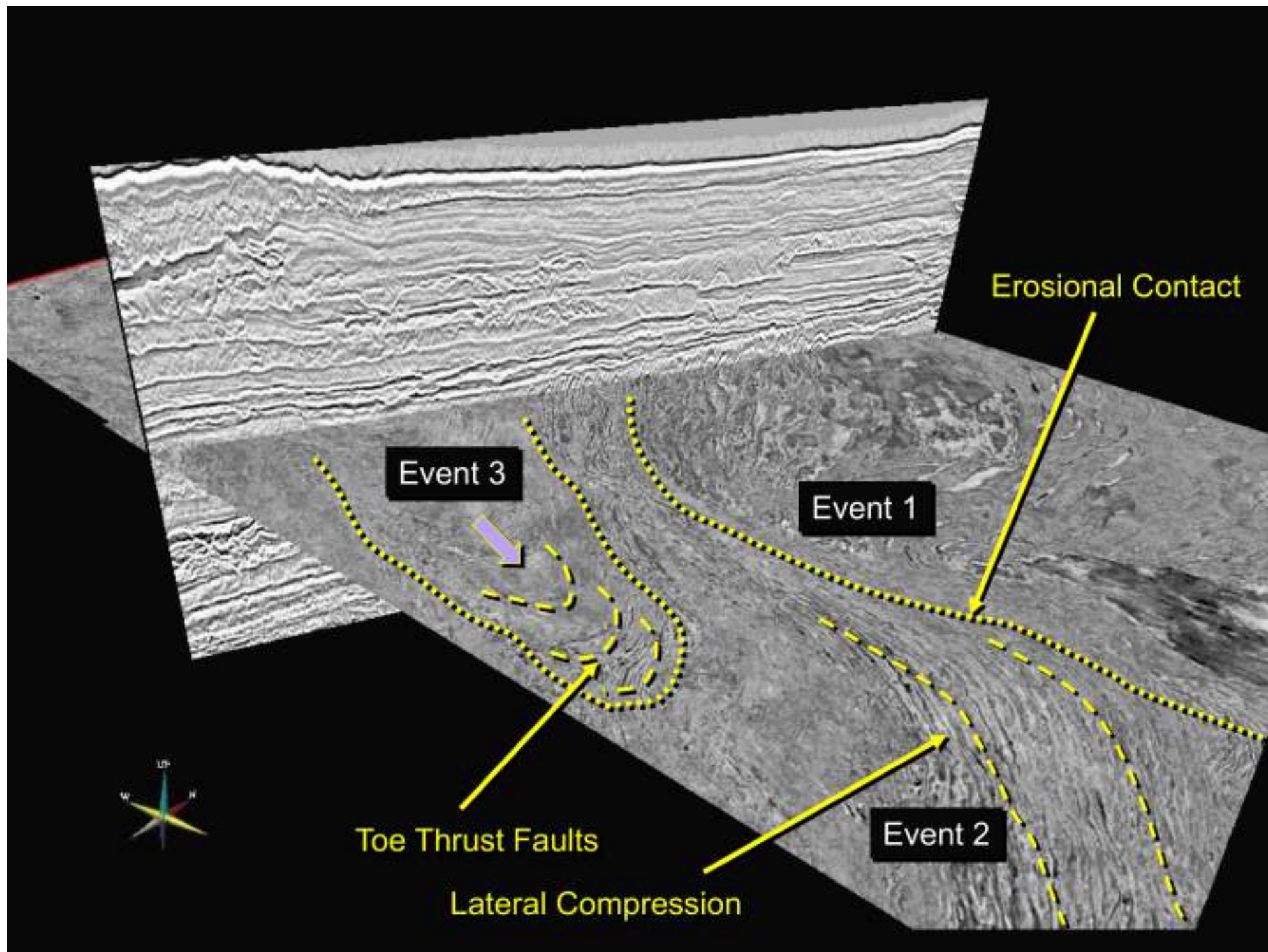


Flow Direction

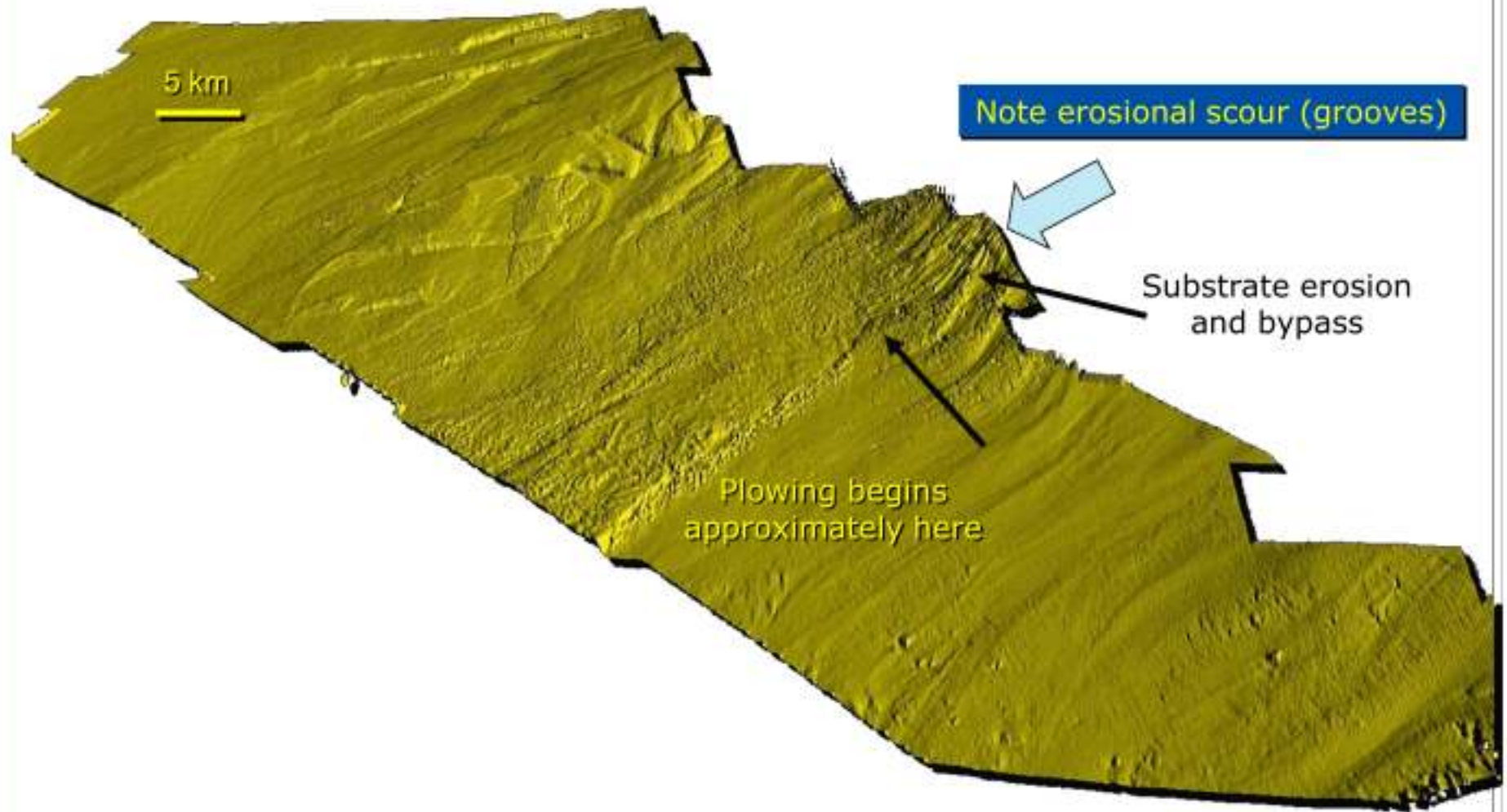
30 km



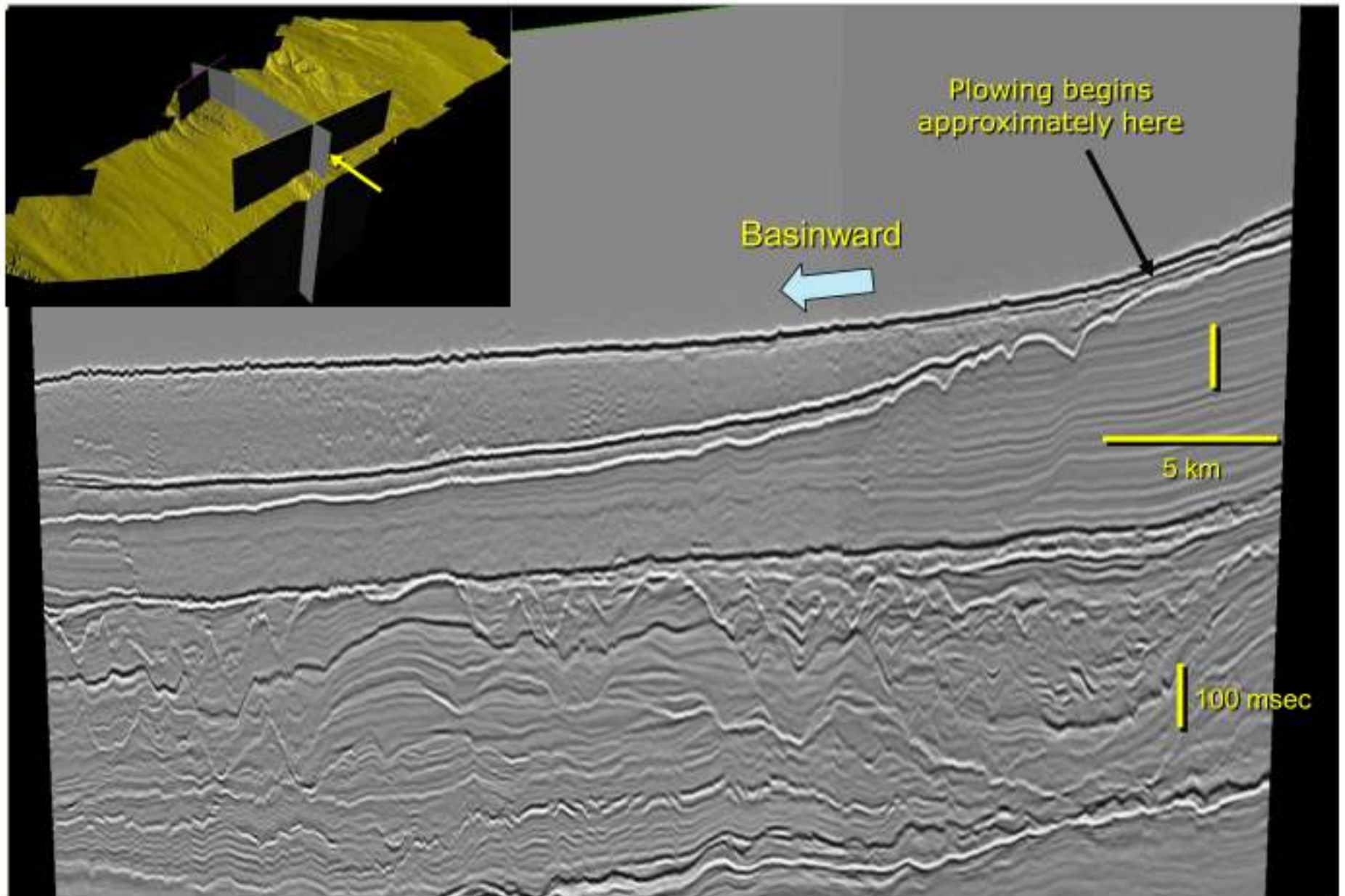




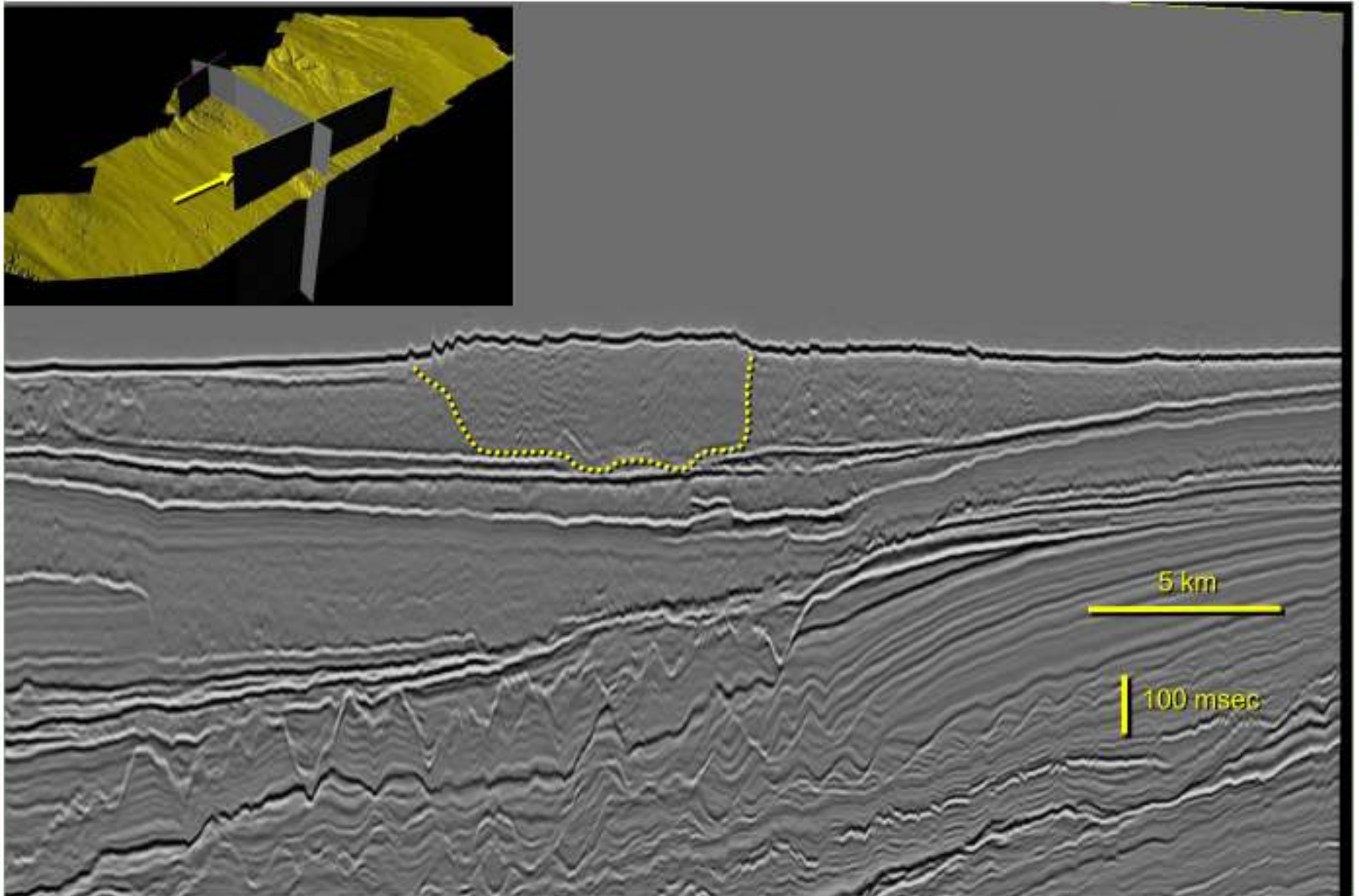
Mass Transport Deposit



Mass Transport Deposit – Axial Section

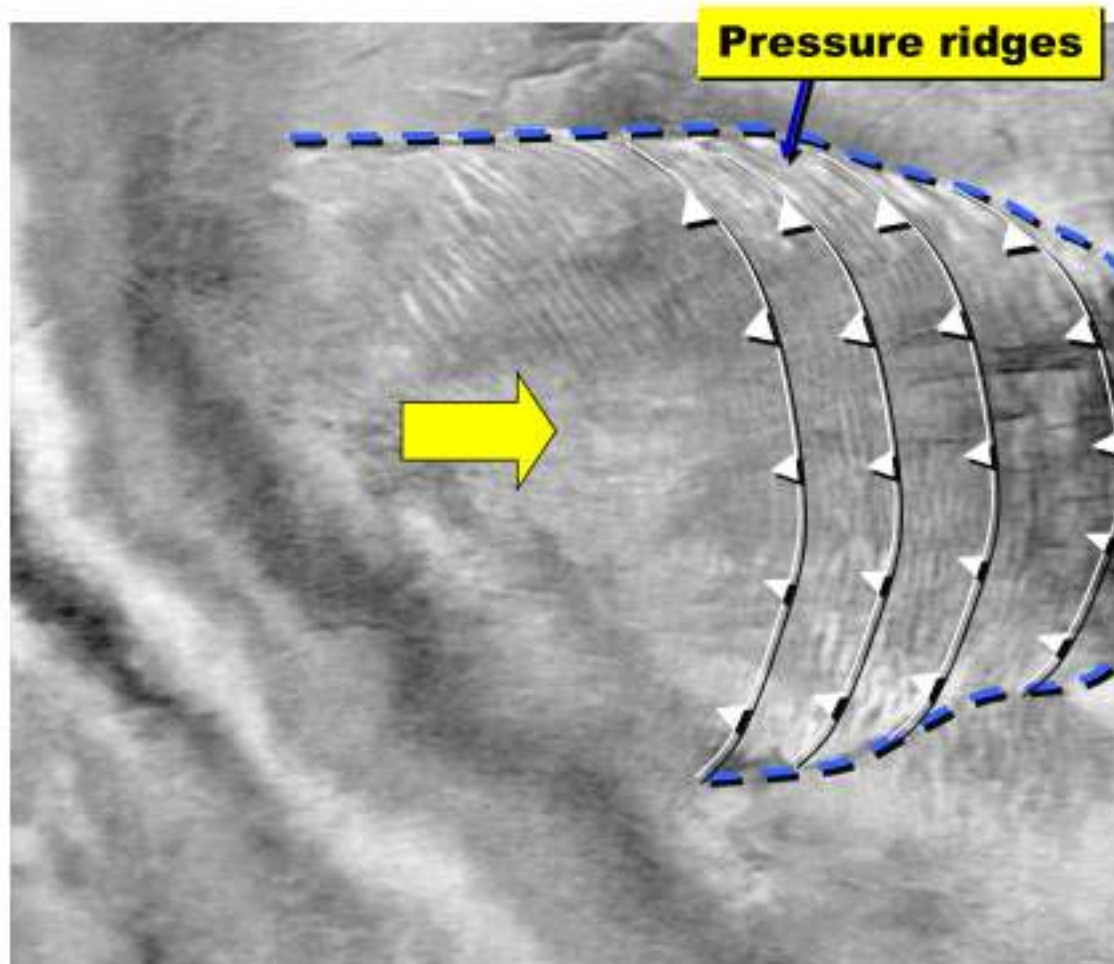


Mass Transport Deposit – Transverse Section

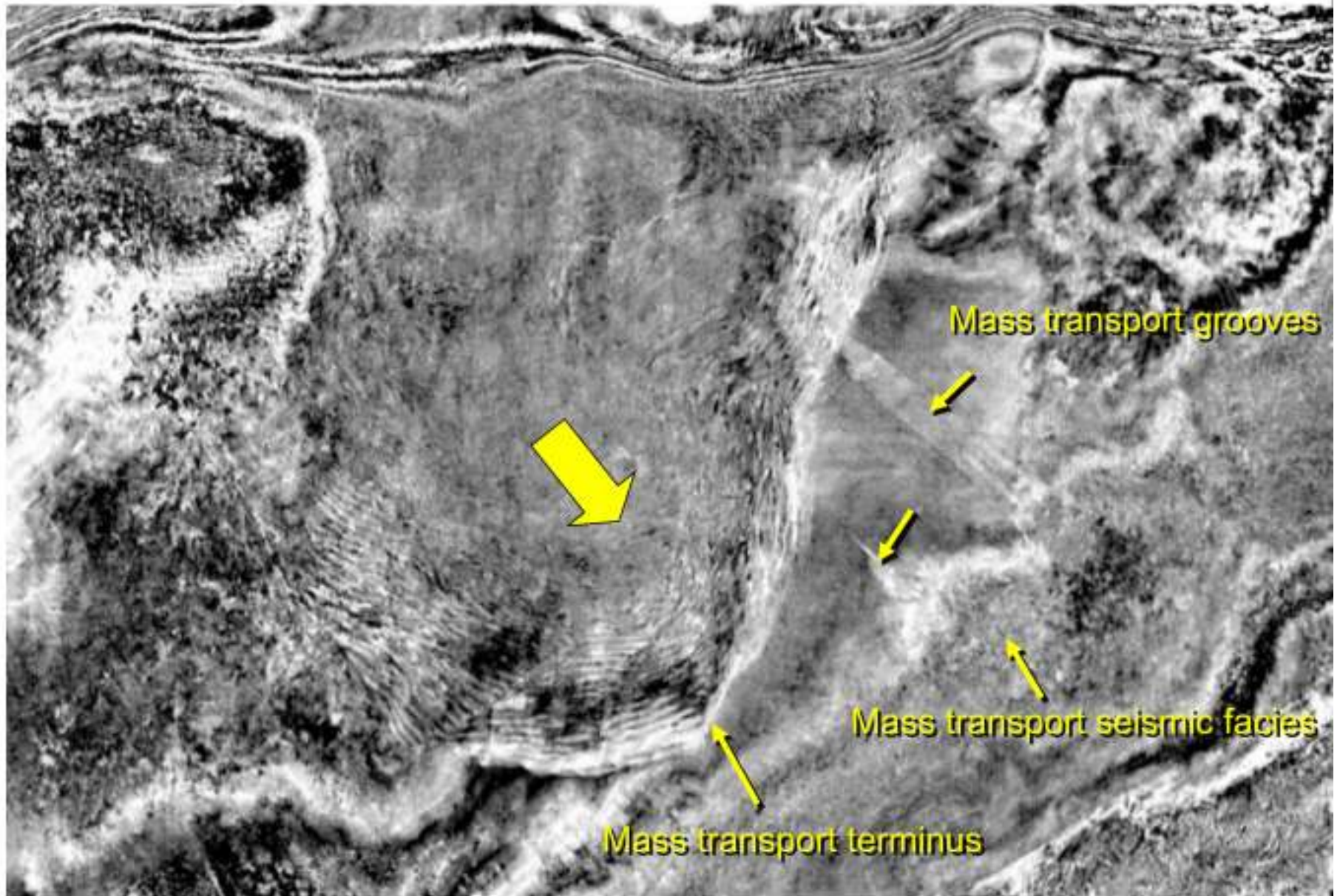


Mass Transport Deposit with Compressional Toe-Thrusts Near Terminus

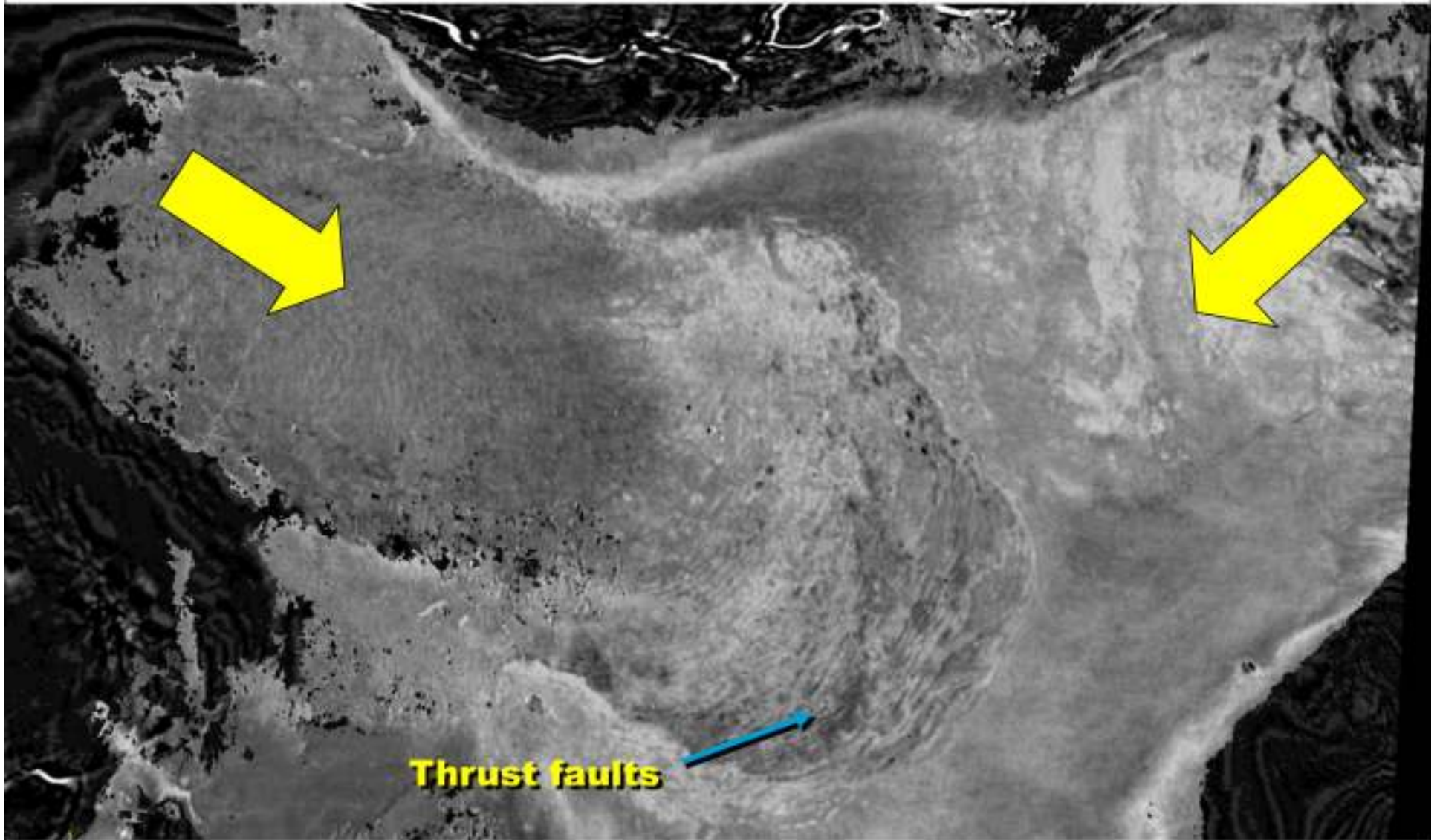
Miocene – Makassar Strait



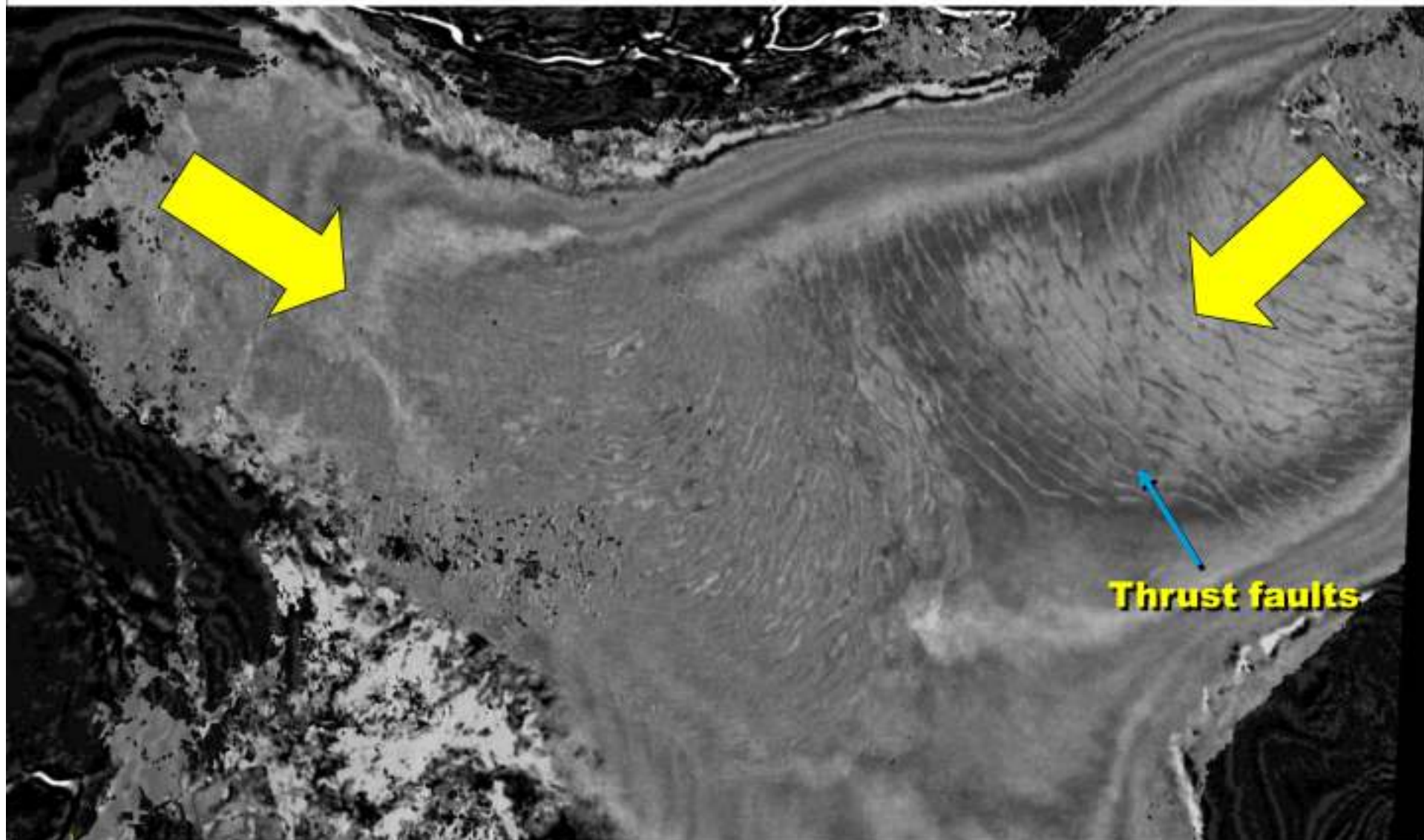
Mass Transport Deposit with Compressional Toe-Thrusts Near Terminus



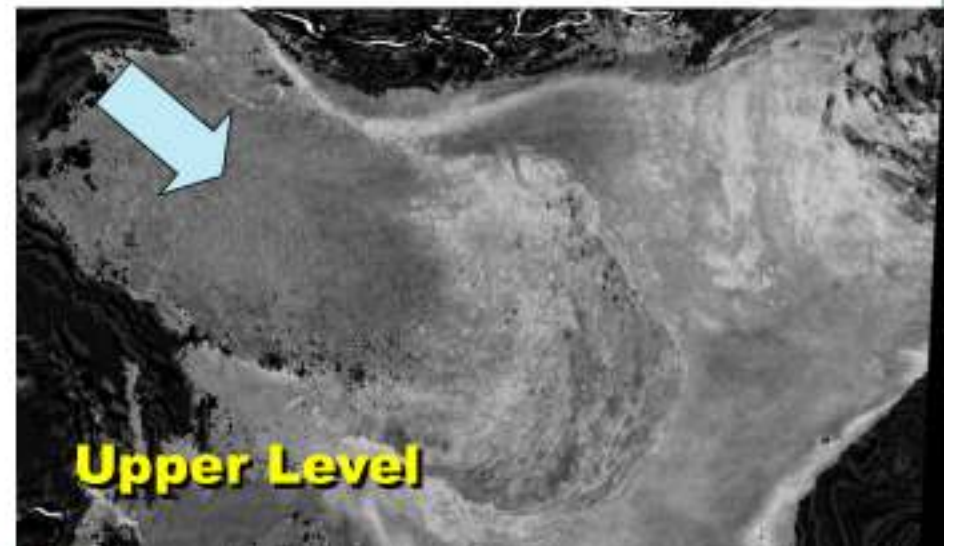
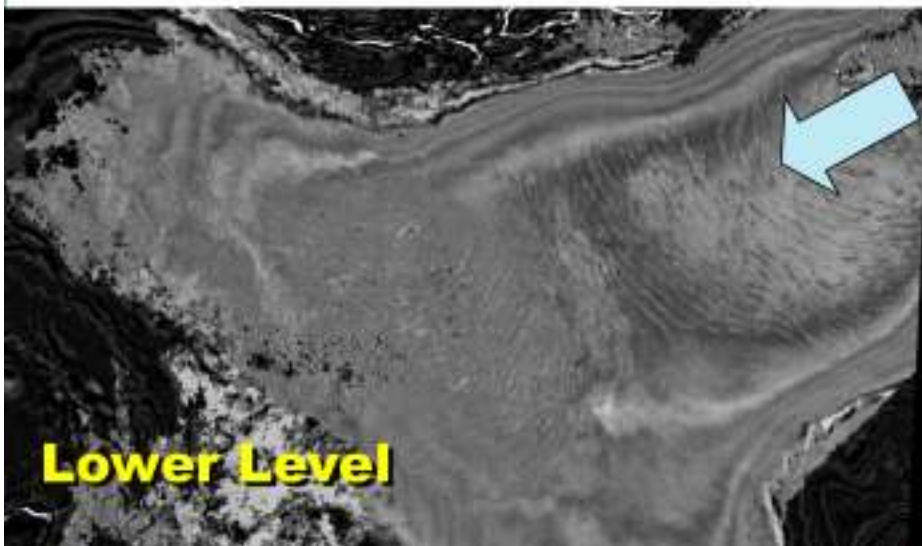
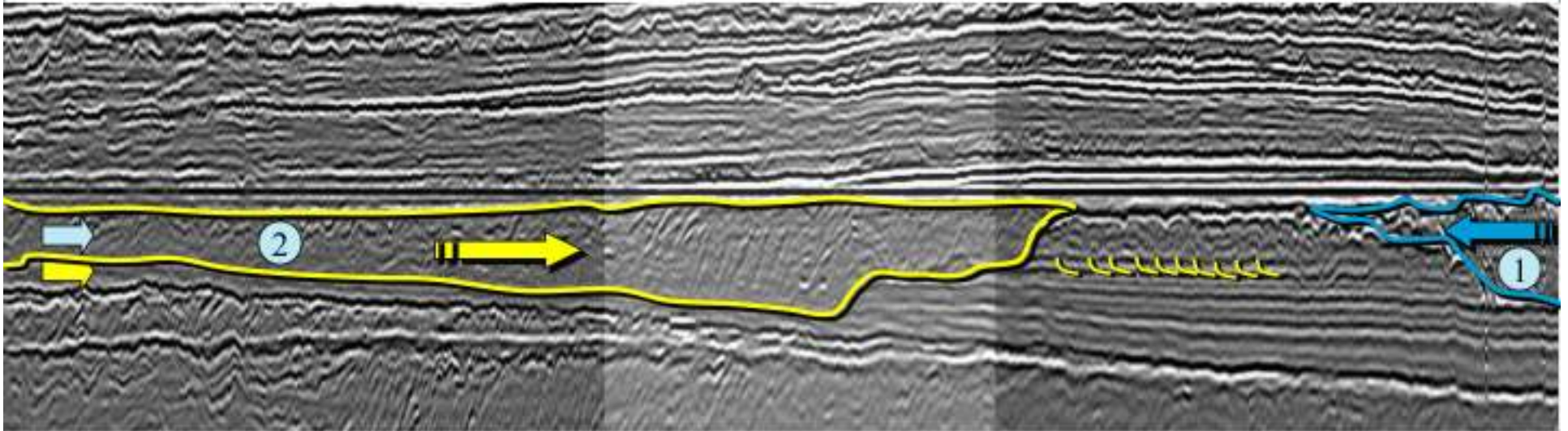
Mini-Basin with Two Entry Points (MTD's)

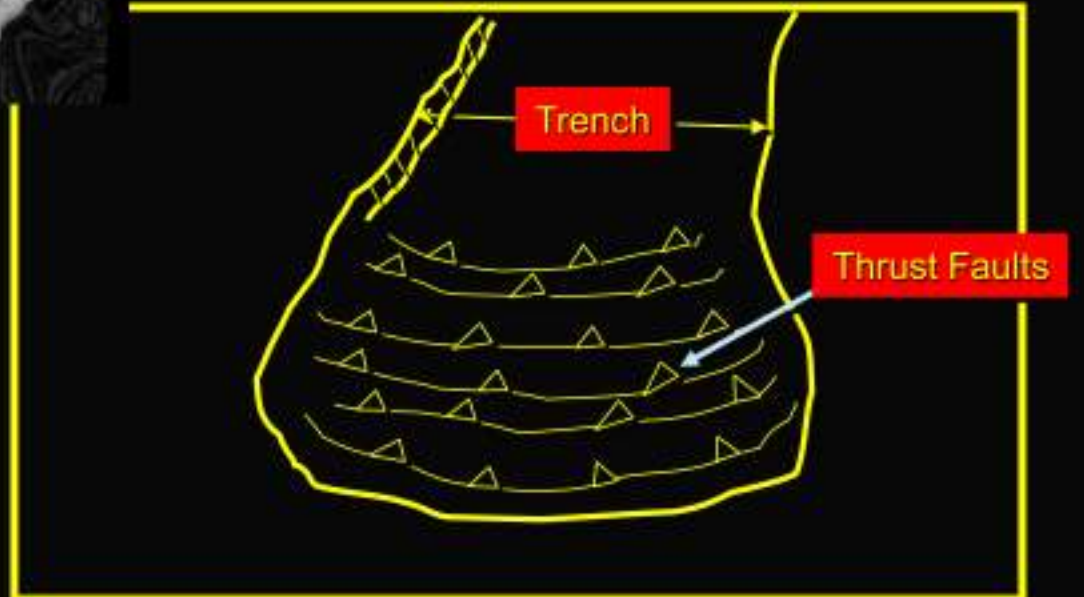
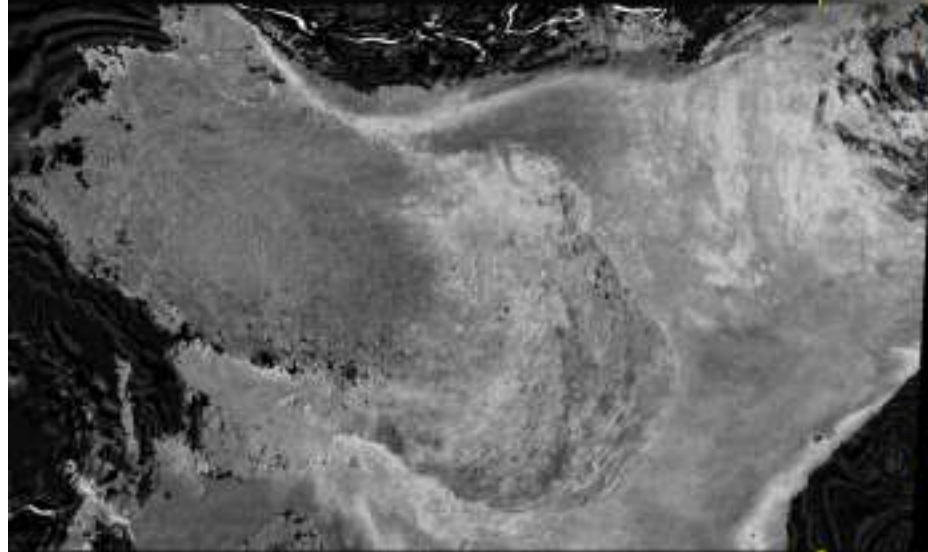


Mini-Basin with Two Entry Points



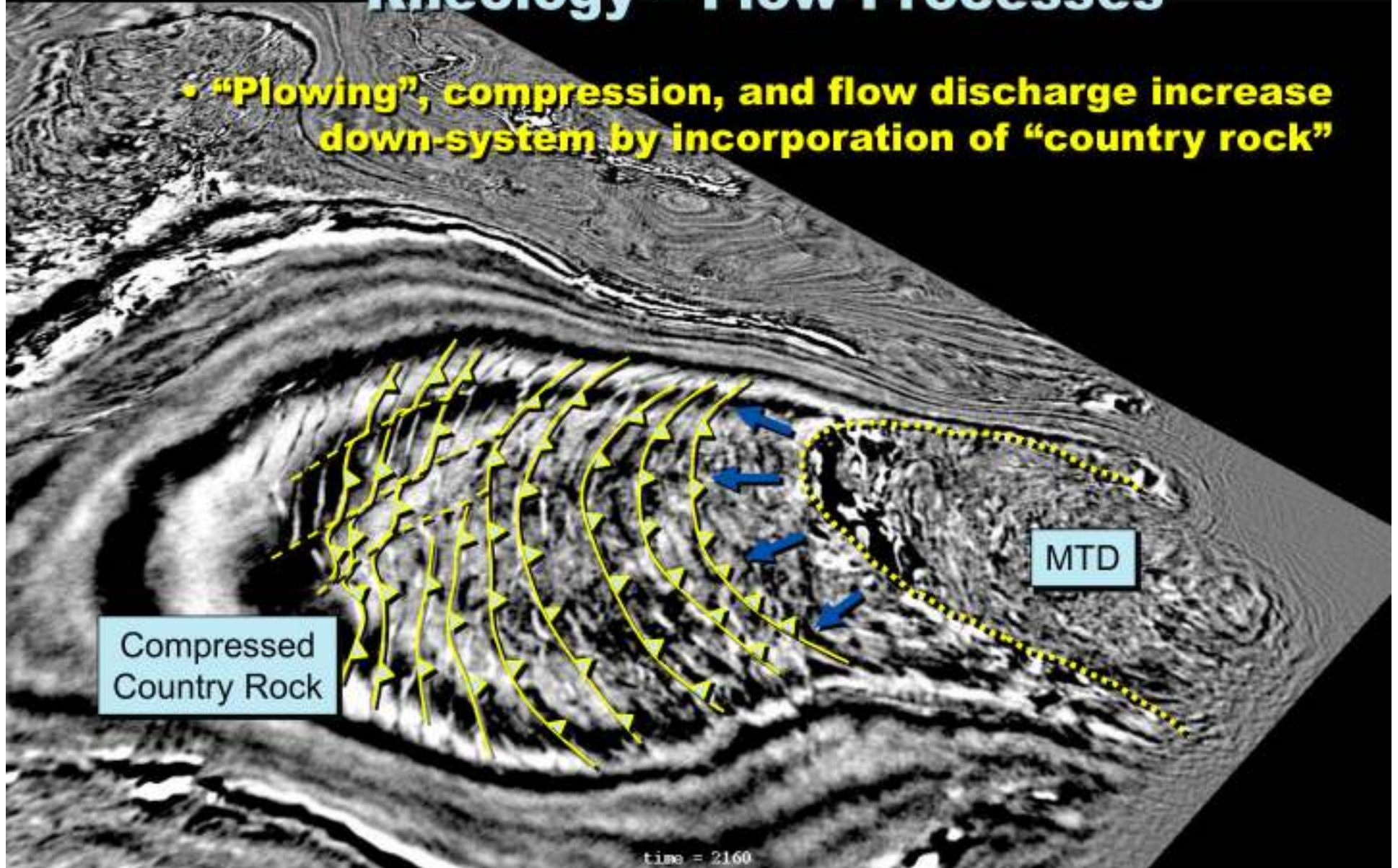
Mini-Basin with Two Entry Points





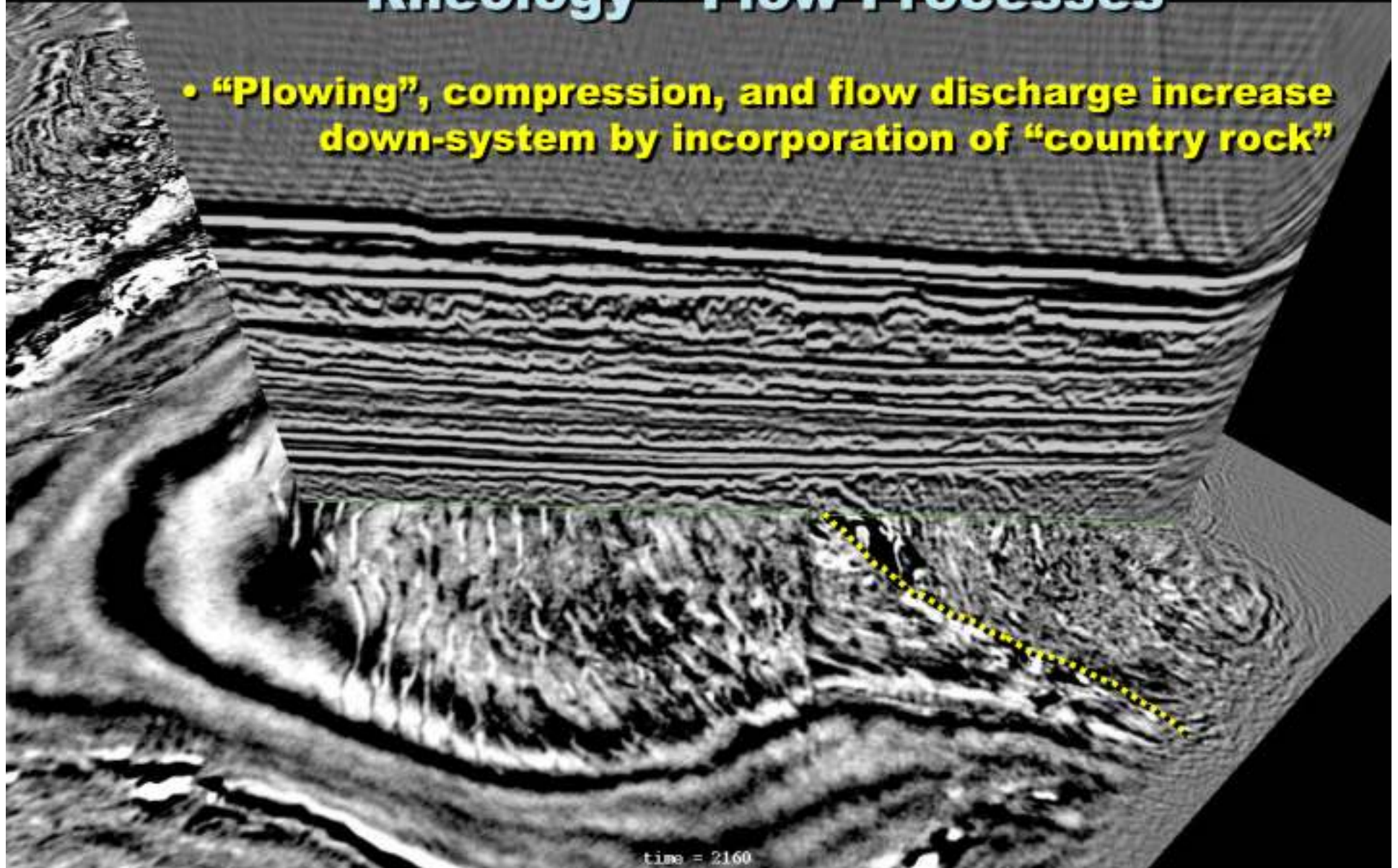
Rheology – Flow Processes

- “Plowing”, compression, and flow discharge increase down-system by incorporation of “country rock”



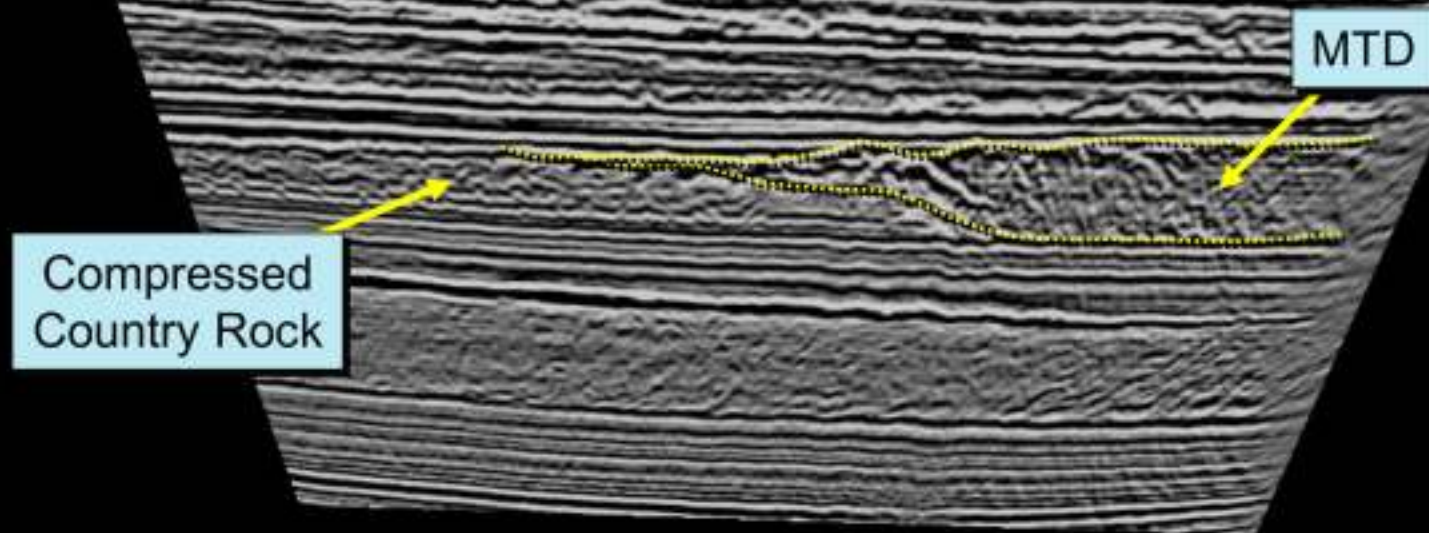
Rheology – Flow Processes

- “Plowing”, compression, and flow discharge increase down-system by incorporation of “country rock”



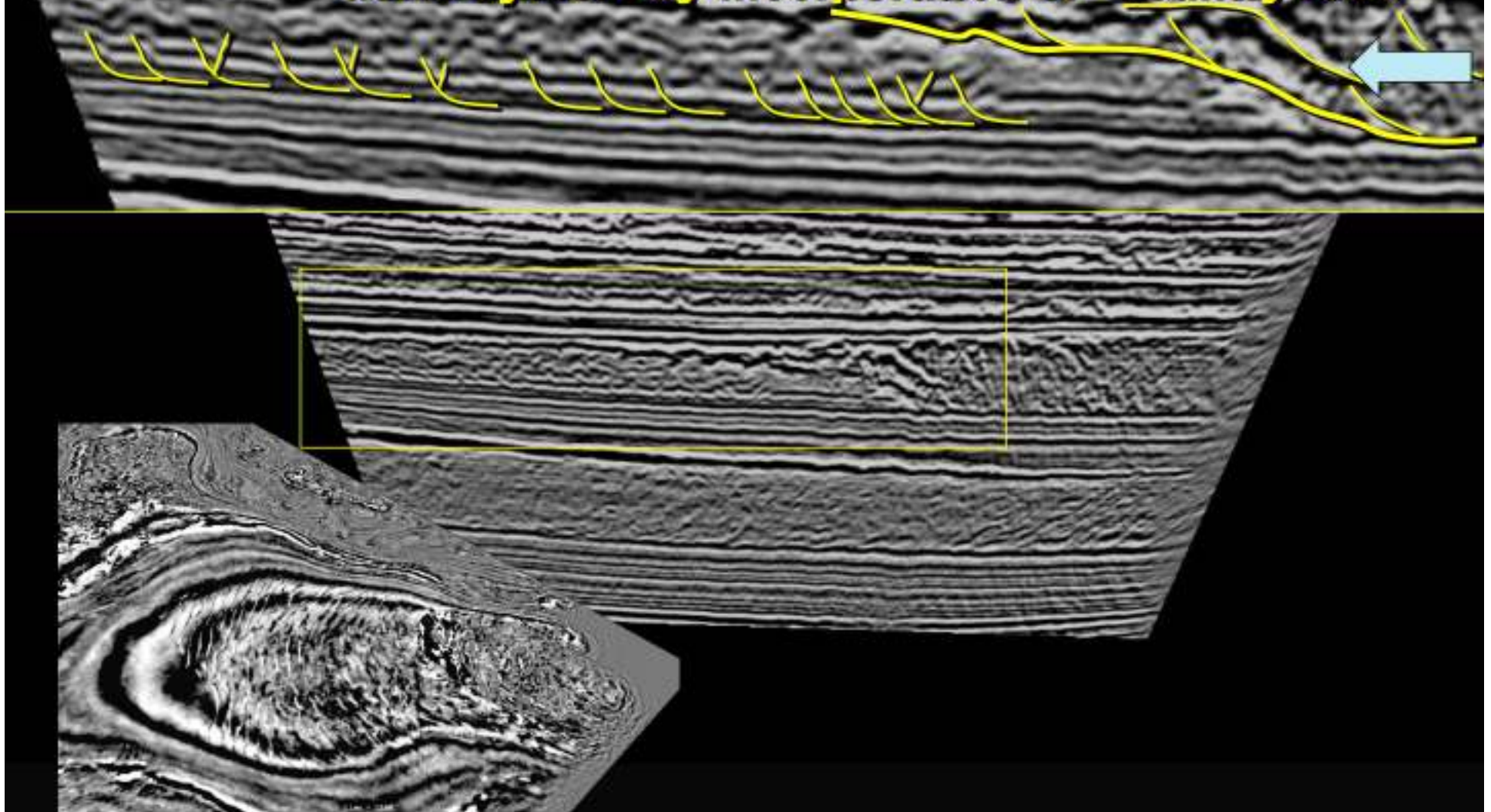
Rheology – Flow Processes

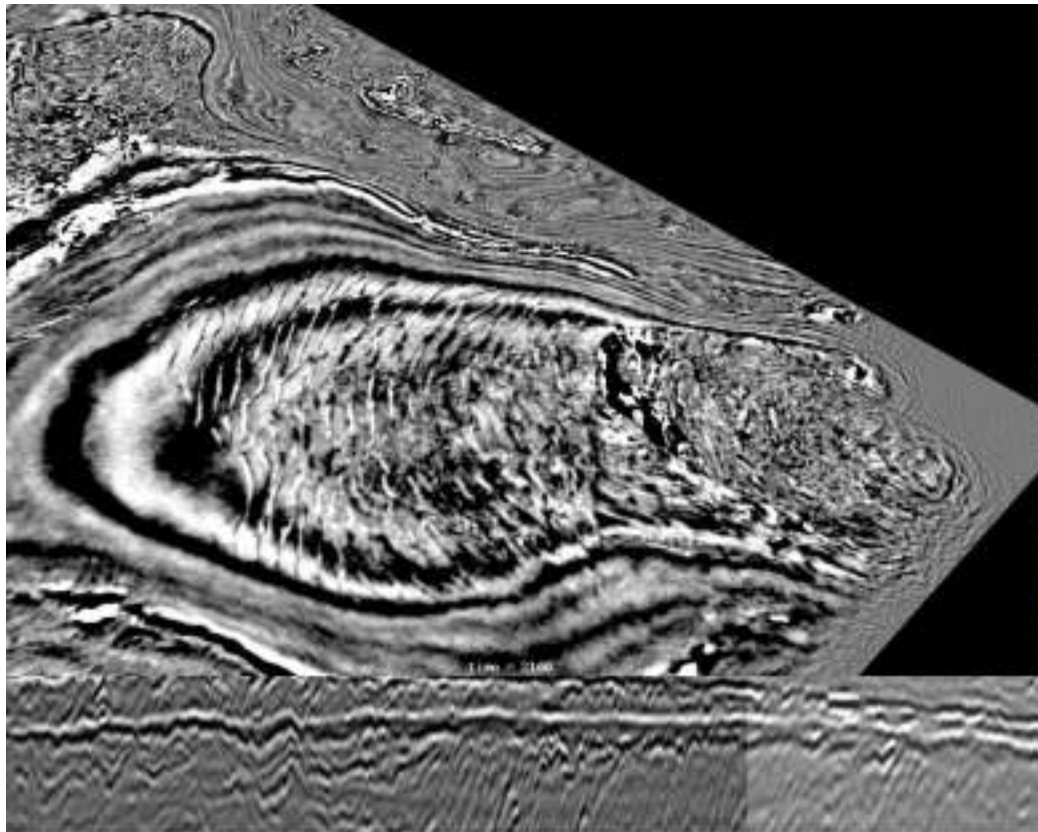
- **“Plowing”, compression, and flow discharge increase down-system by incorporation of “country rock”**



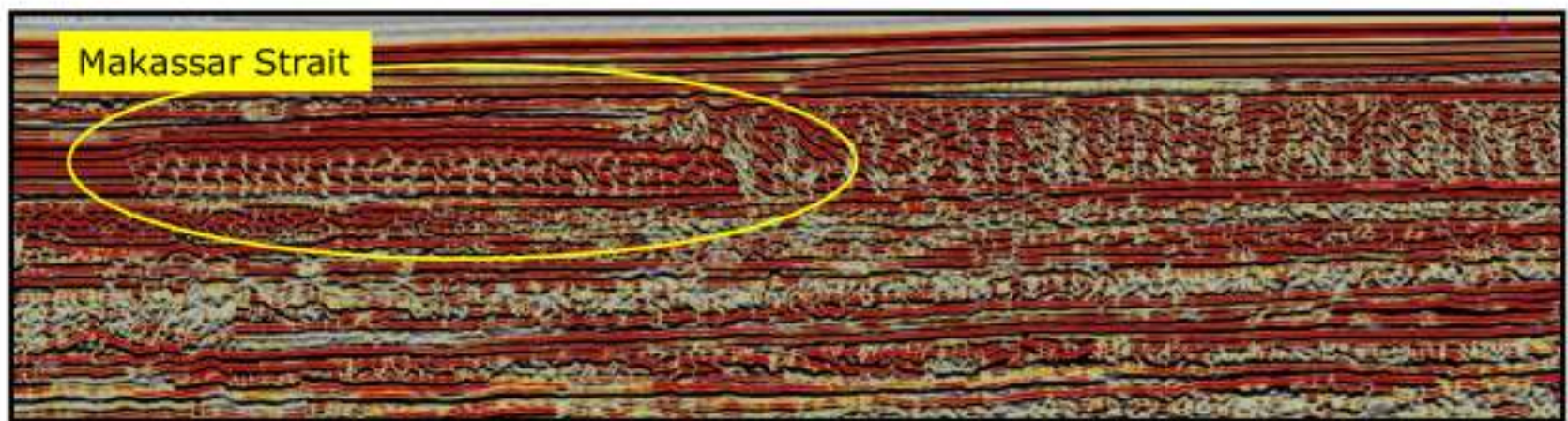
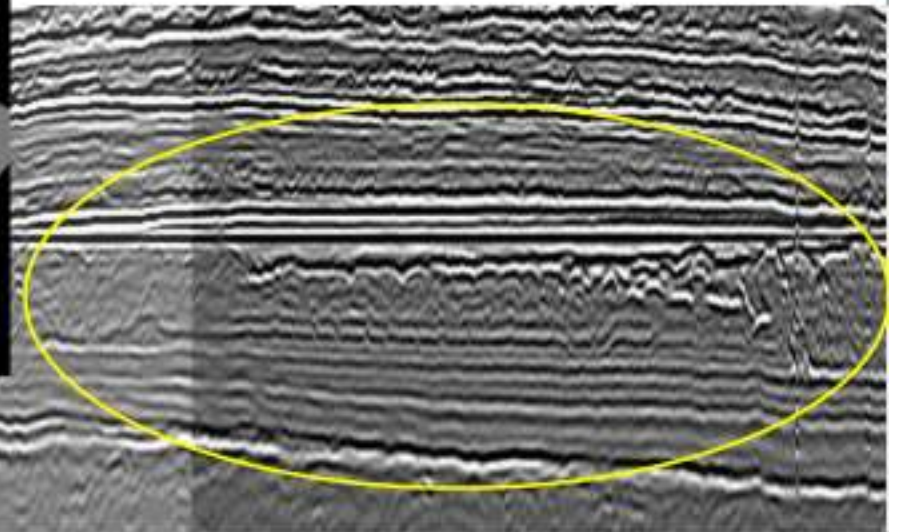
Rheology – Flow Processes

- “Plowing”, compression, and flow discharge increase down-system by incorporation of “country rock”





Faulted "Country Rock" Distal
to mass Transport Deposit



From John Decker, 2012

Makassar Strait

Faulted "Country Rock" Distal to mass Transport Deposit

Decollement Surface

Time 1

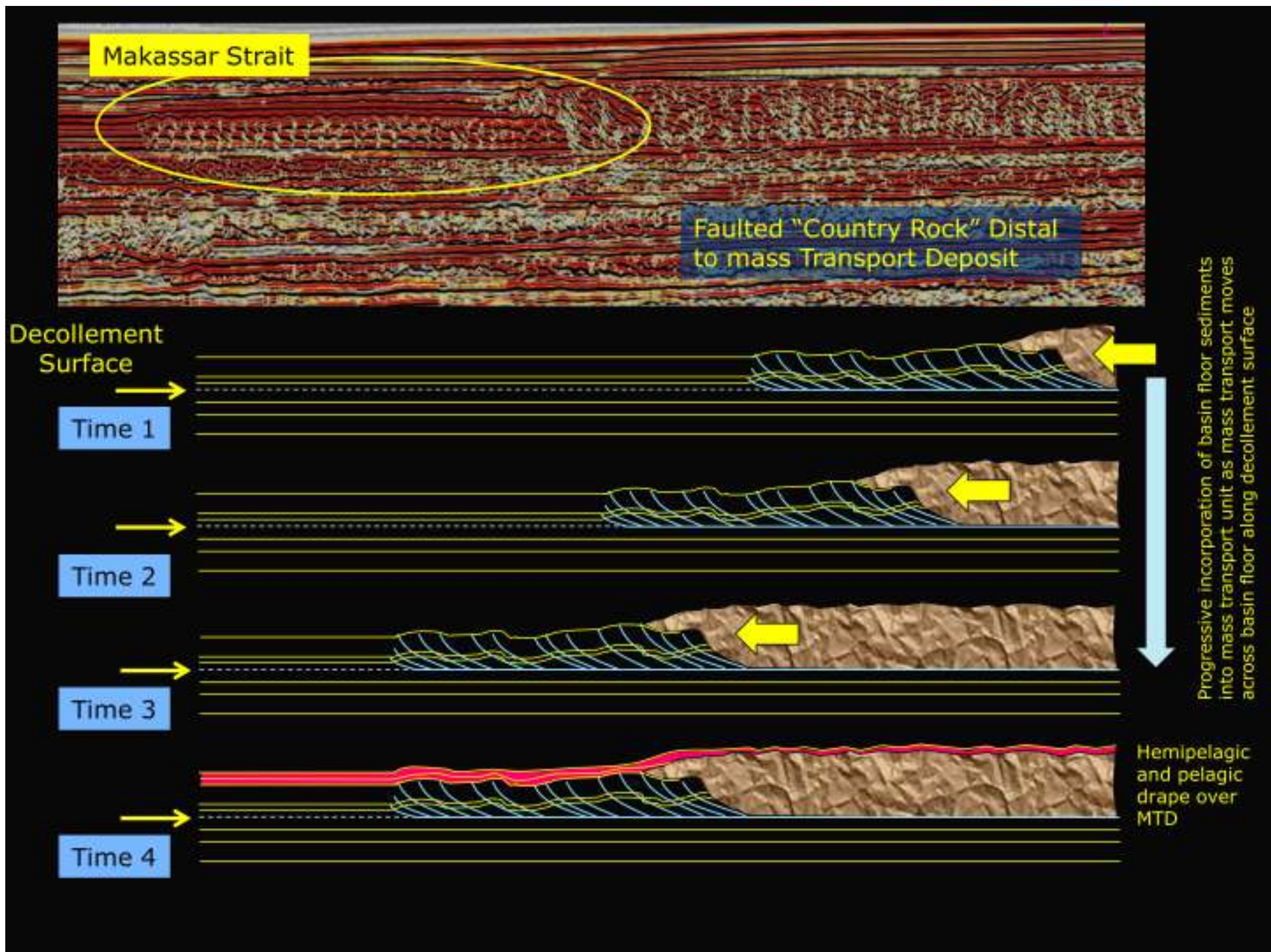
Time 2

Time 3

Time 4

Progressive incorporation of basin floor sediments into mass transport unit as mass transport moves across basin floor along decollement surface

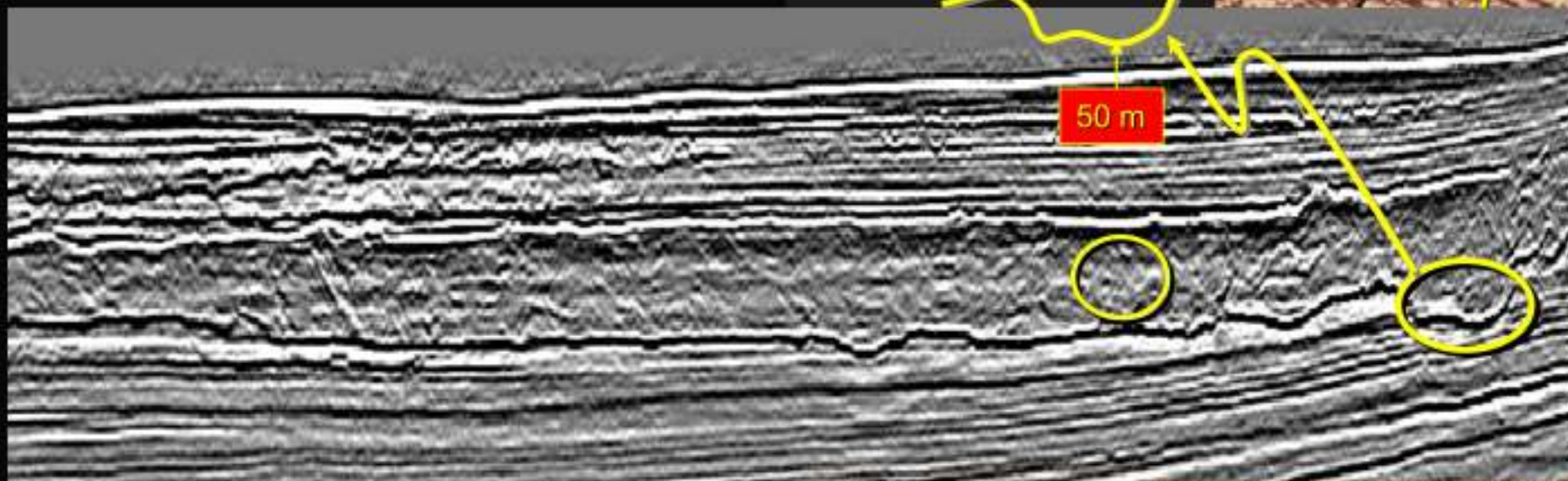
Hemipelagic and pelagic drape over MTD



Striations and Grooves; Erosion at Base

Mass Transport Deposit – Basal Grooves

SSW



50 msec

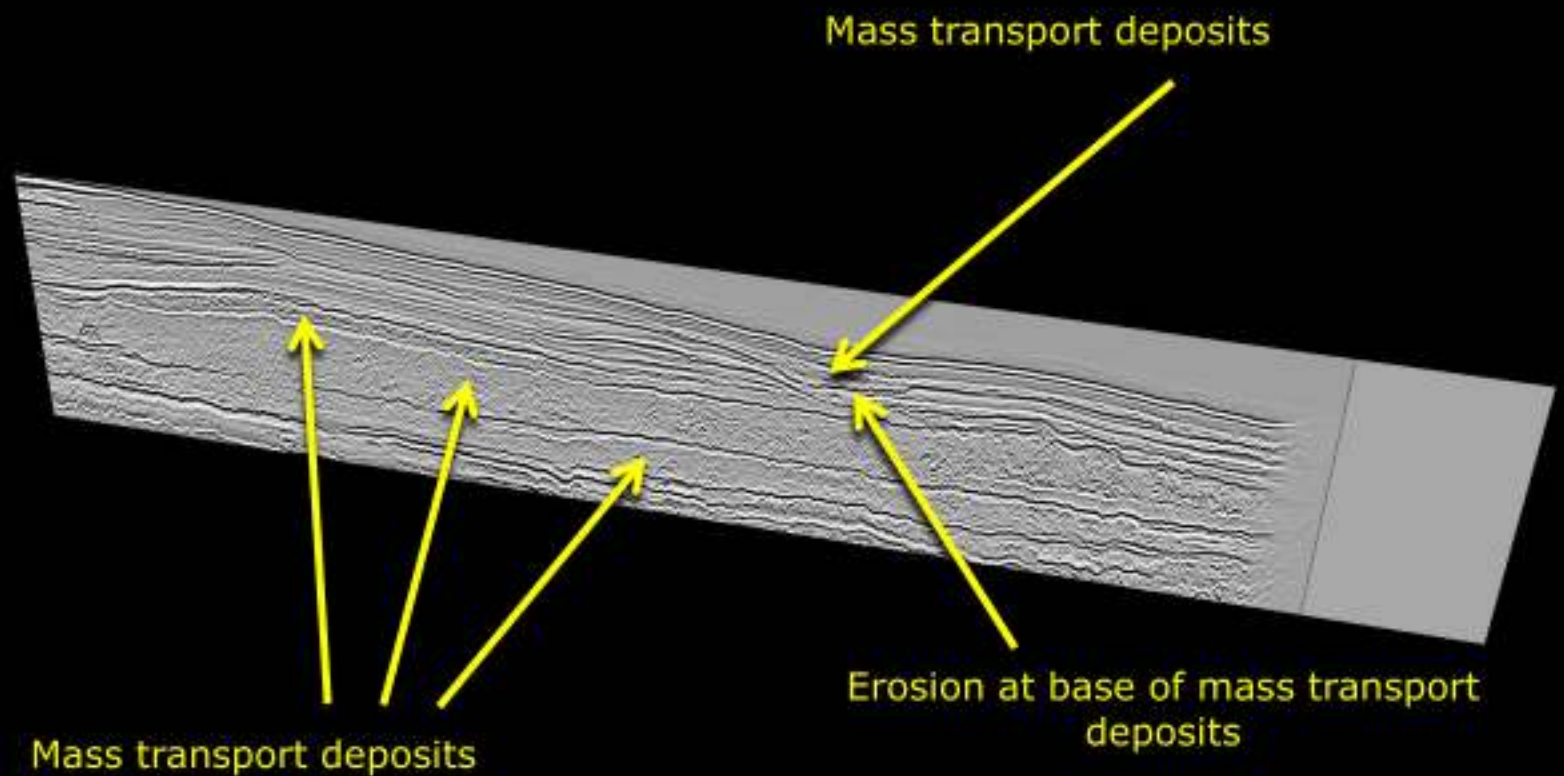
one km



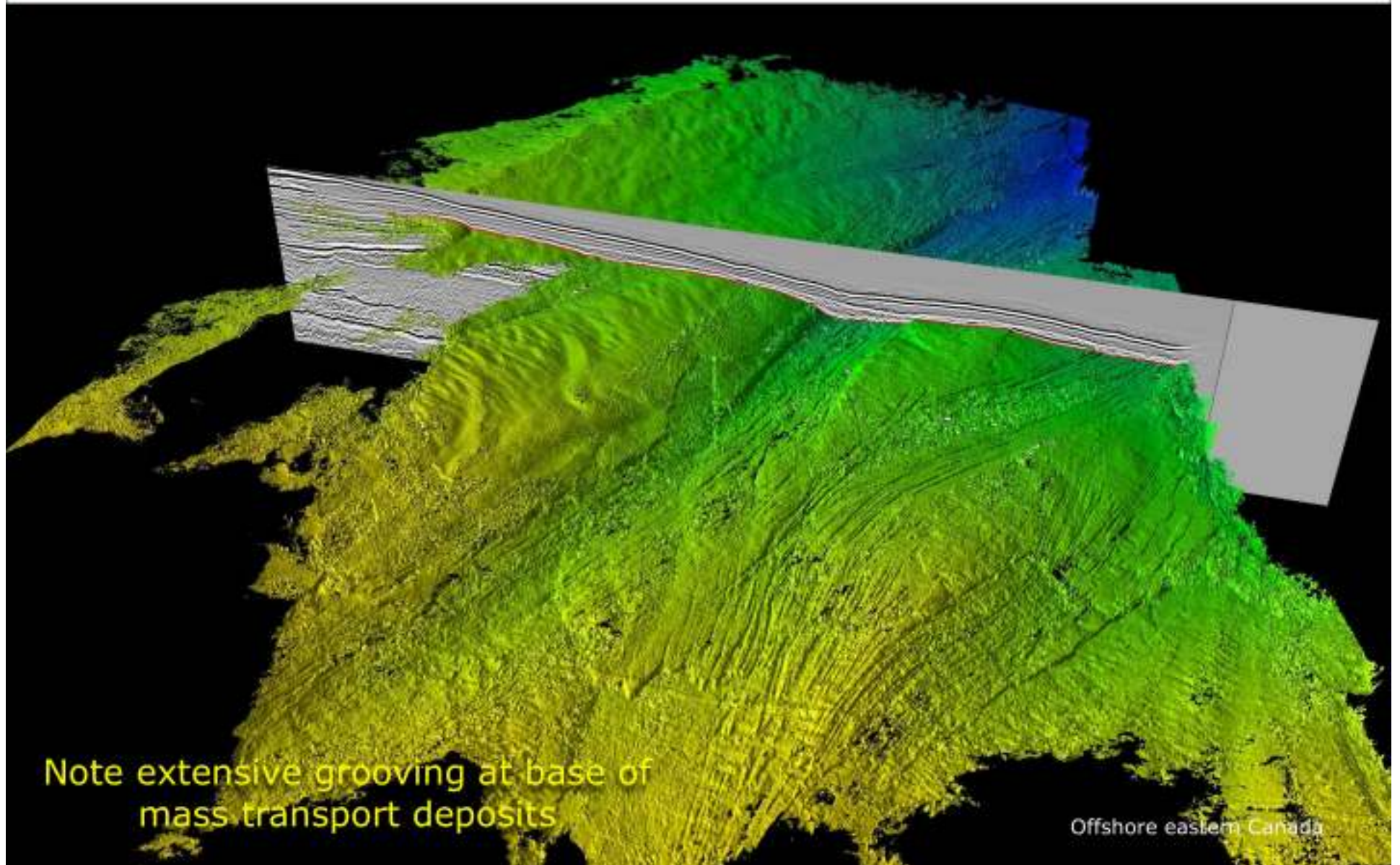
one km



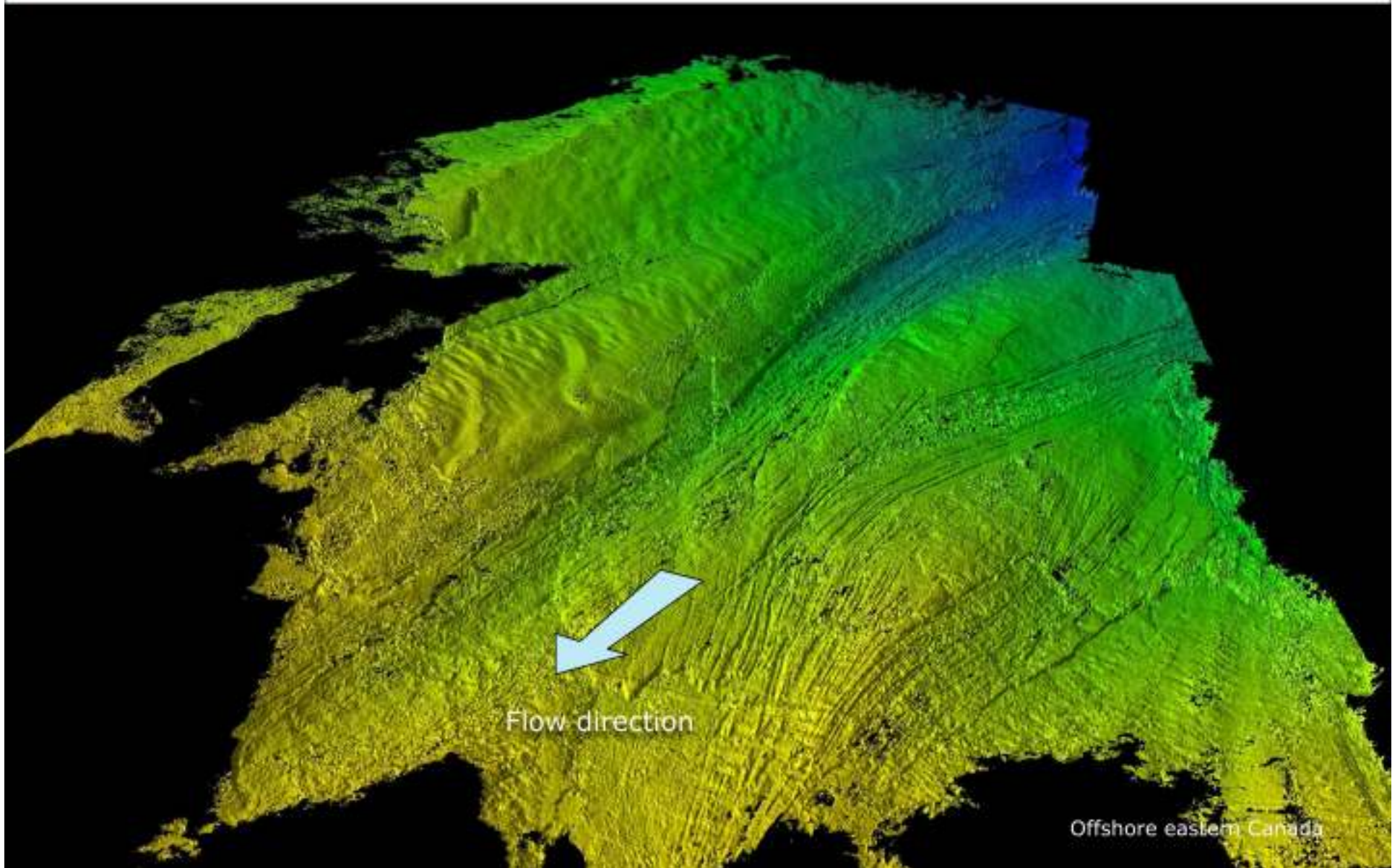
Erosion at base of mass transport deposits



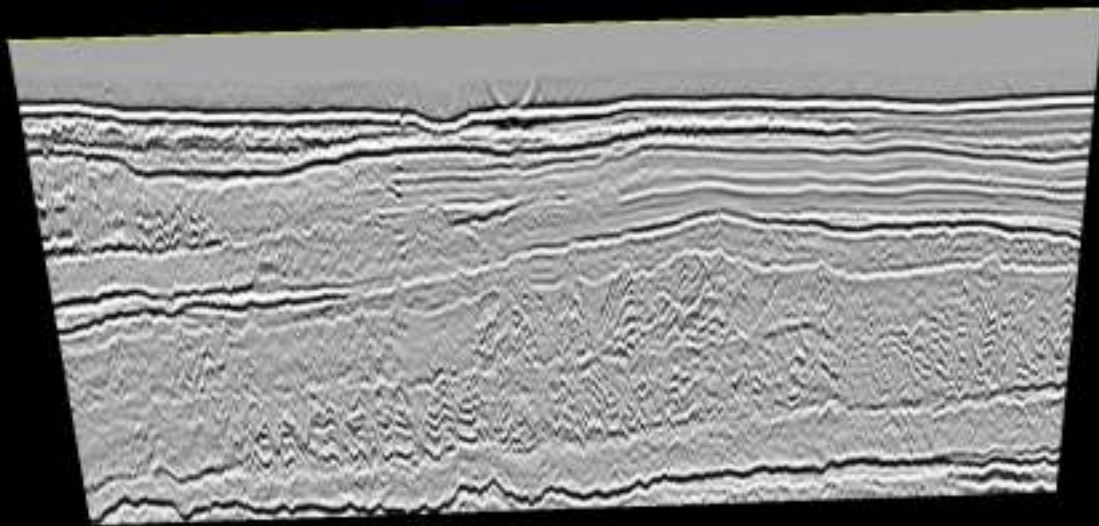
Erosion at base of mass transport deposits



Erosion at base of mass transport deposits

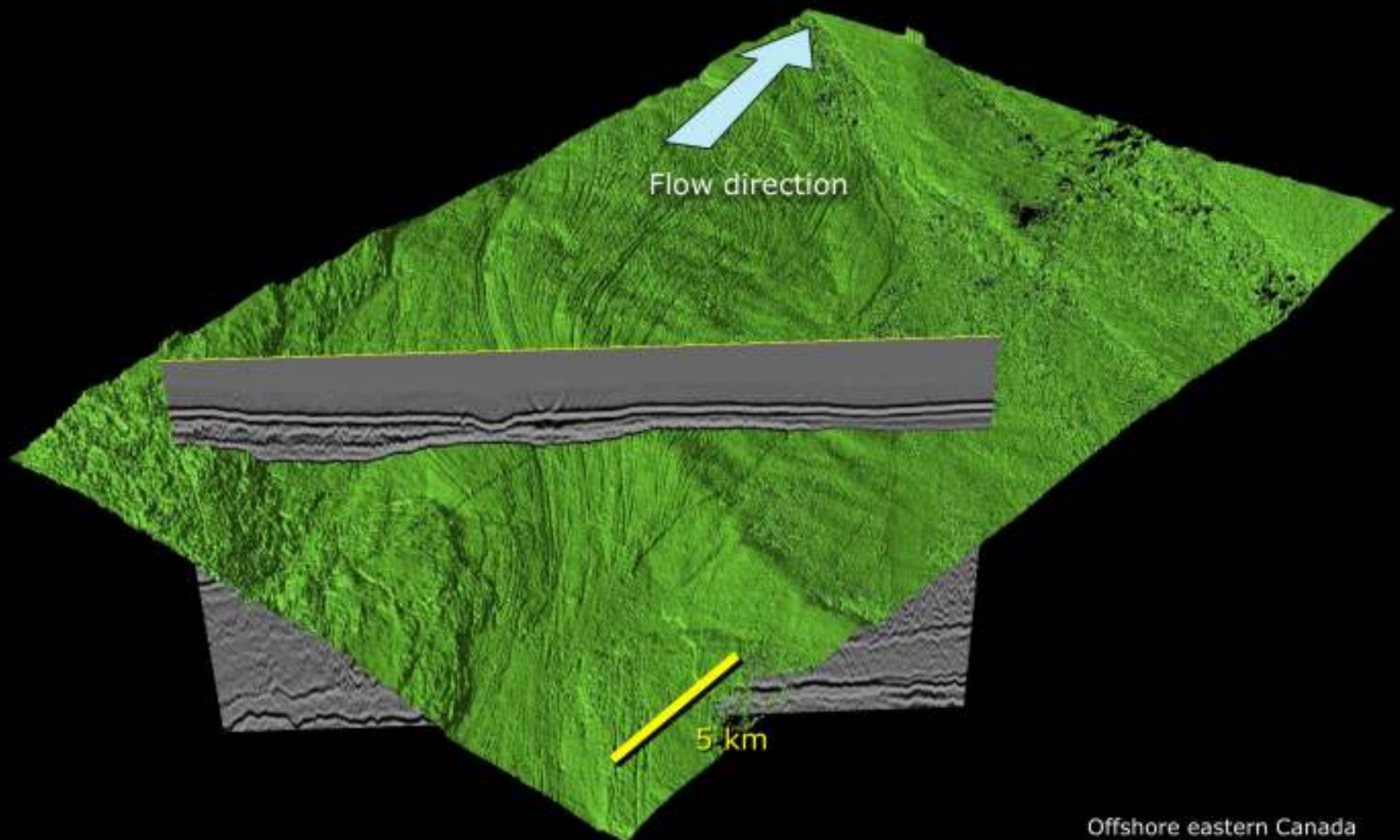


Erosion at base of mass transport deposits



Offshore eastern Canada

Erosion at base of mass transport deposits



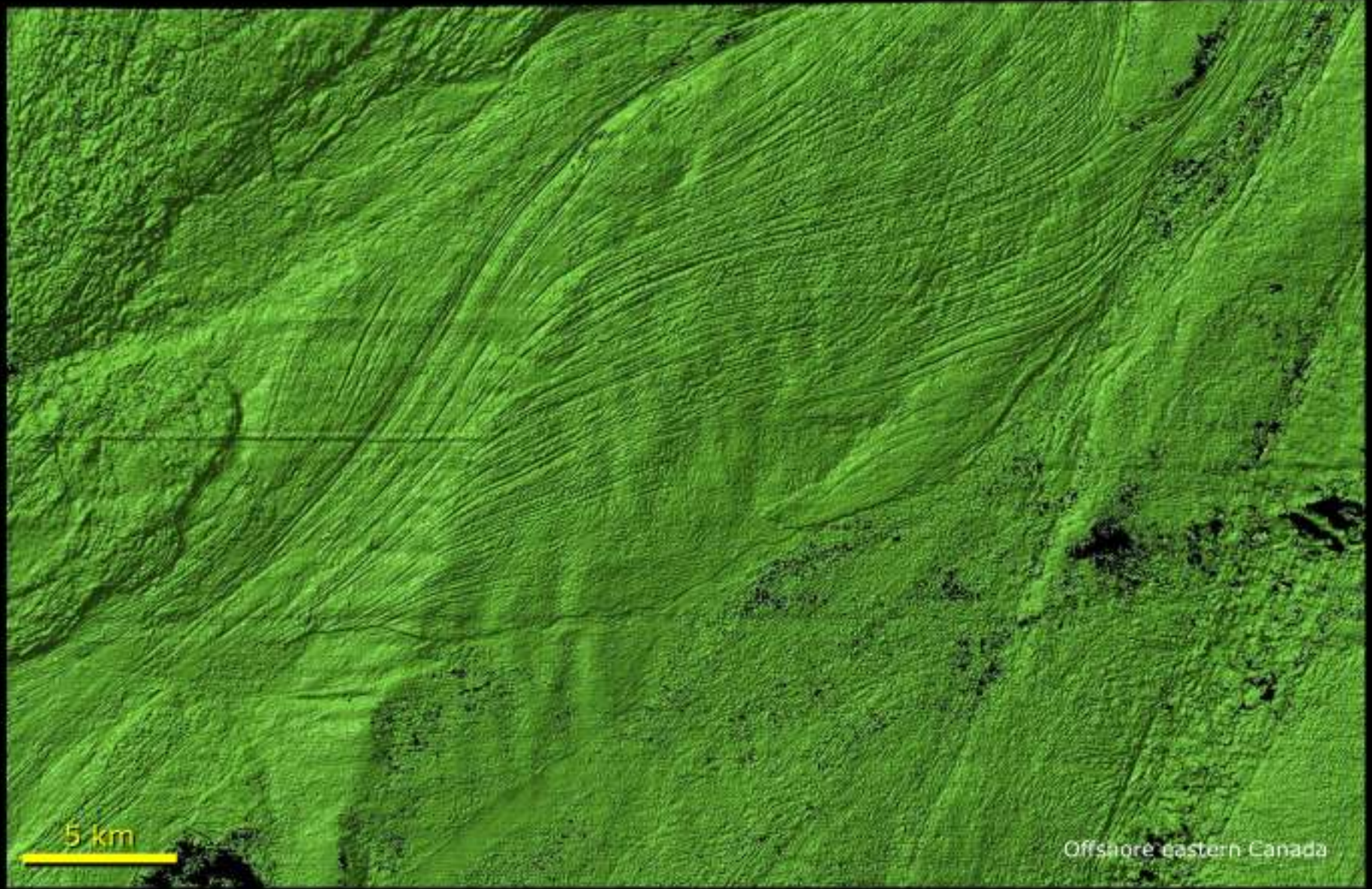
Offshore eastern Canada

Erosion at base of mass transport deposits

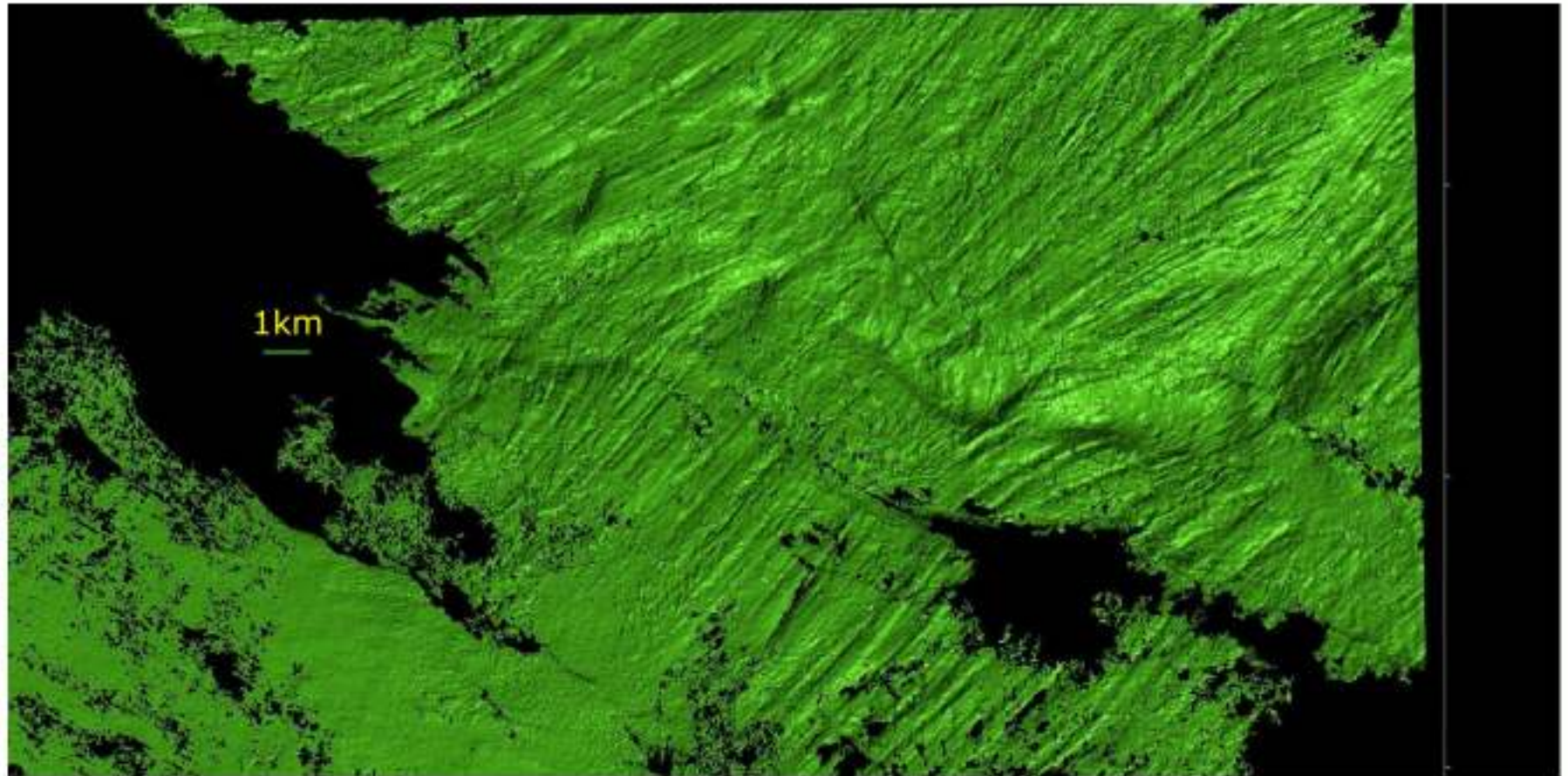


Offshore eastern Canada

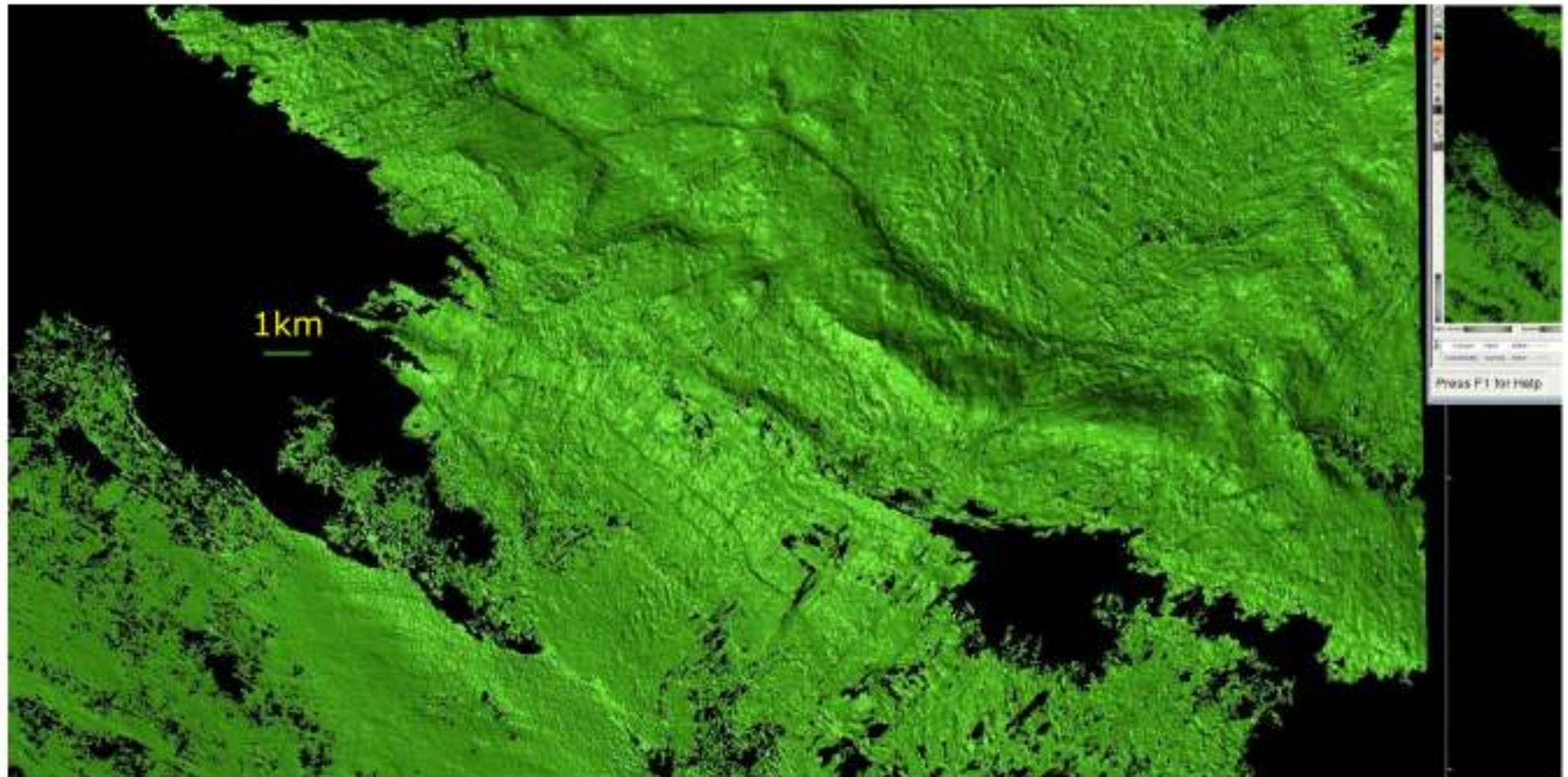
Erosion at base of mass transport deposits



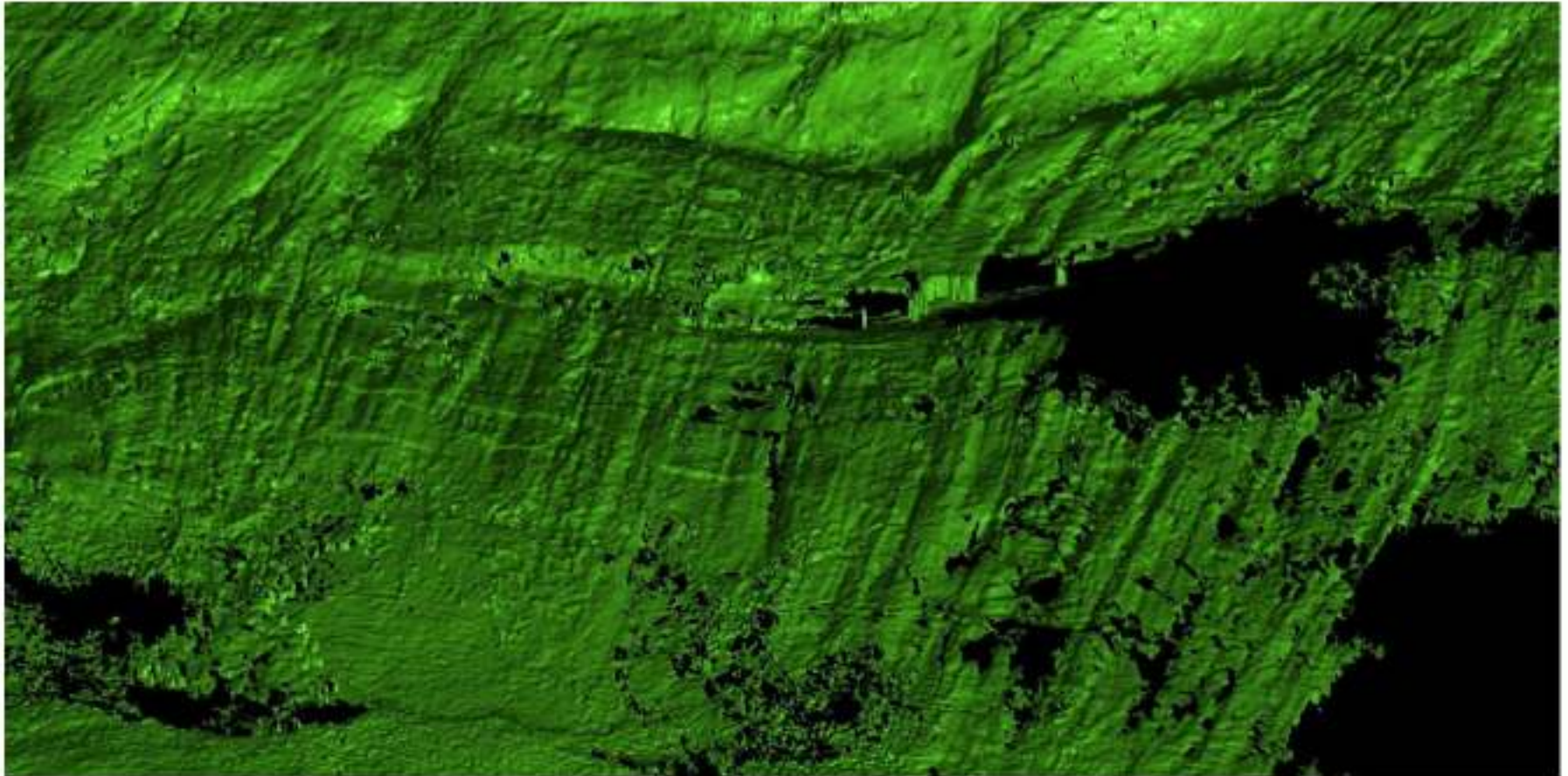
Mass Transport Grooves - Brazil



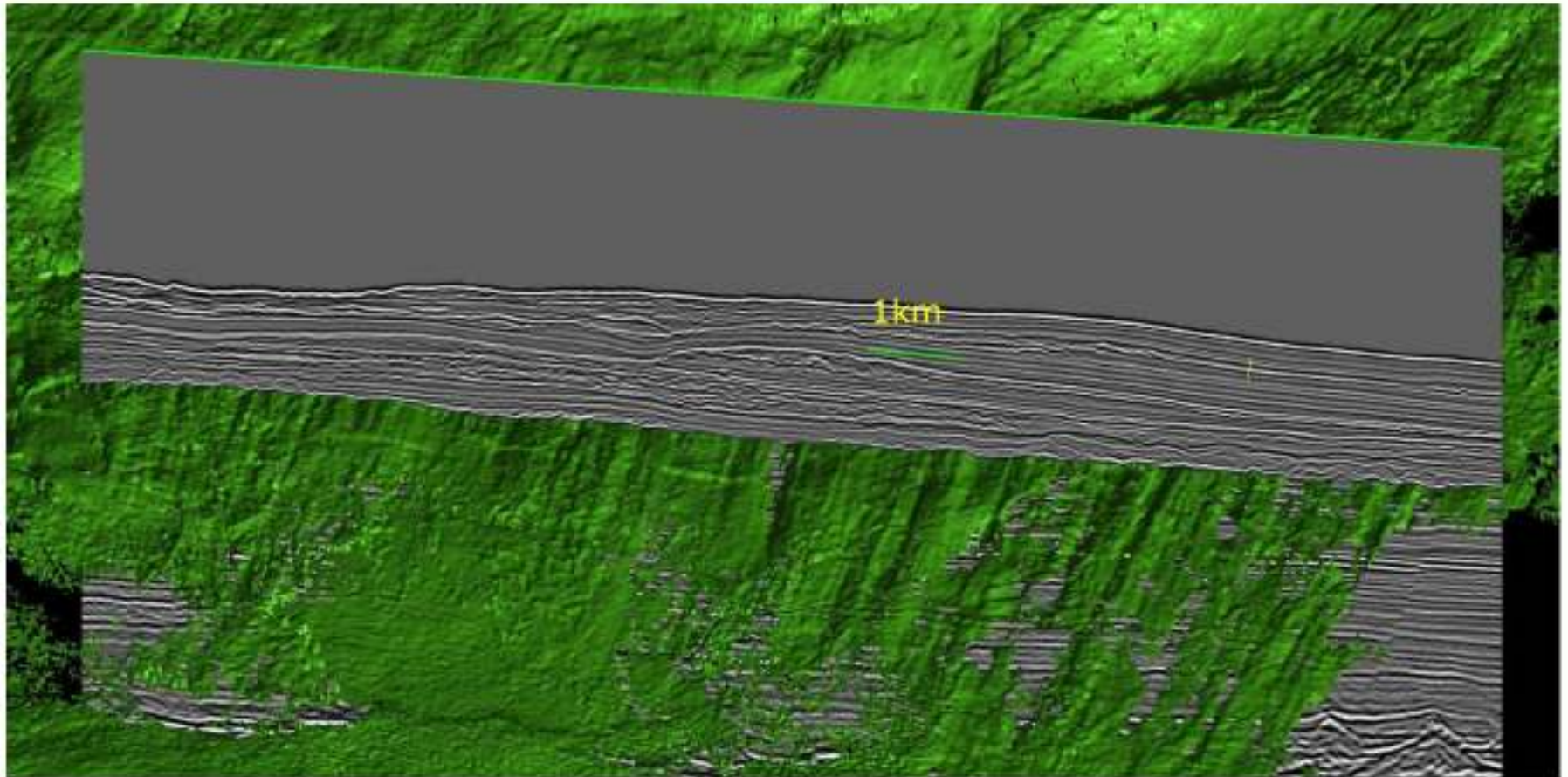
Mass Transport Grooves - Brazil



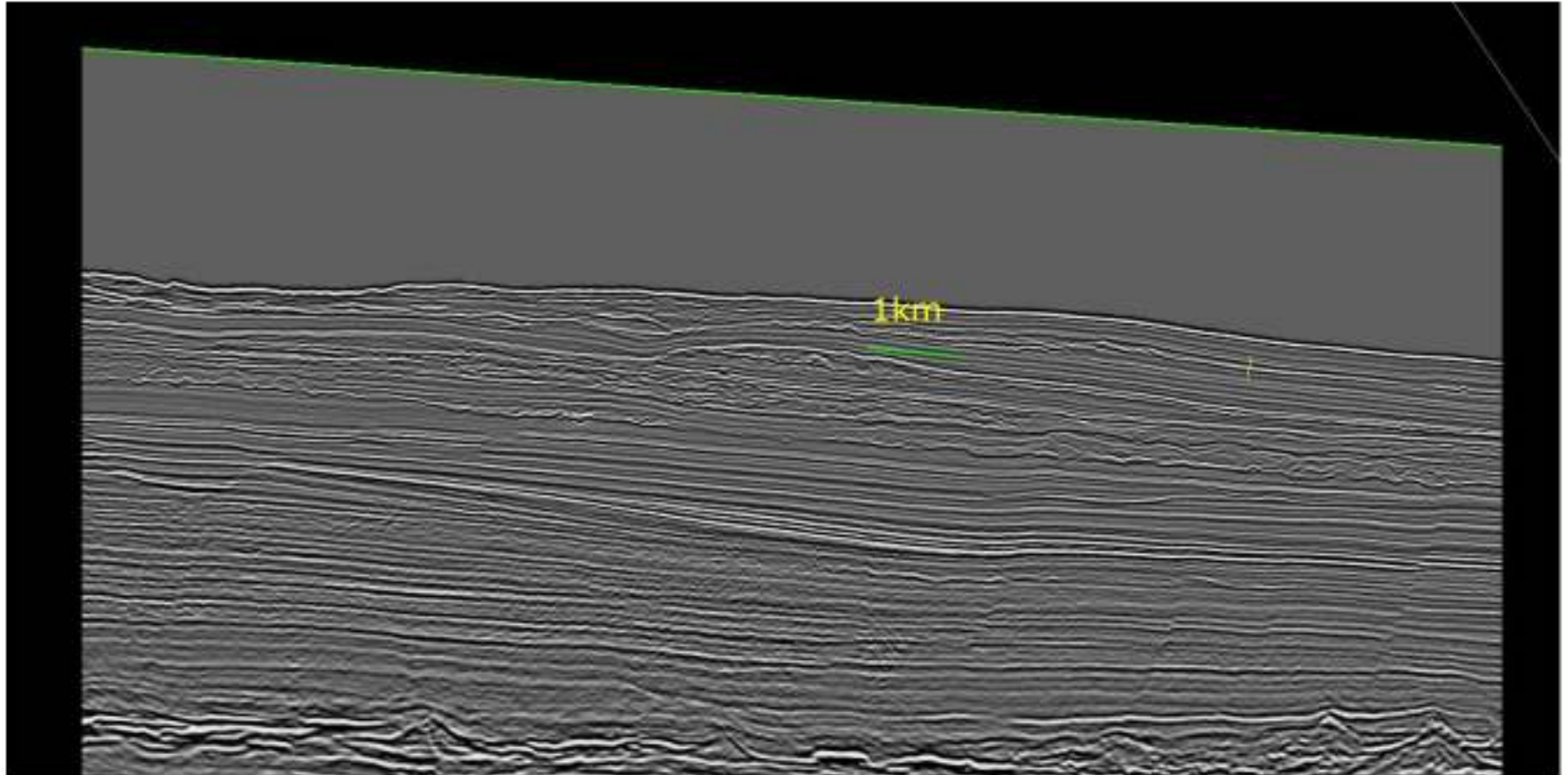
Mass Transport Grooves - Brazil



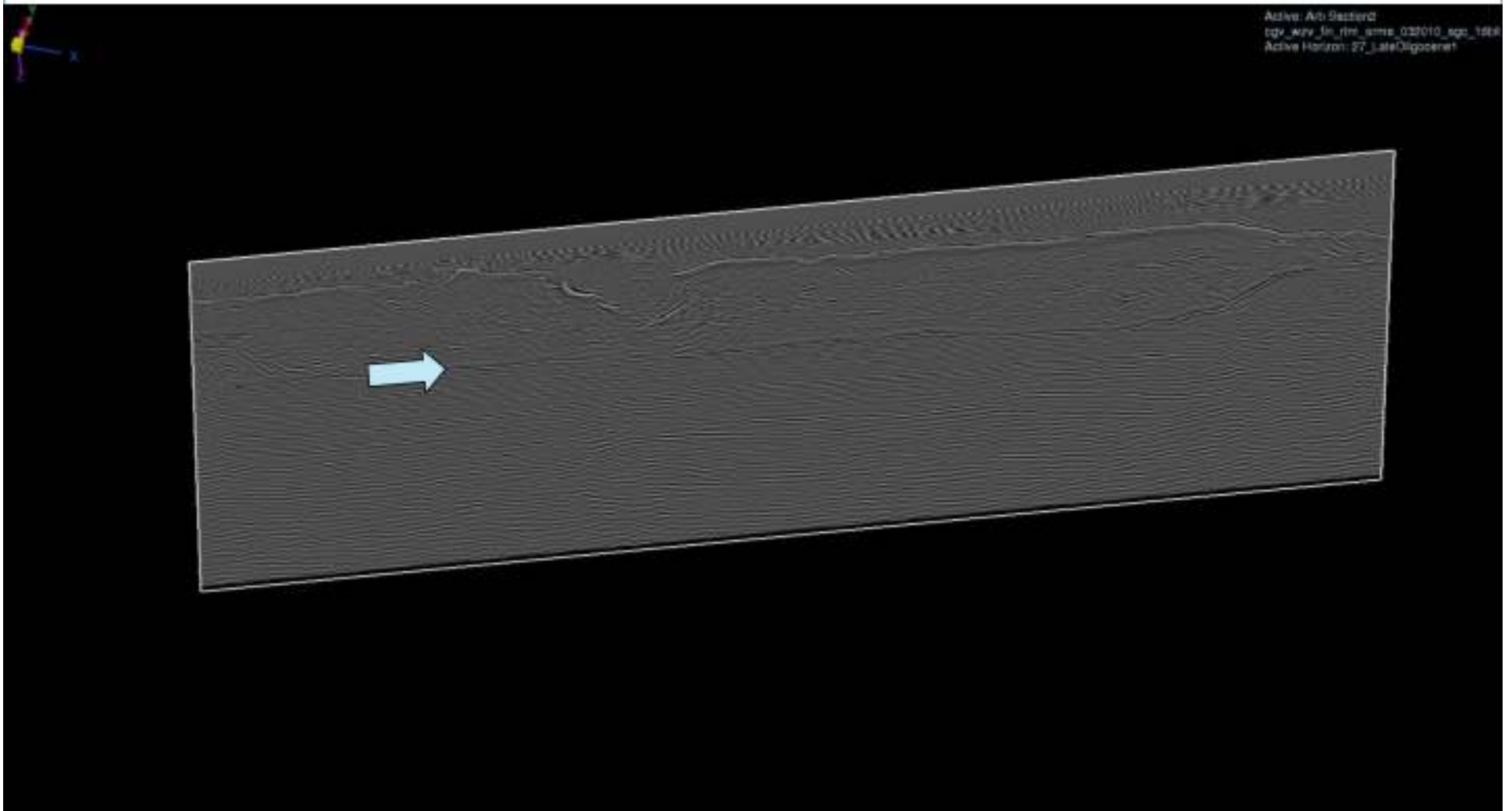
Mass Transport Grooves - Brazil



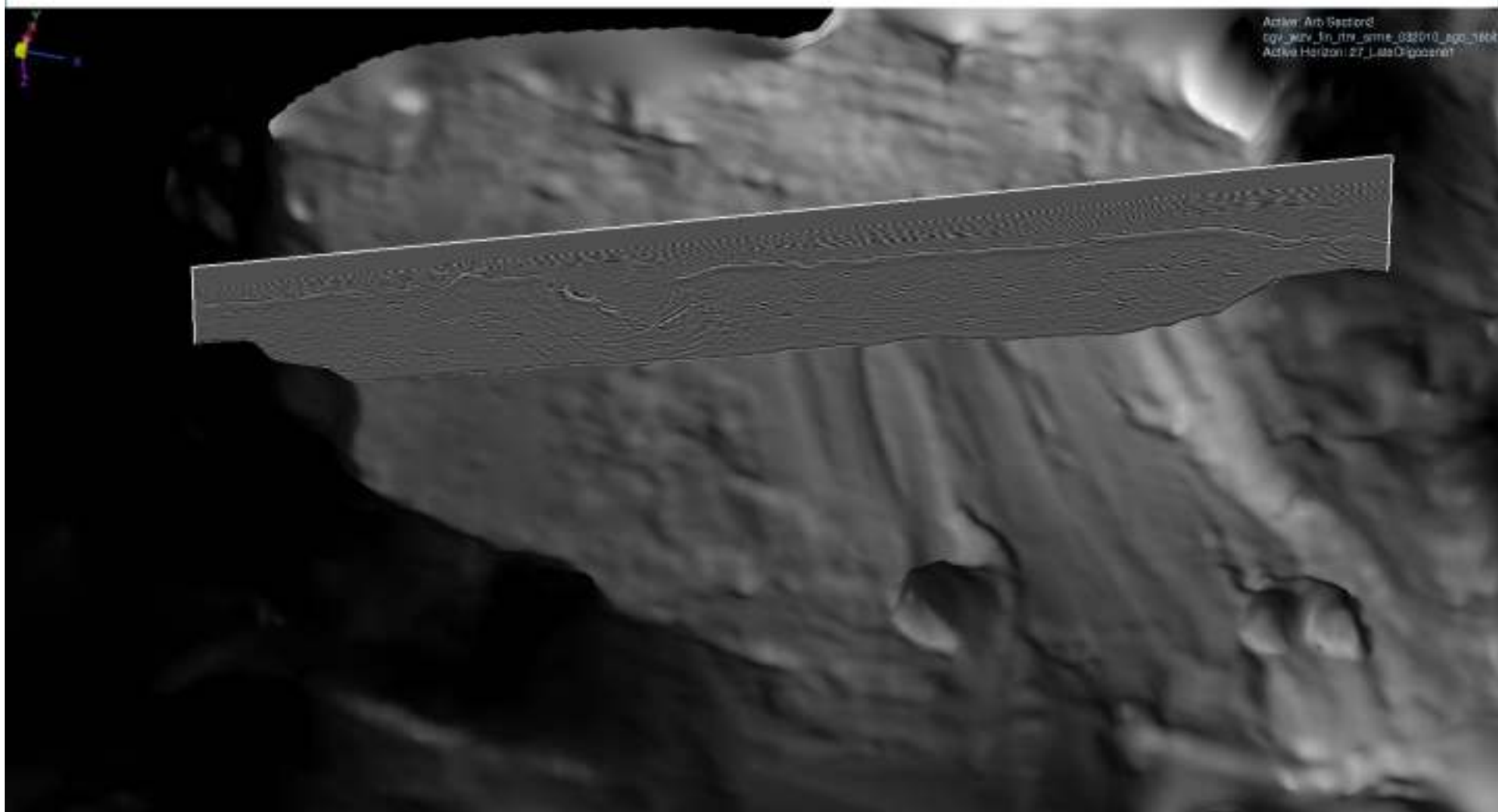
Mass Transport Grooves - Brazil



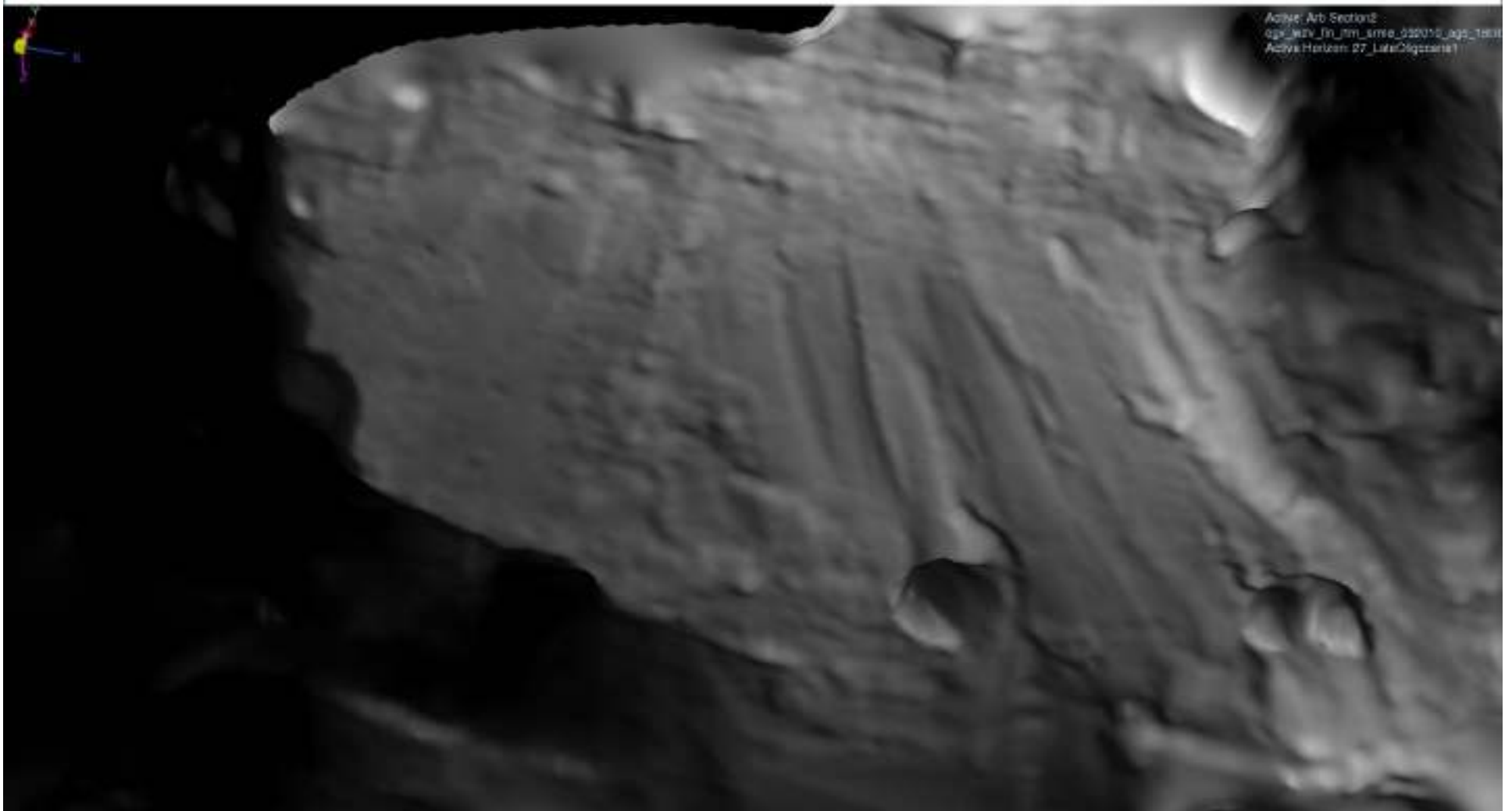
Grooves at Base of Salt

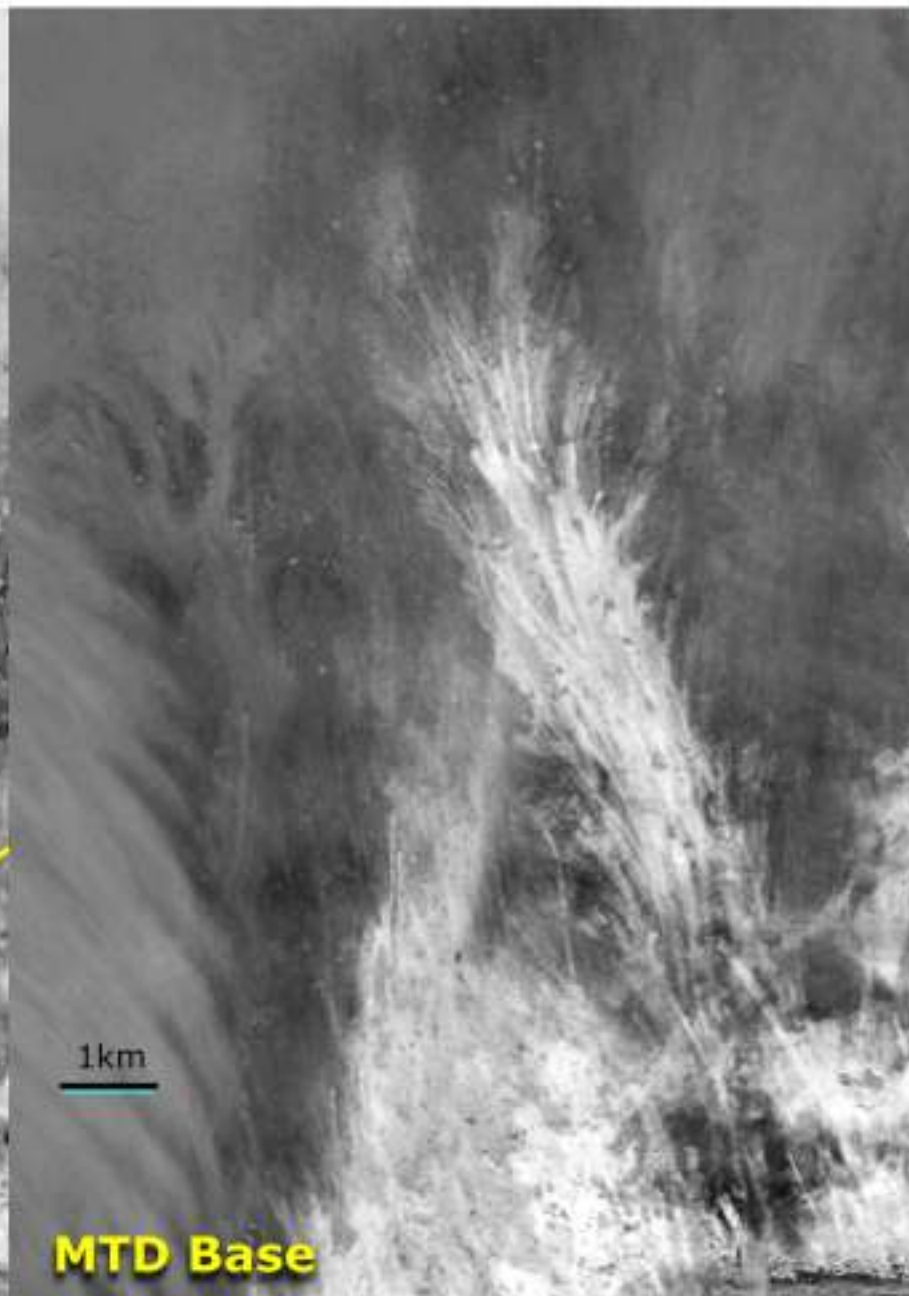
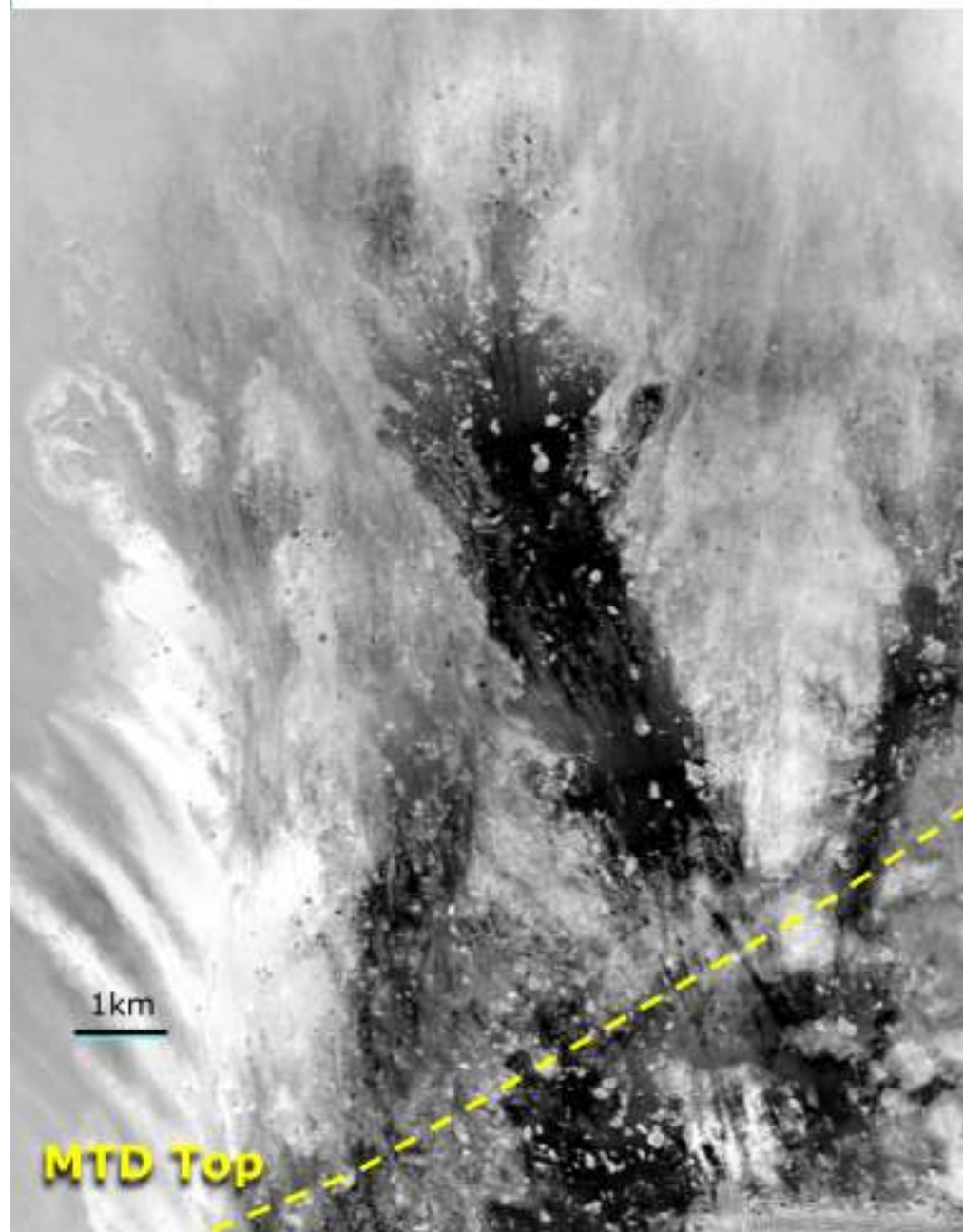


Grooves at Base of Salt



Grooves at Base of Salt

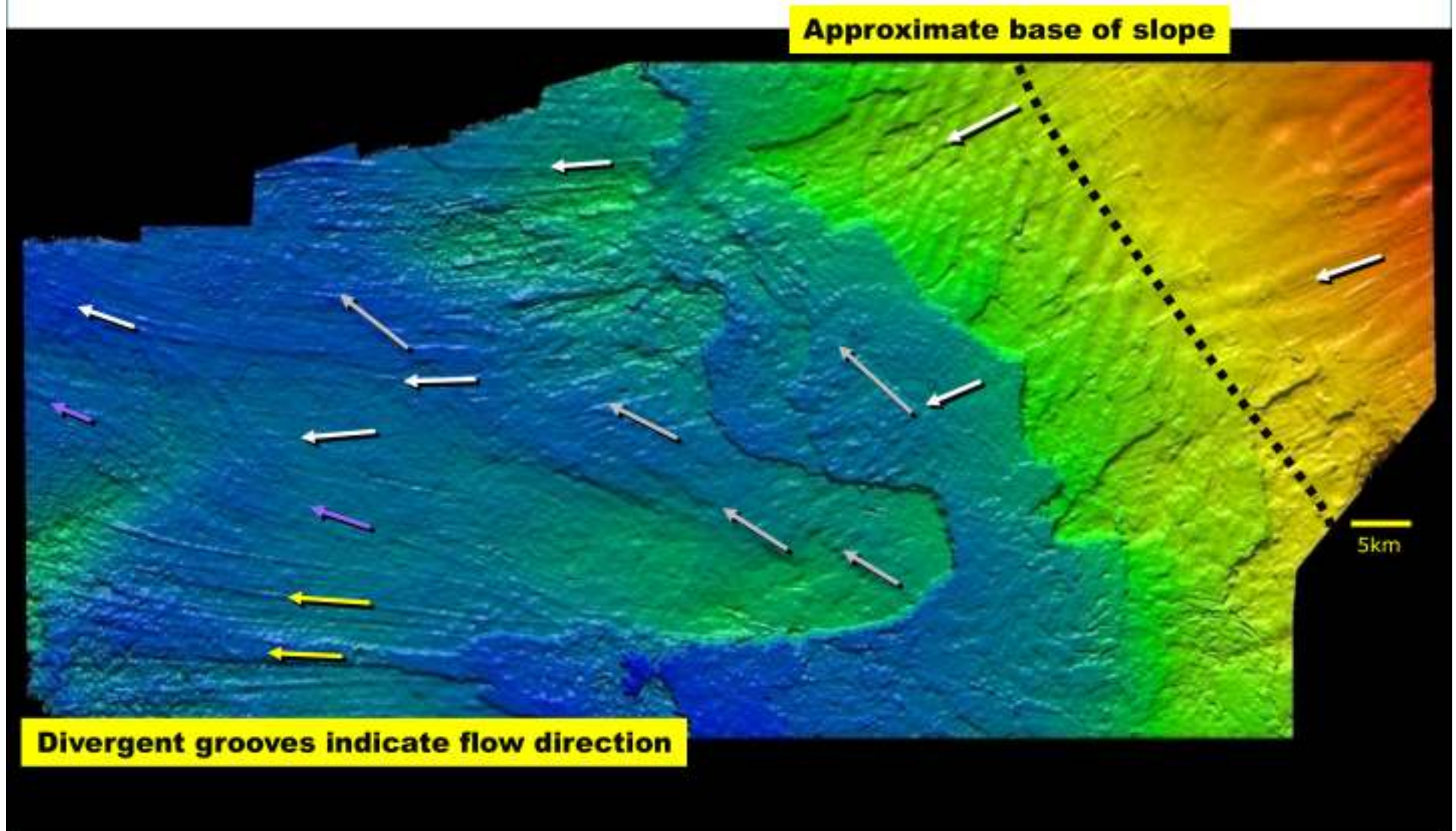




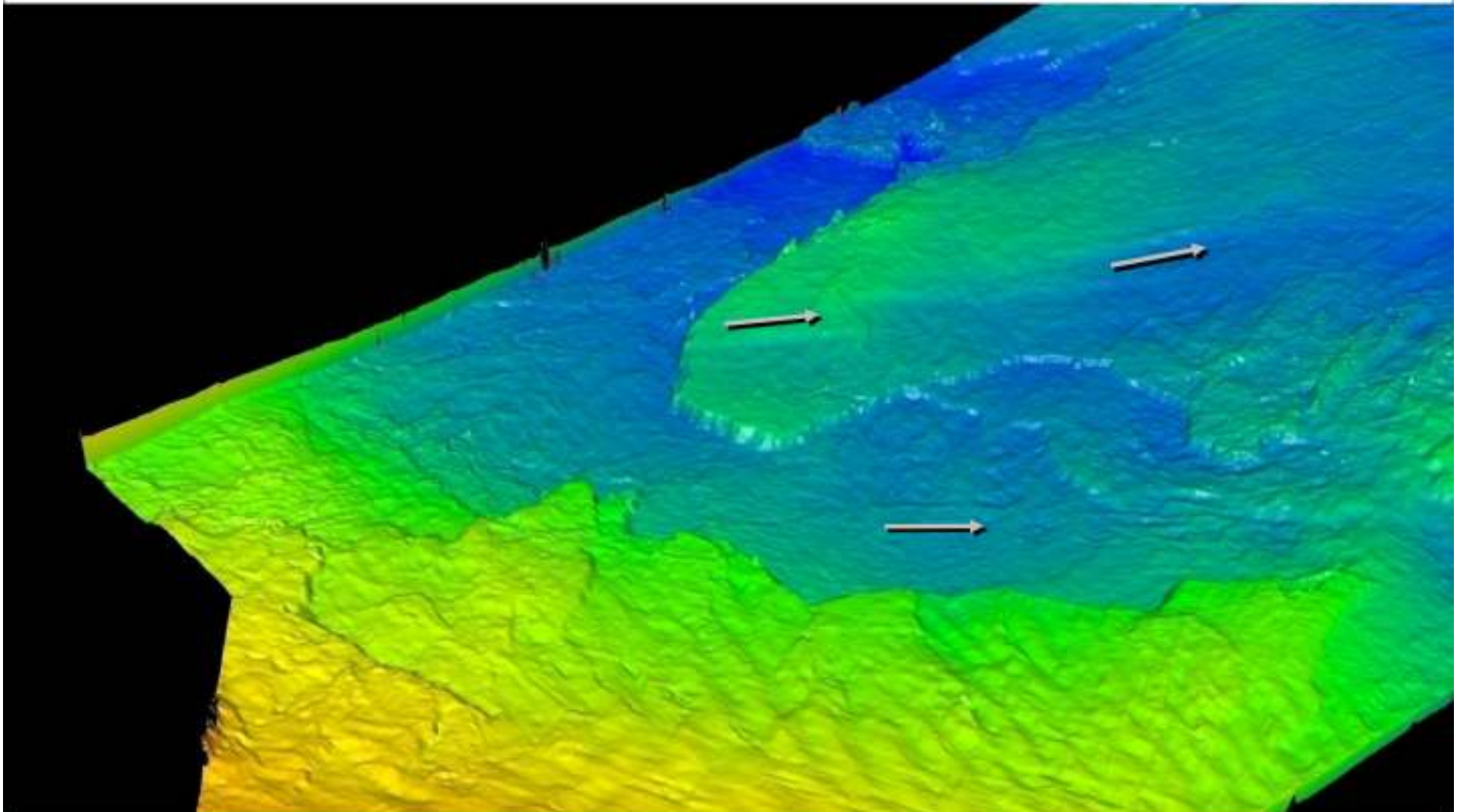
Note "clasts" with associated grooves



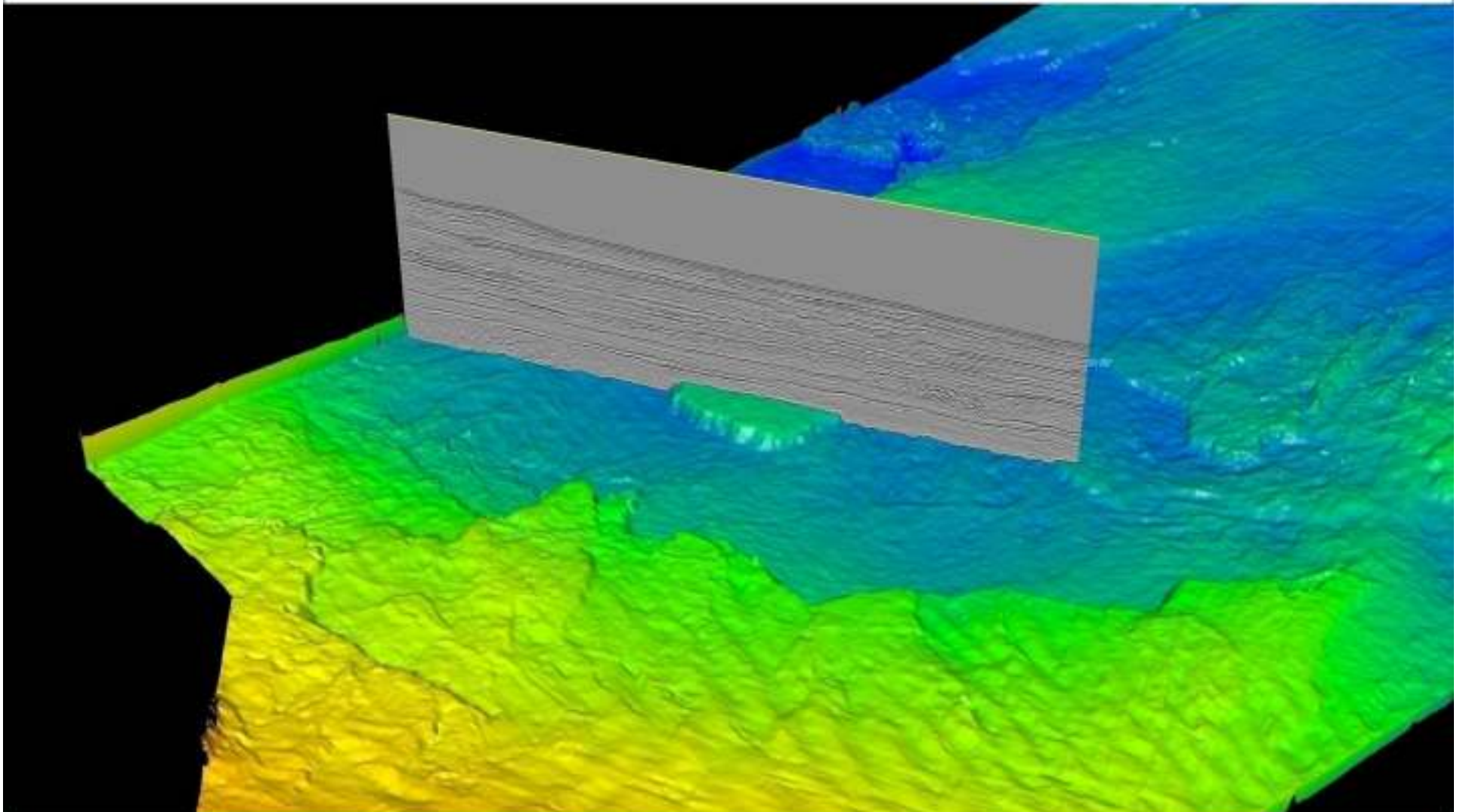
Sediment Transport Direction – Grooves Indicate Multiple Events



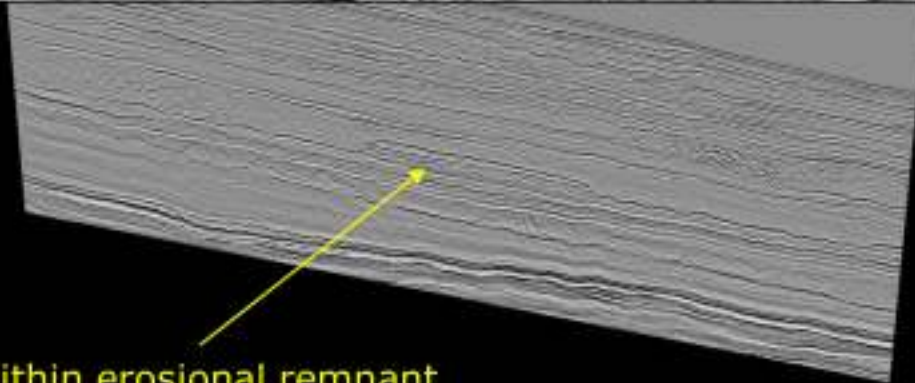
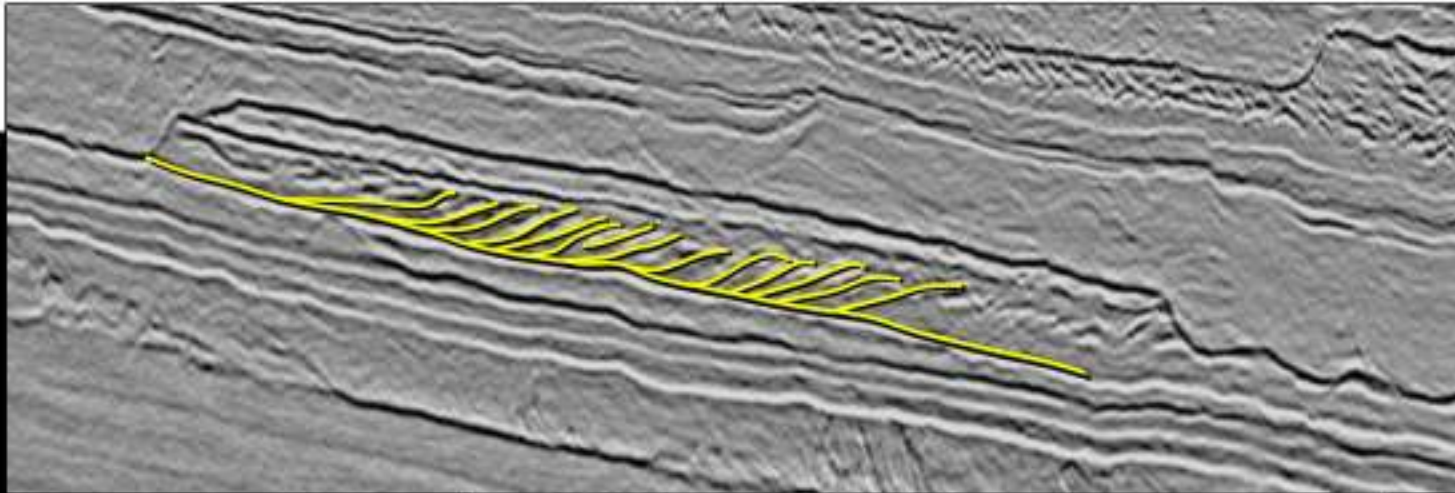
Sediment Transport Direction – Grooves Indicate Multiple Events



Transect Through Erosional Remnant

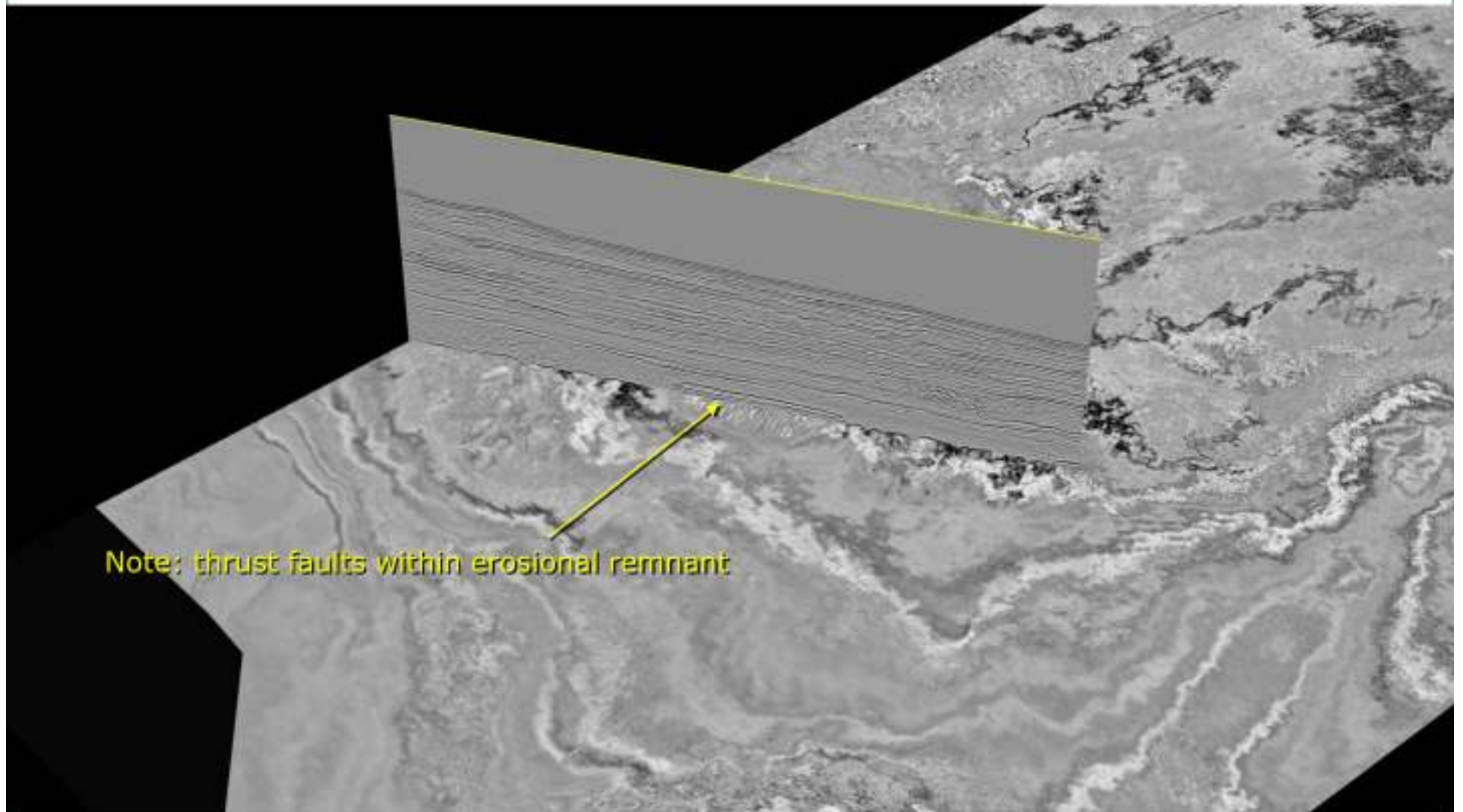


Transect Through Erosional Remnant

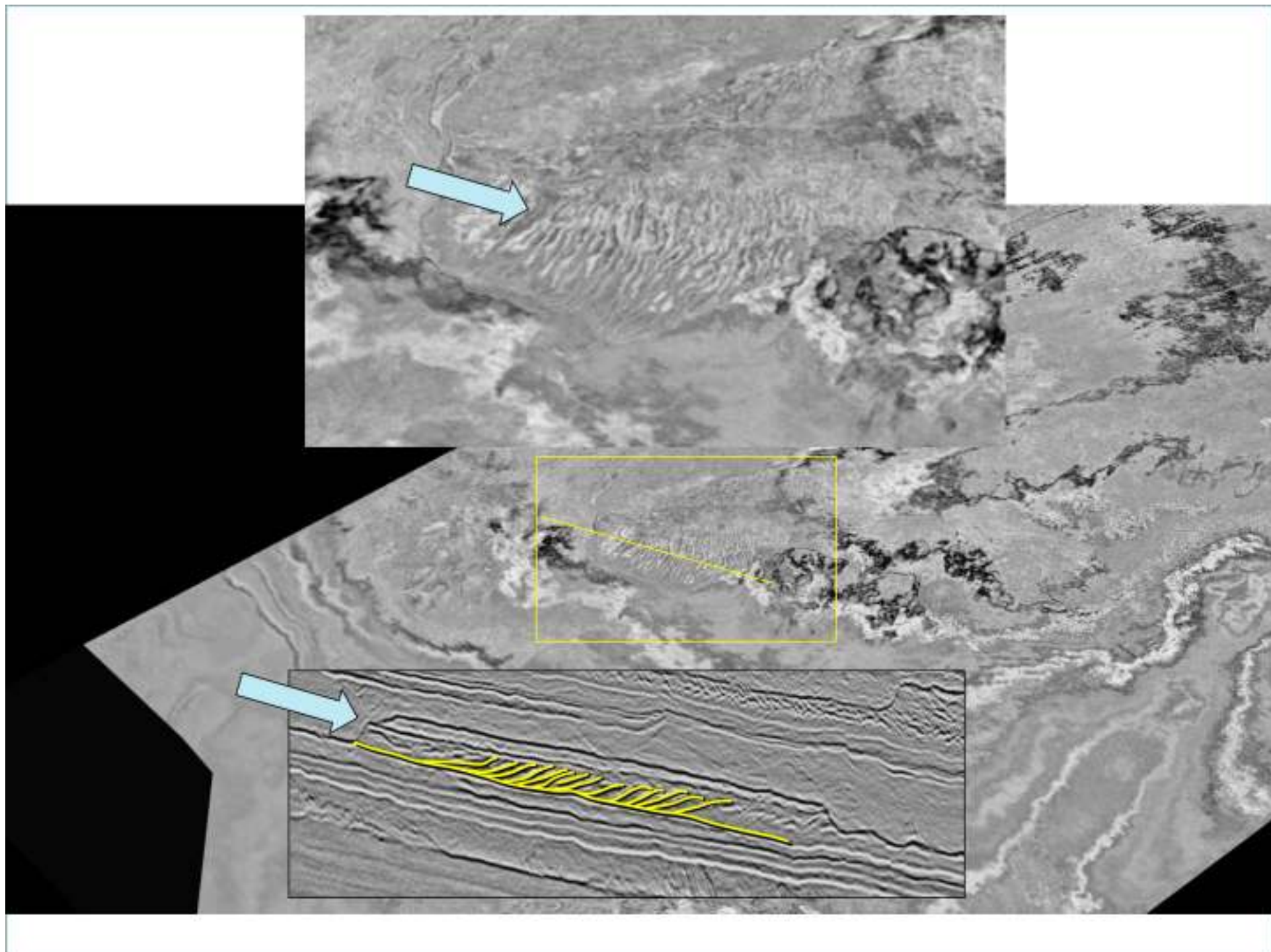


Note: thrust faults within erosional remnant

Transect Through Erosional Remnant

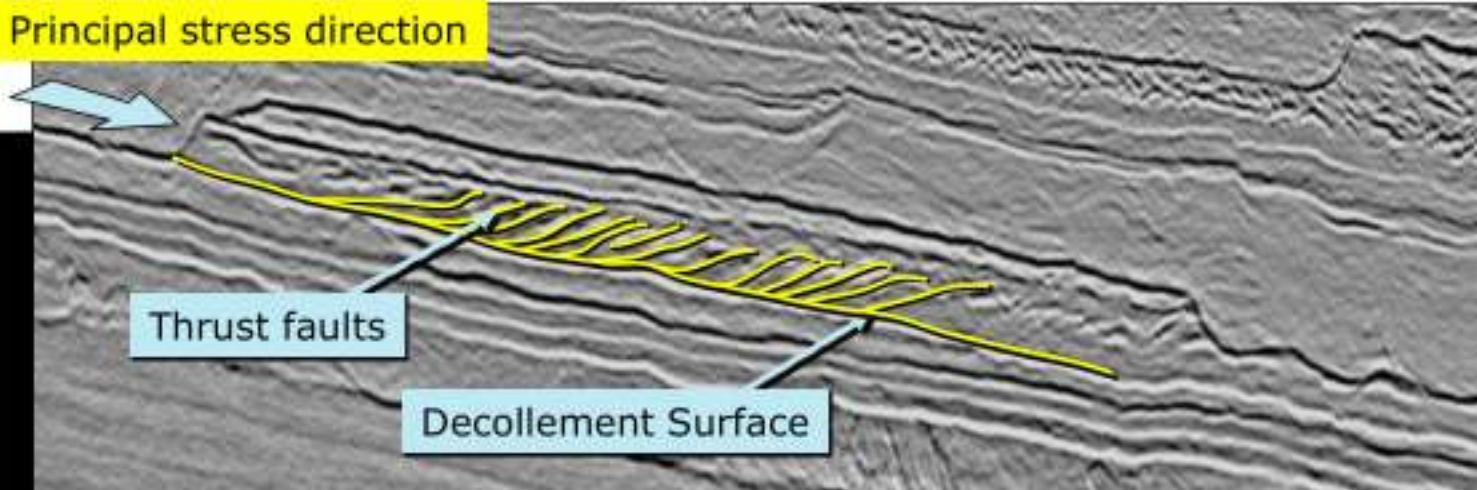


Note: thrust faults within erosional remnant



Transect Through Erosional Remnant

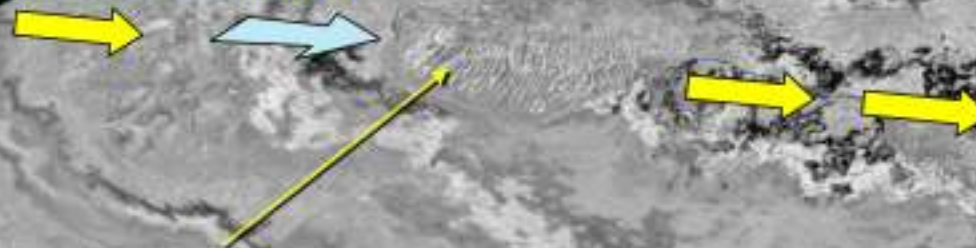
Principal stress direction



Principal stress direction

Note: thrust faults within erosional remnant

Faults indirectly indicate MTD flow direction



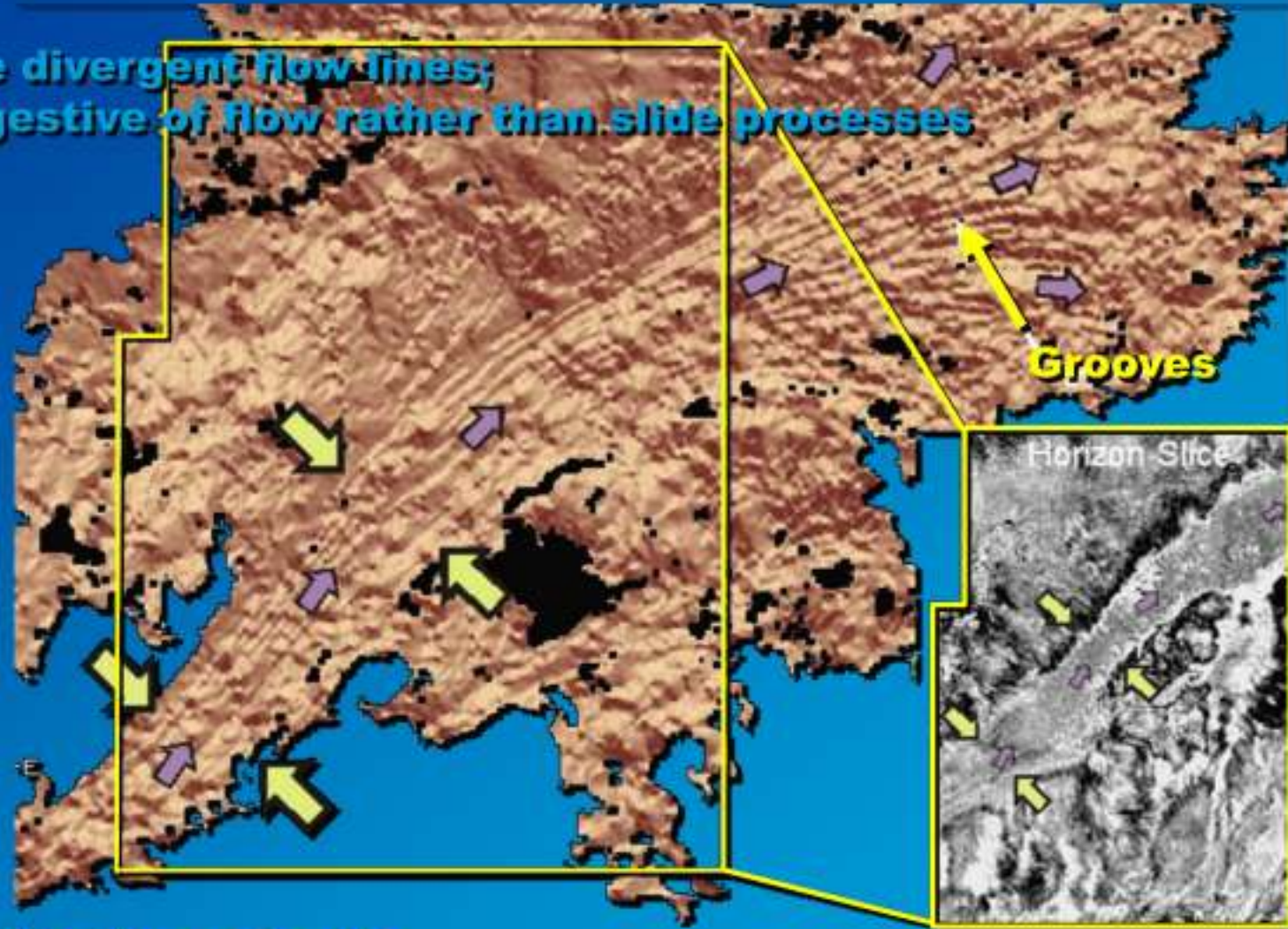
Base of Channelized Debris Flow Deposit

Note divergent flow lines;
suggestive of flow rather than slide processes

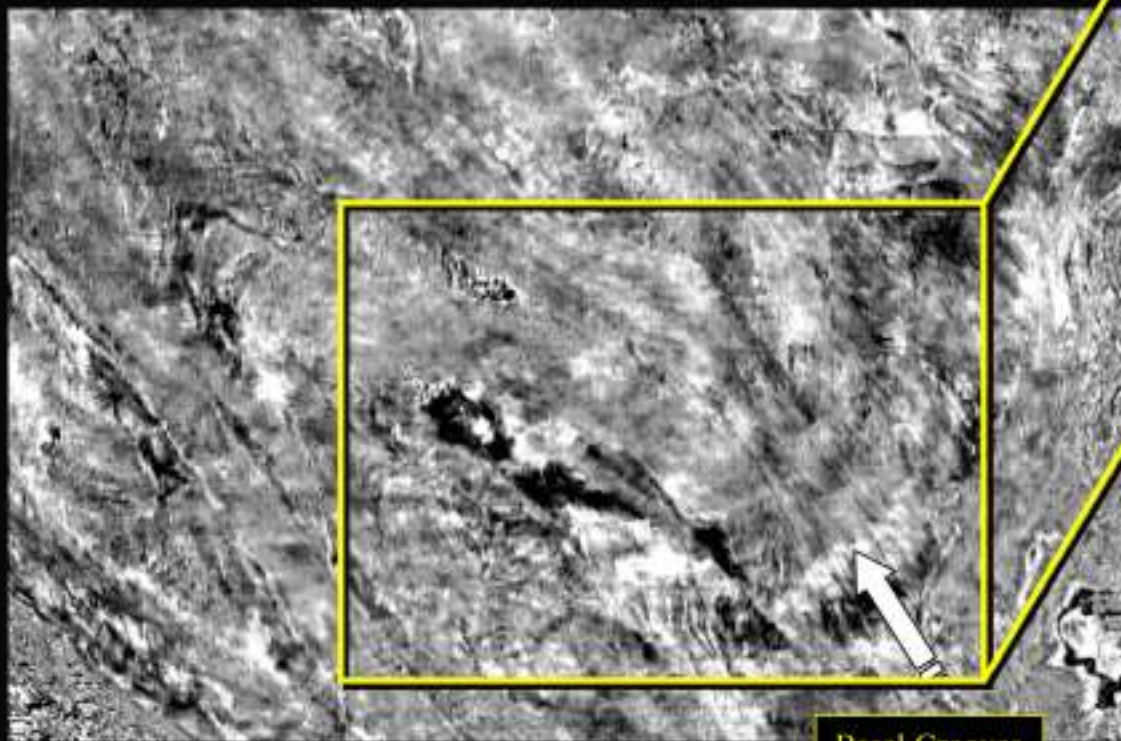
Grooves

Horizon Slice

Reflection Azimuth

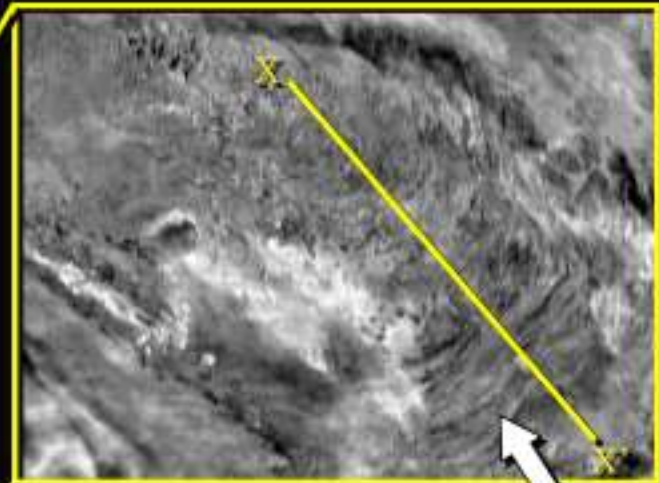


Debris Flow; Base & Top

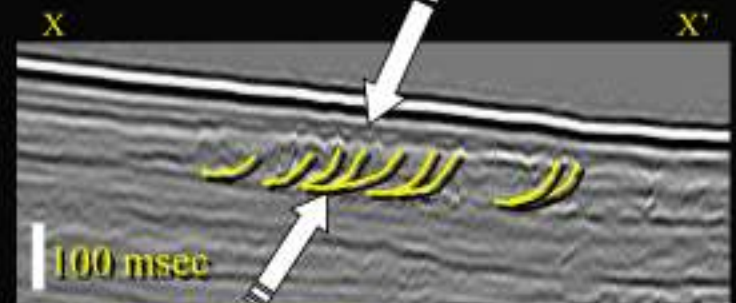


five km

Basal Grooves



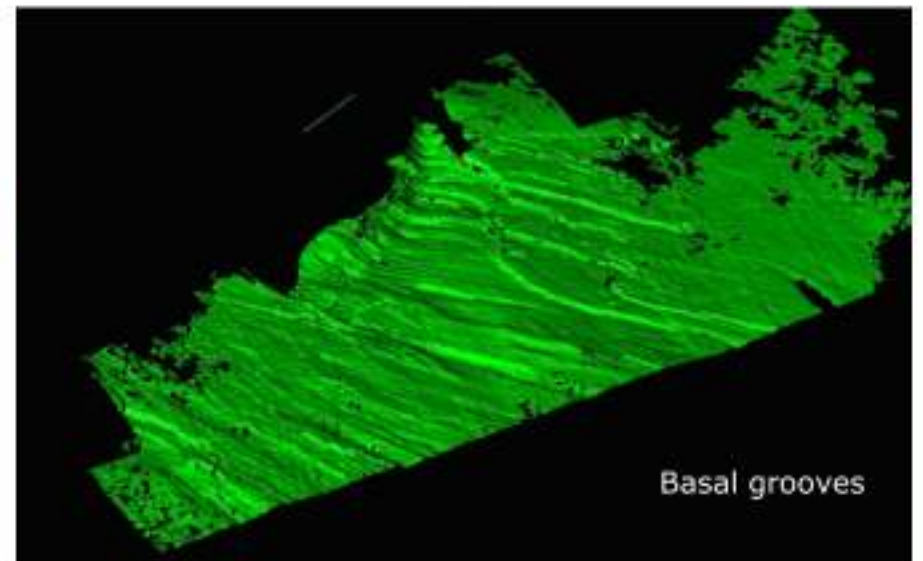
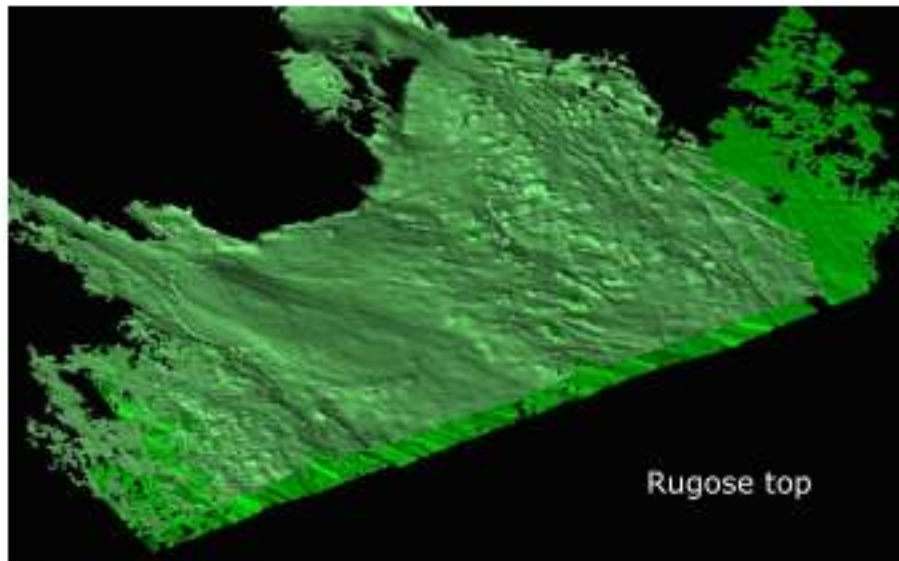
Pressure Ridges

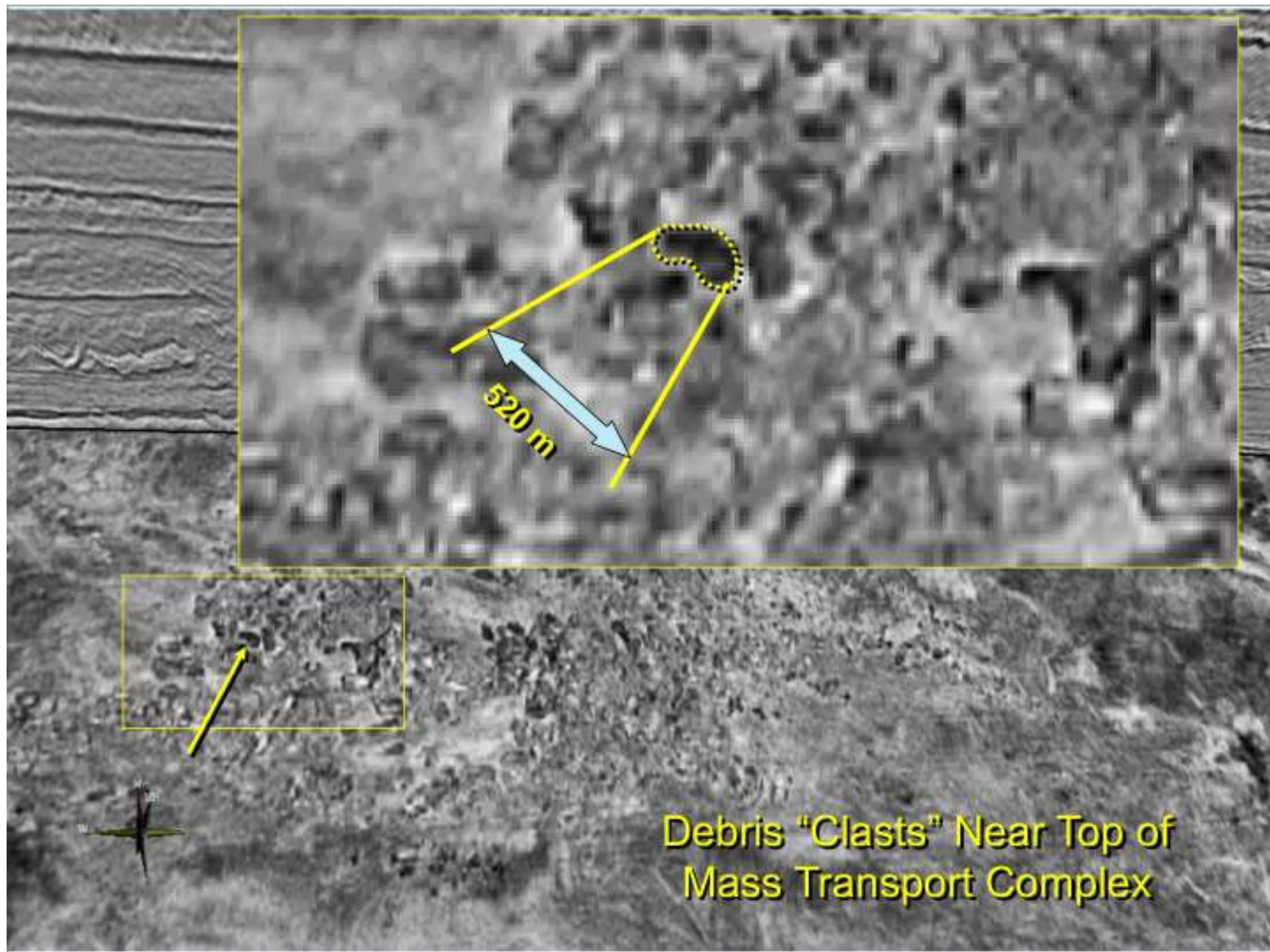


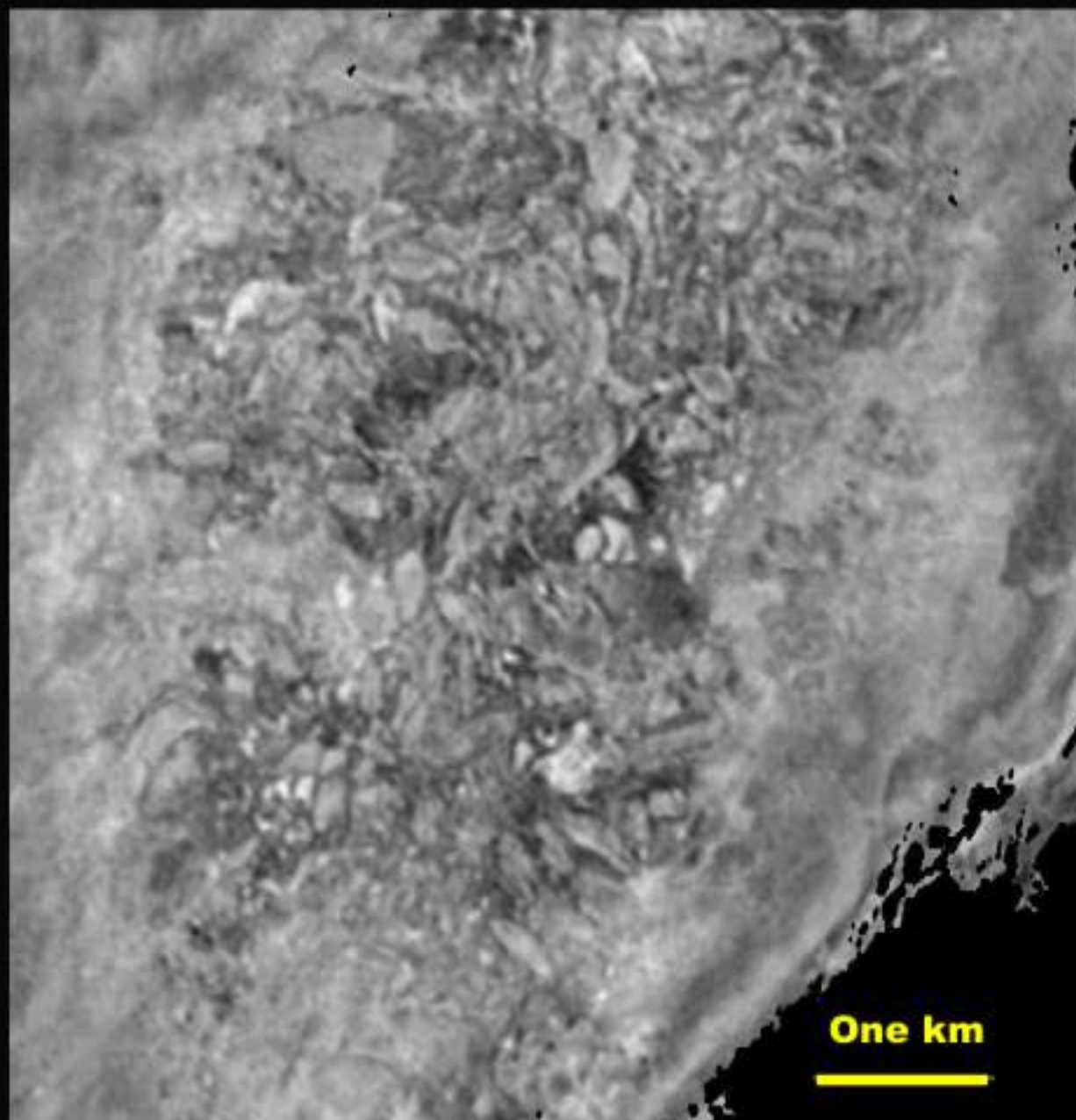
Basal Grooves

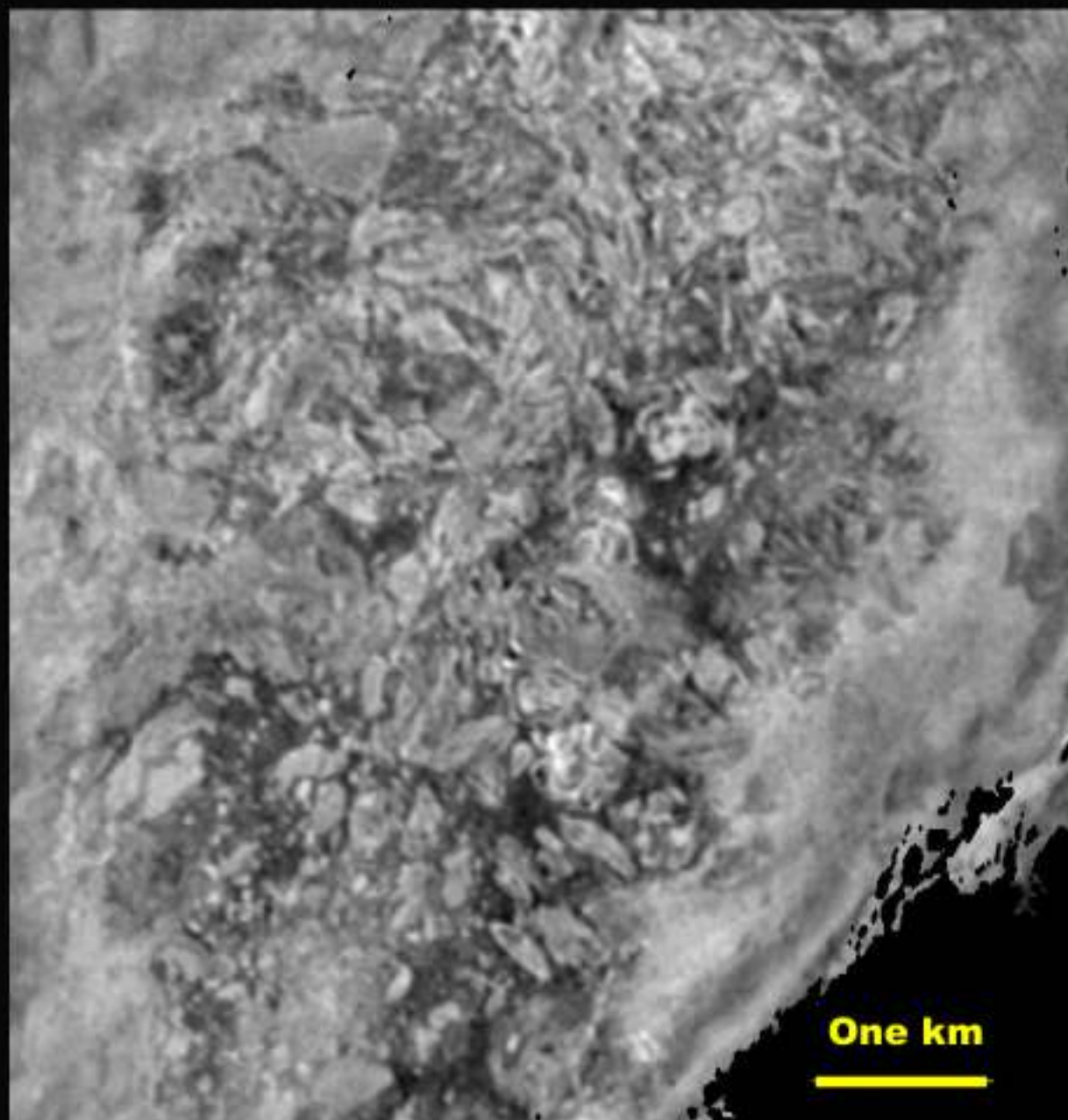
one km

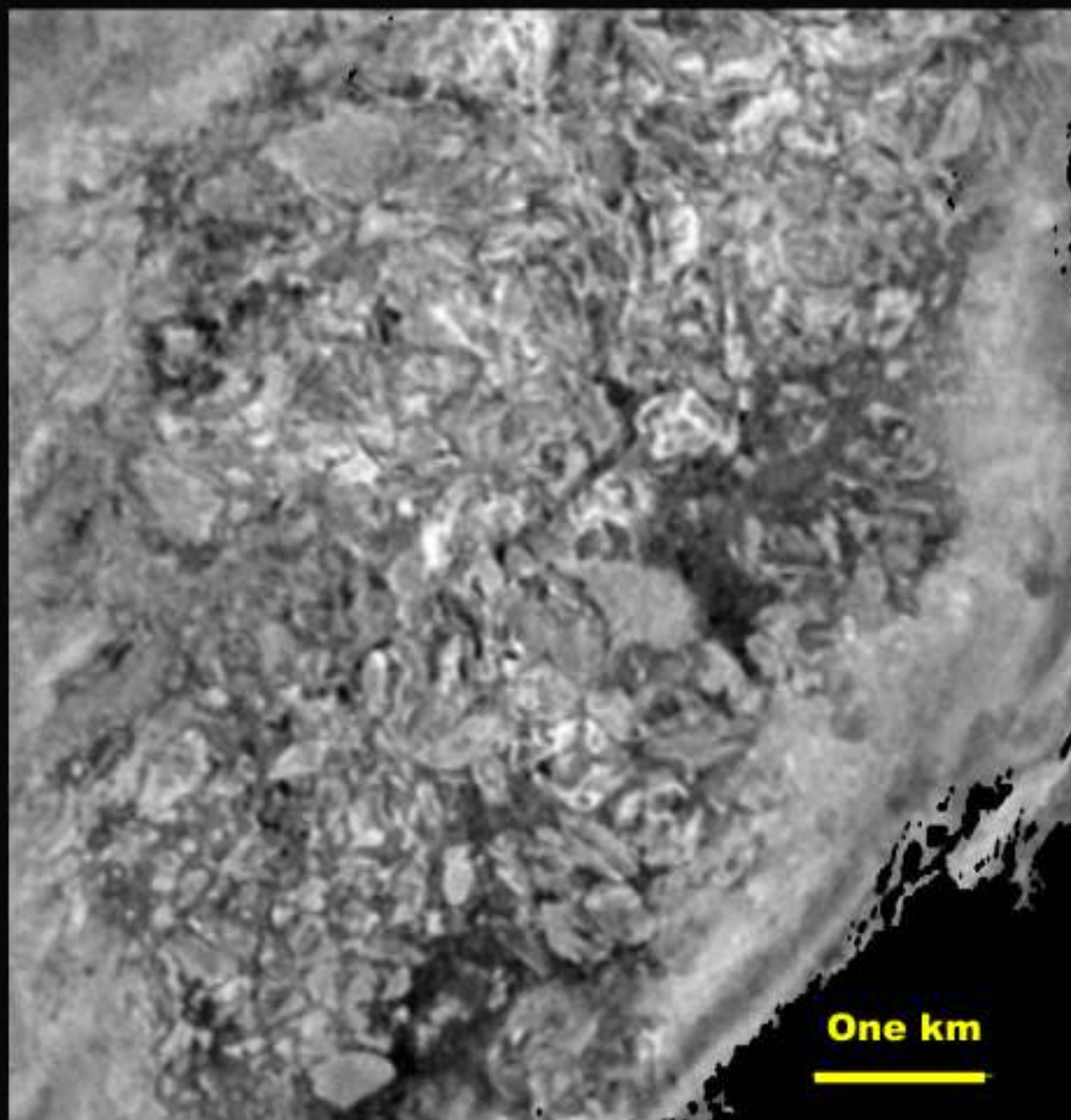
Mass Transport Deposit – Basal Grooves and Rugose Top



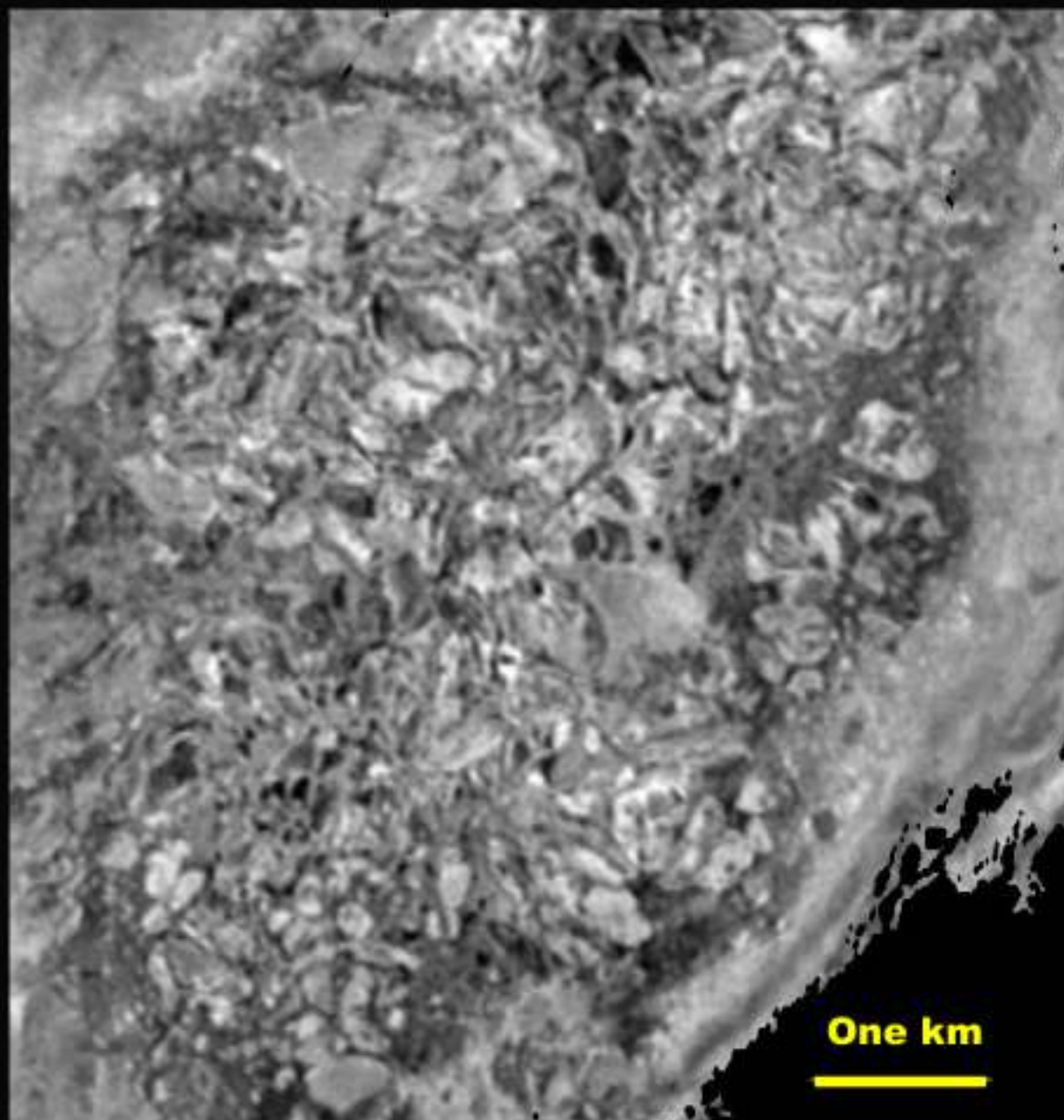




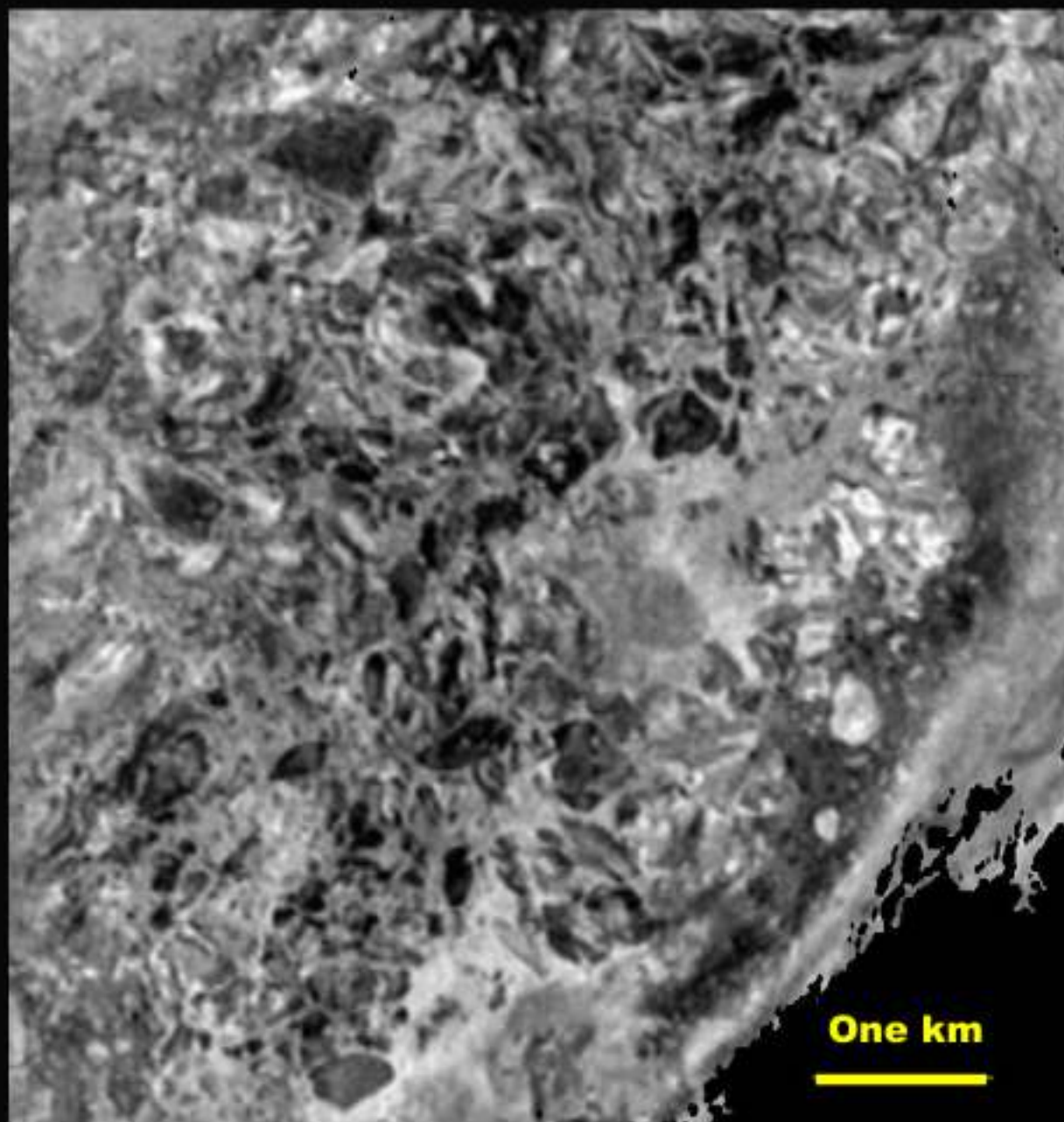




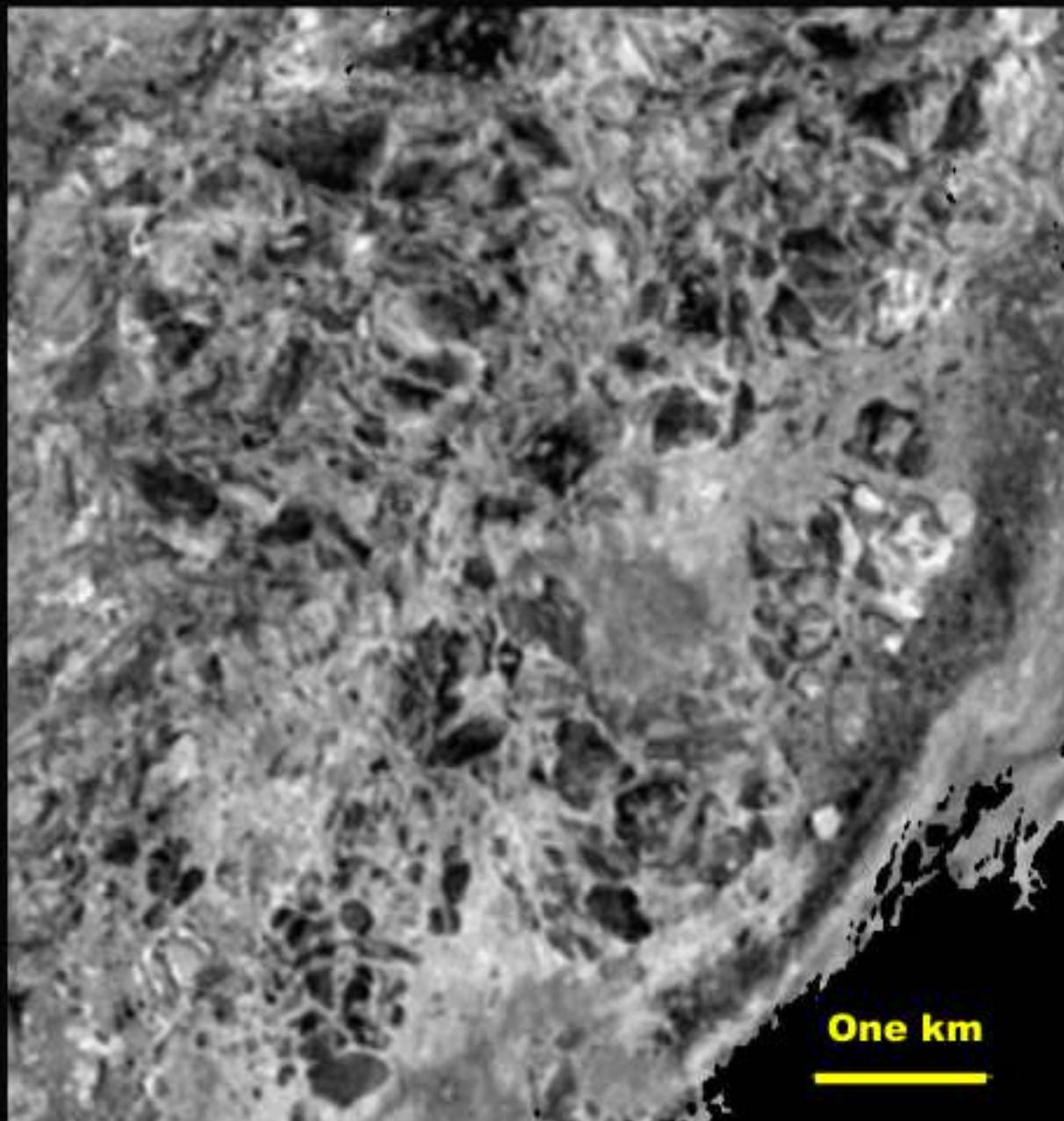
One km

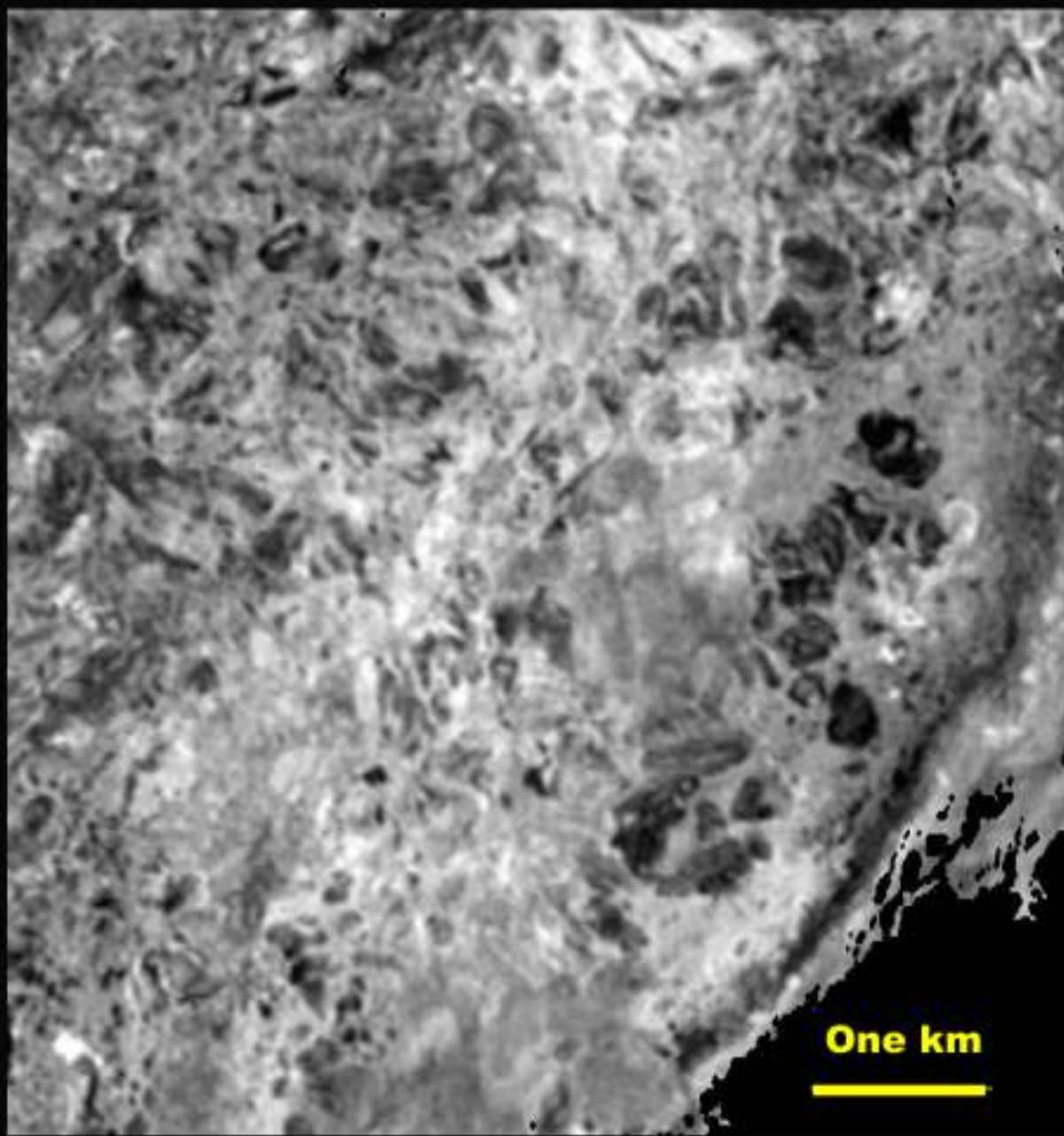


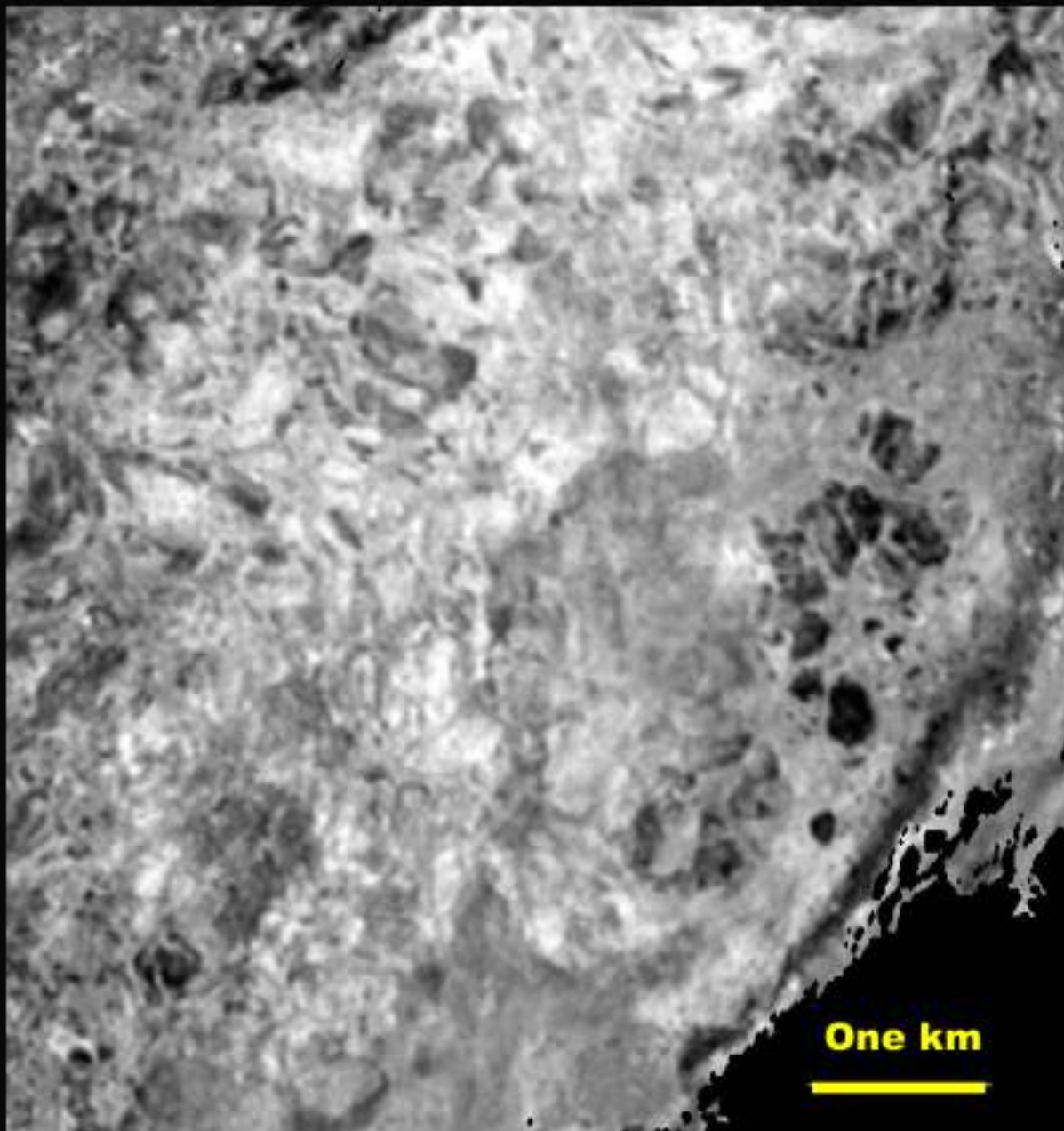
One km



One km

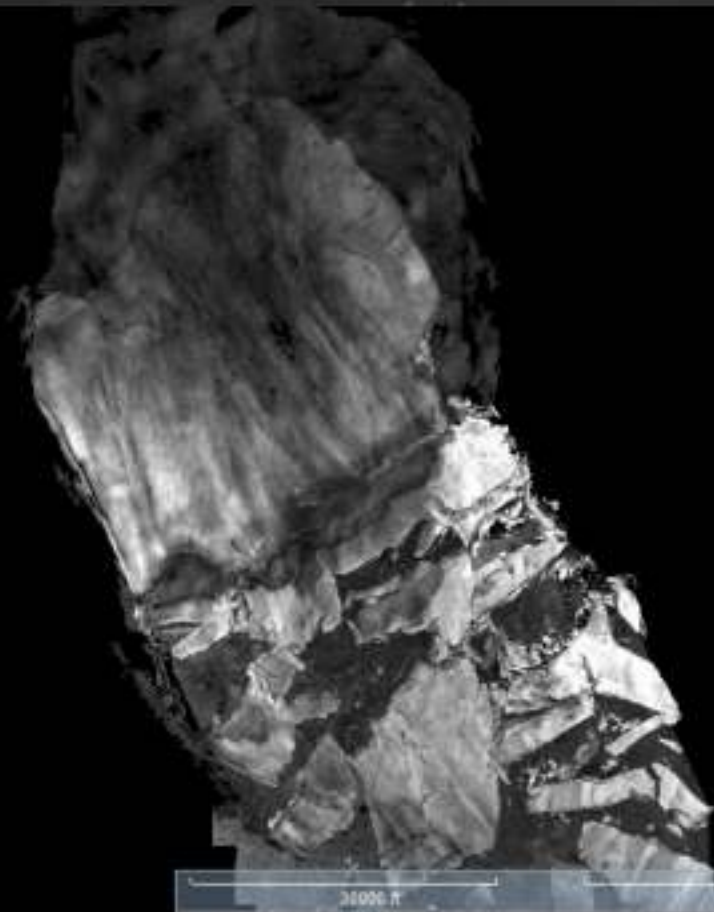






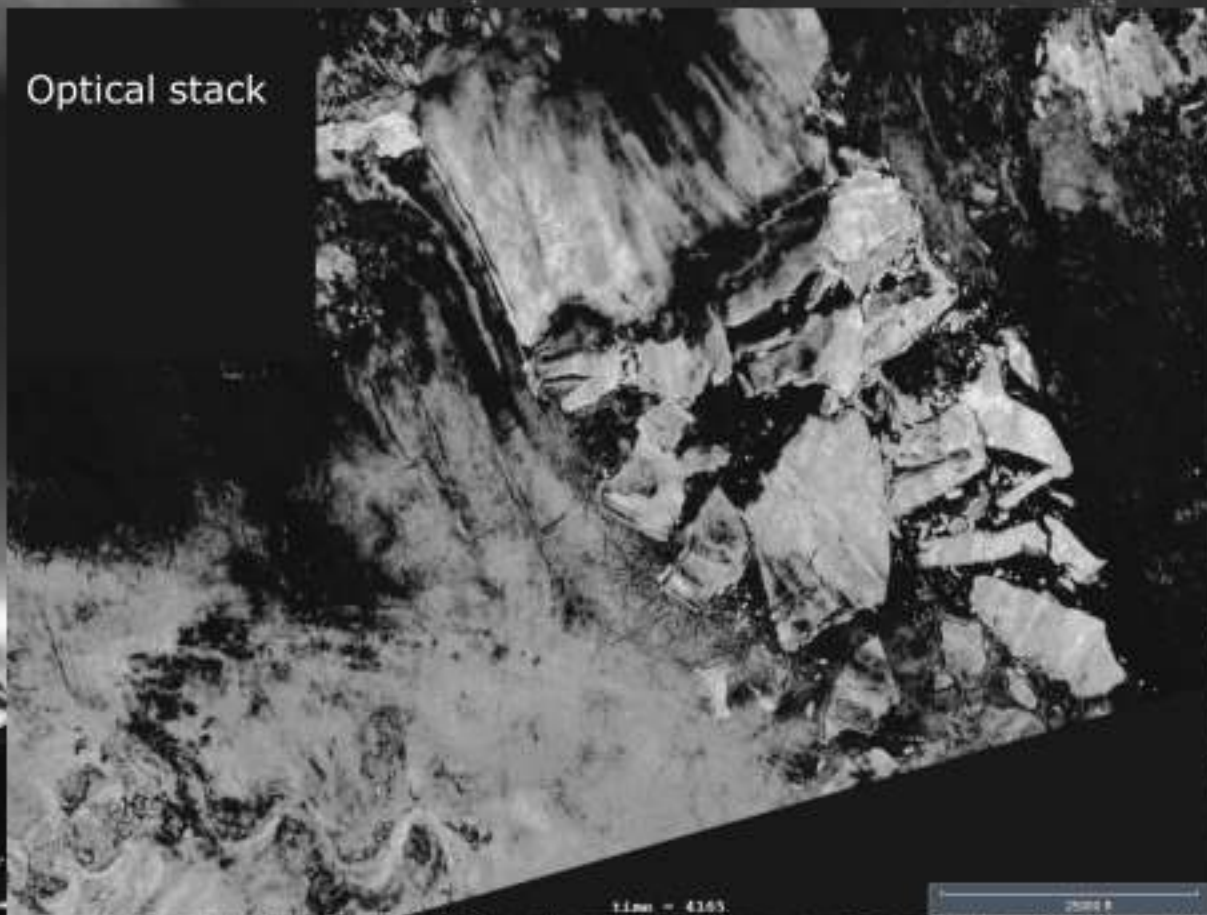
MASS TRANSPORT DEPOSITS – SLIDE

Horizon slice



MASS TRANSPORT DEPOSITS – SLIDE

Optical stack



time = 4163

0000 0

MASS TRANSPORT DEPOSITS – SLIDE

Reflection amplitude (interpreted horizon) – not illuminated

25000 ft

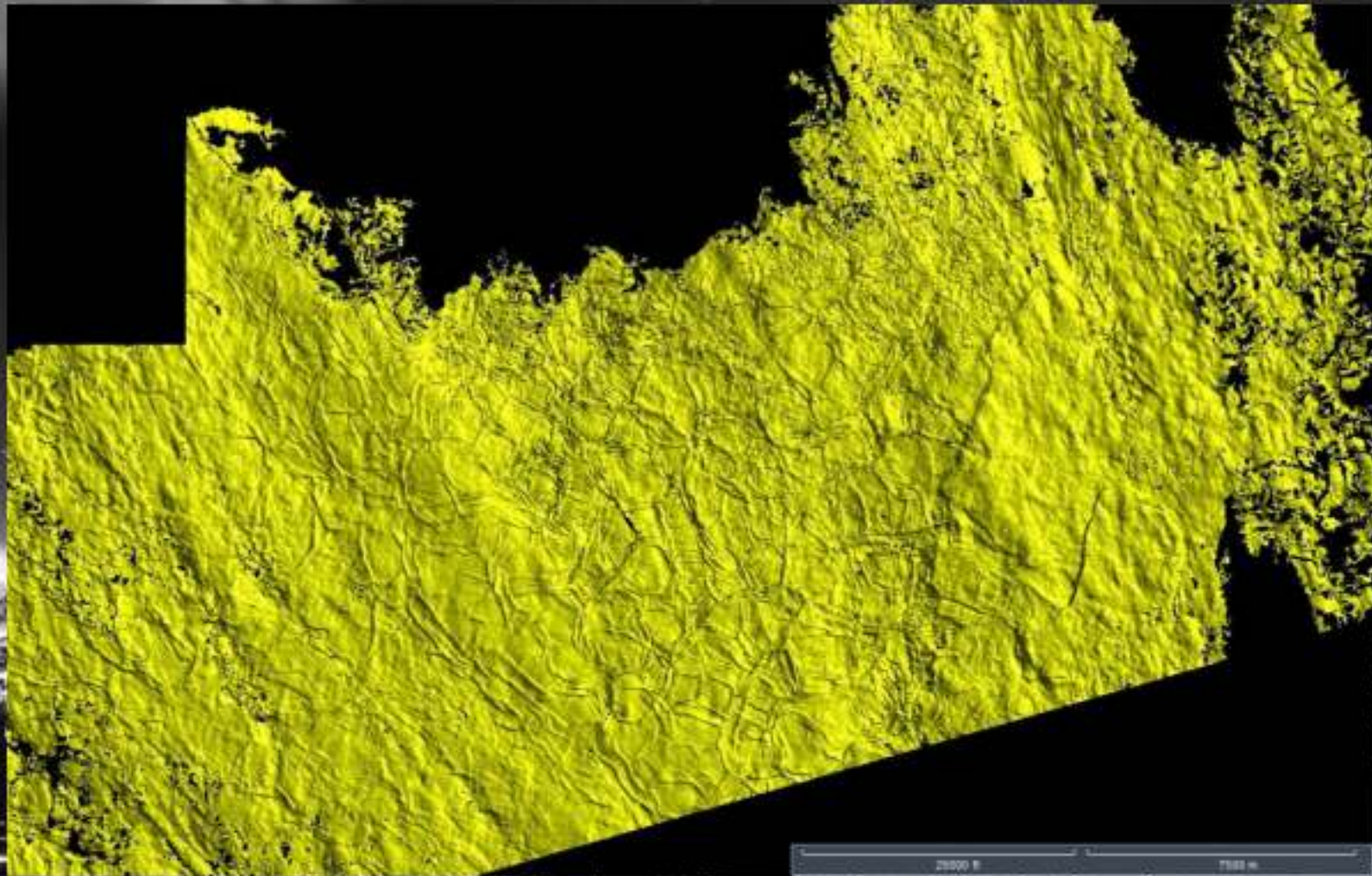
1500 m

MASS TRANSPORT DEPOSITS – SLIDE

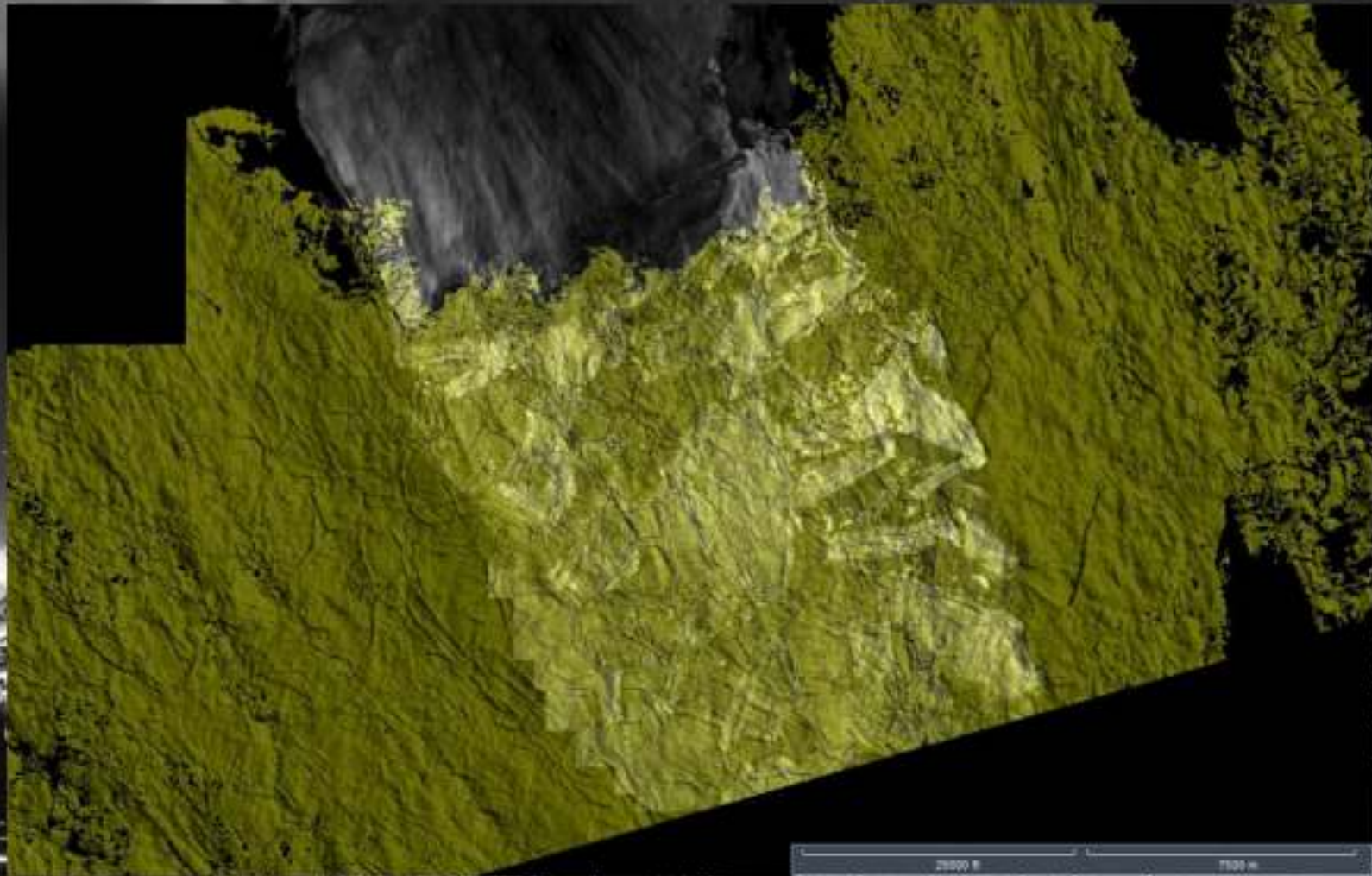
Reflection amplitude (interpreted horizon) – illuminated



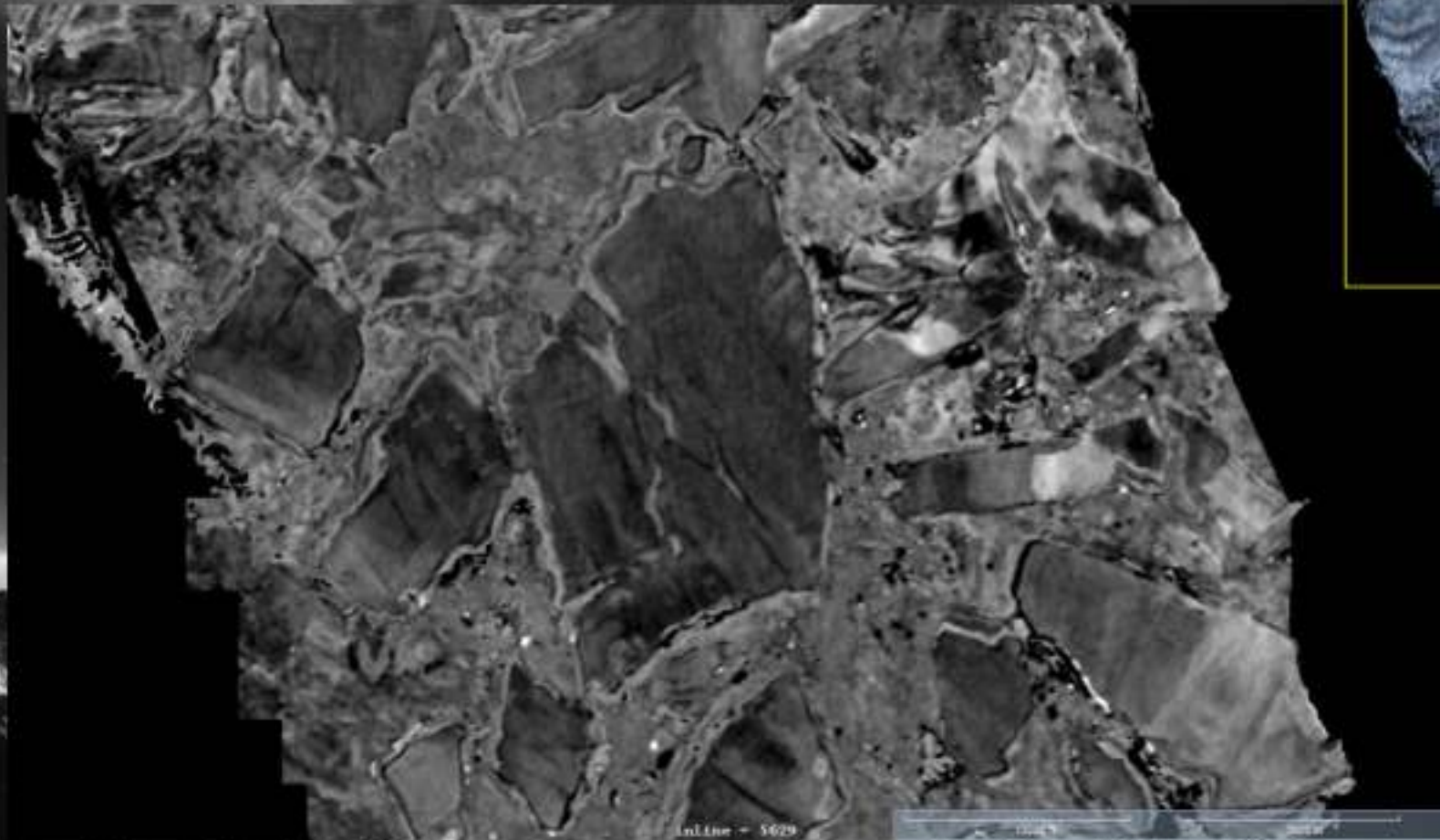
MUDSTONE OVERLYING MTD

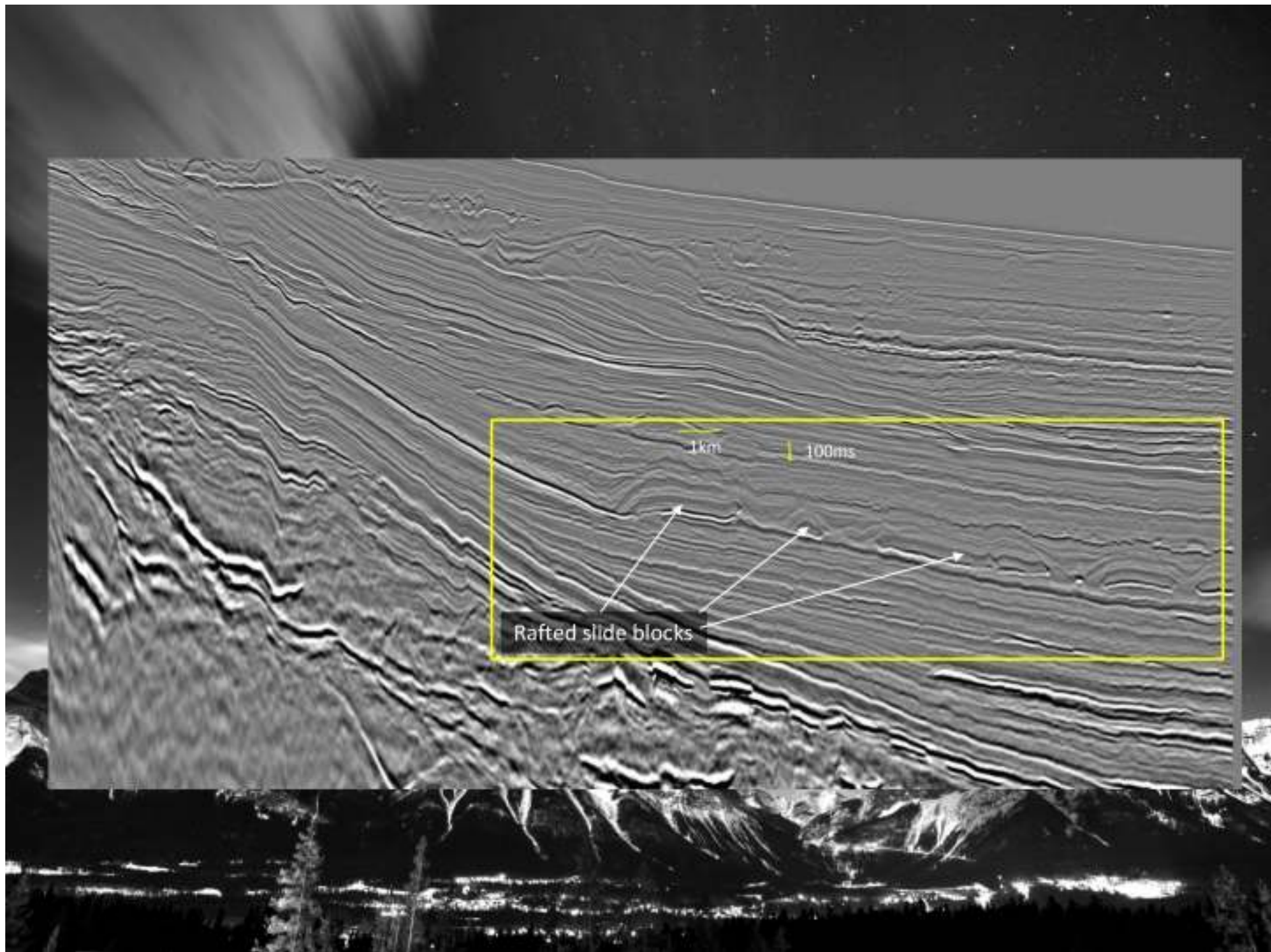


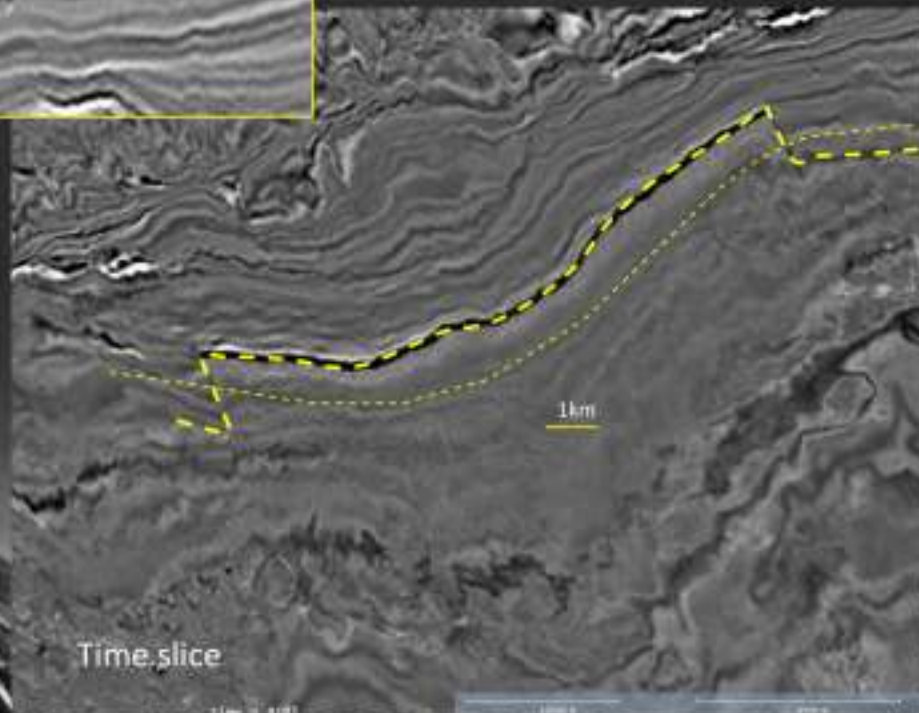
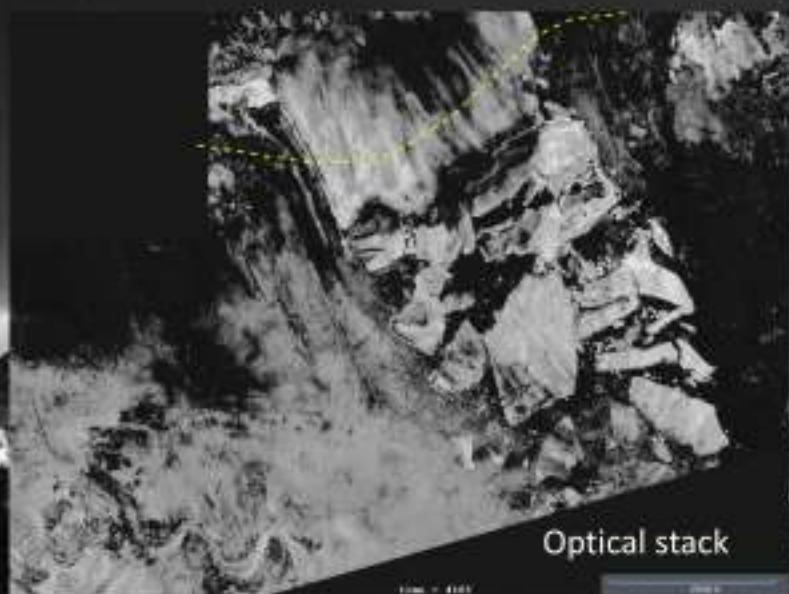
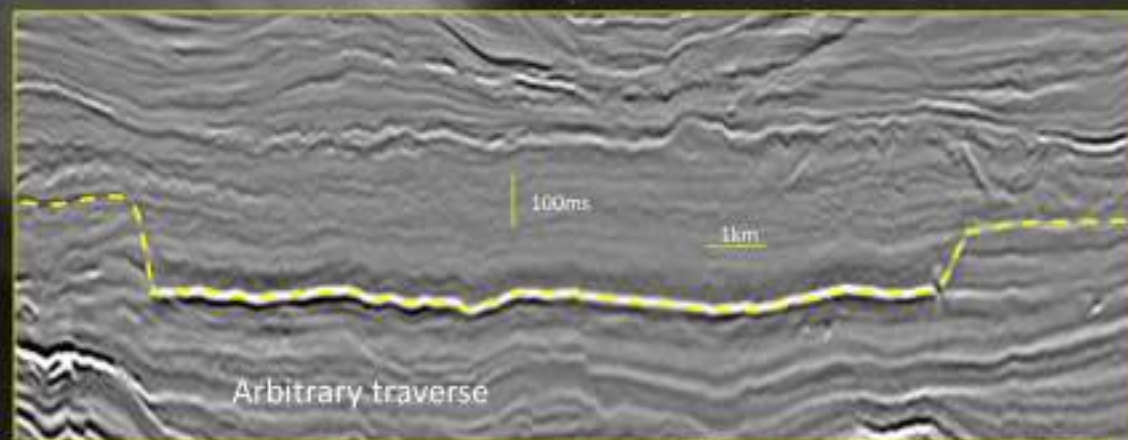
MUDSTONE OVERLYING MTD – CO-RENDERED WITH MTD

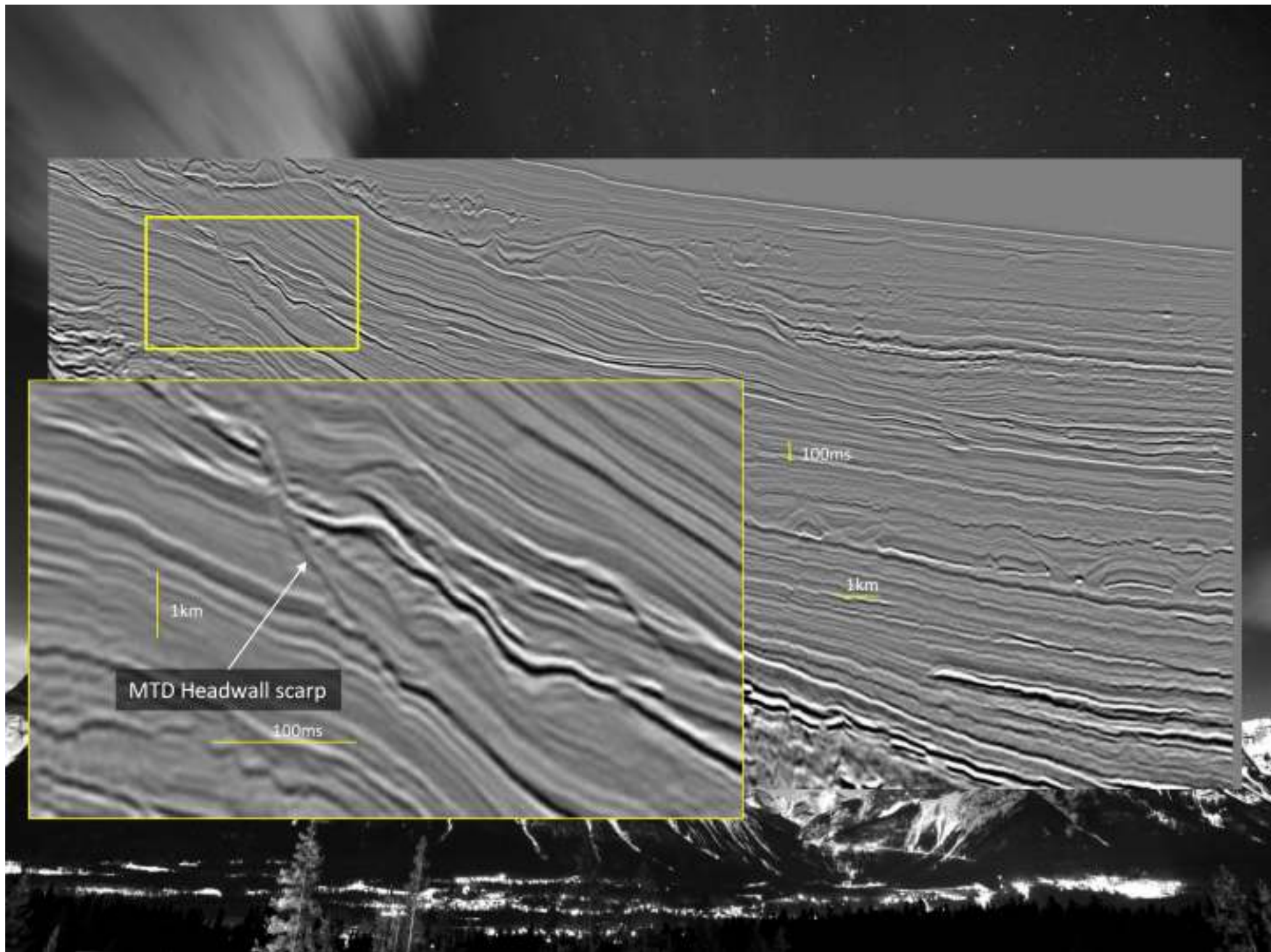


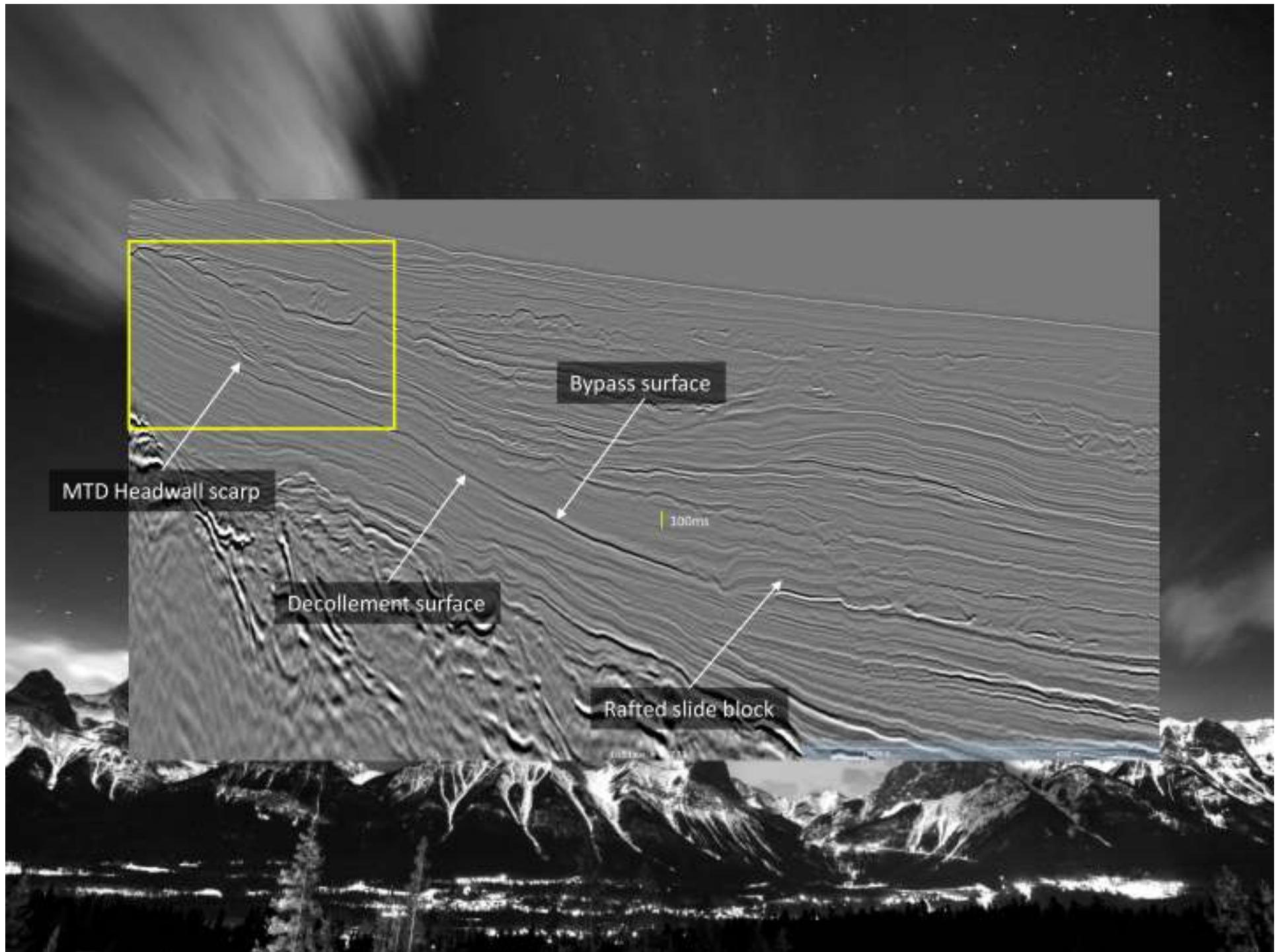
SLIDE BLOCKS - DETAIL



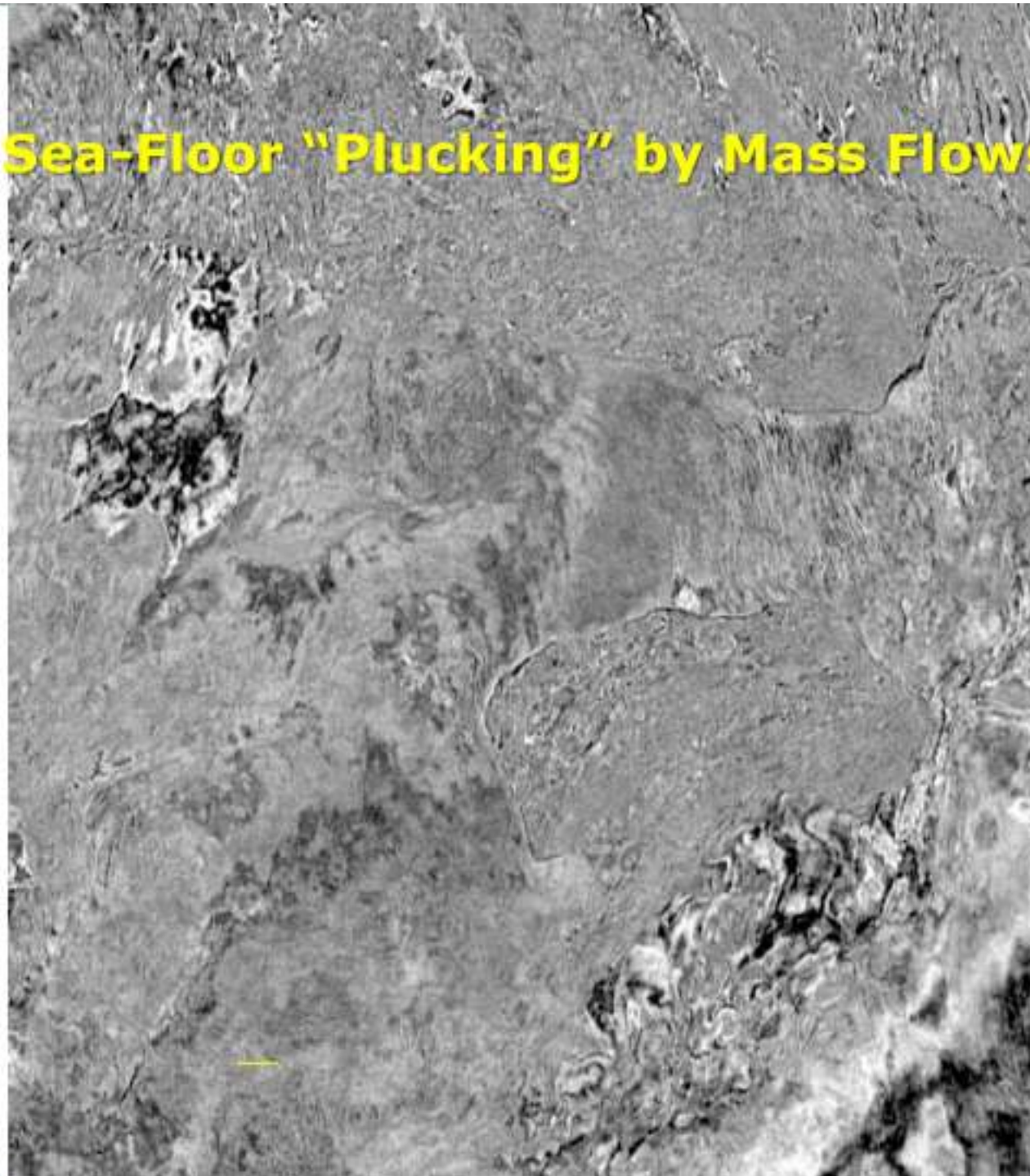




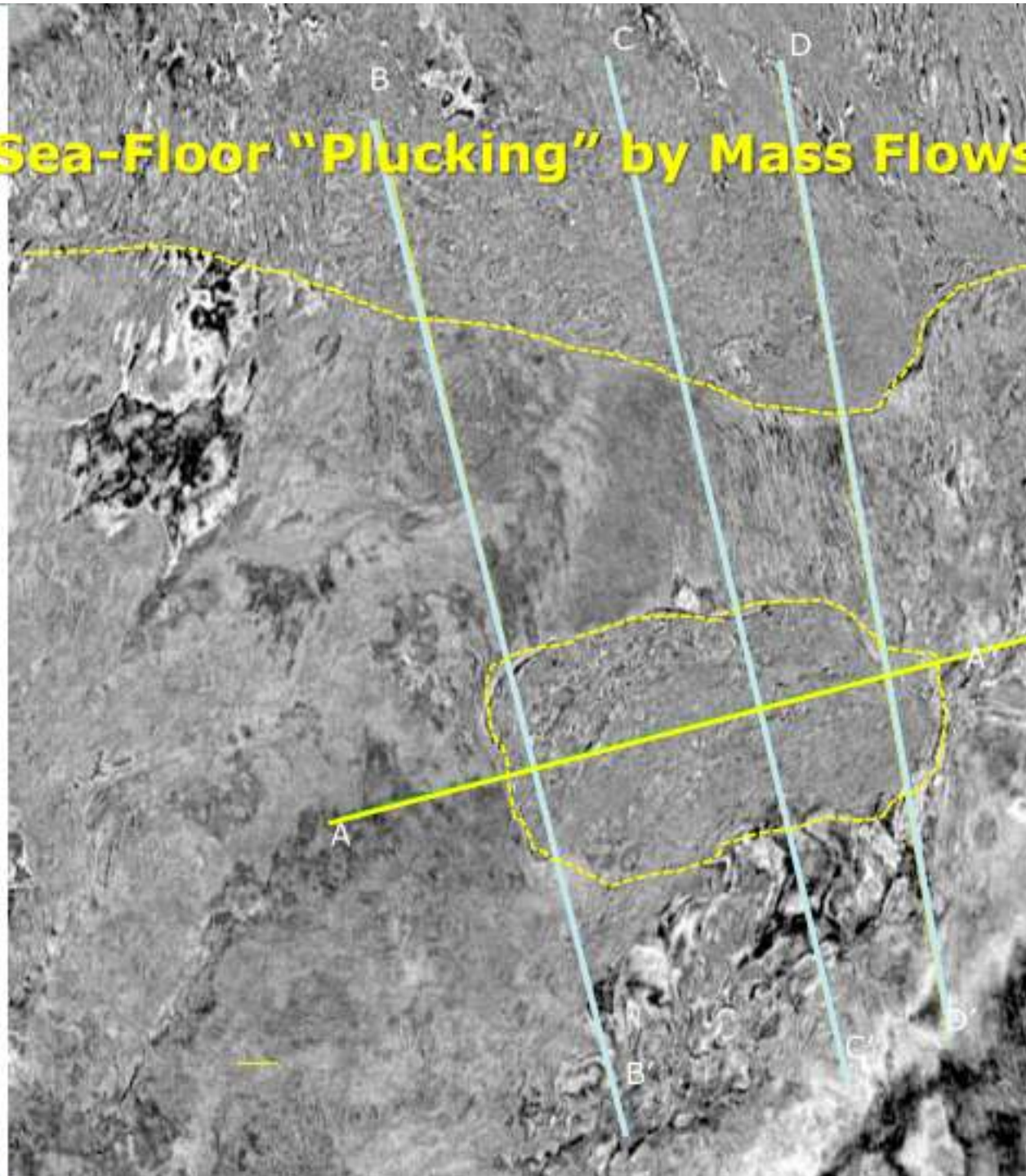


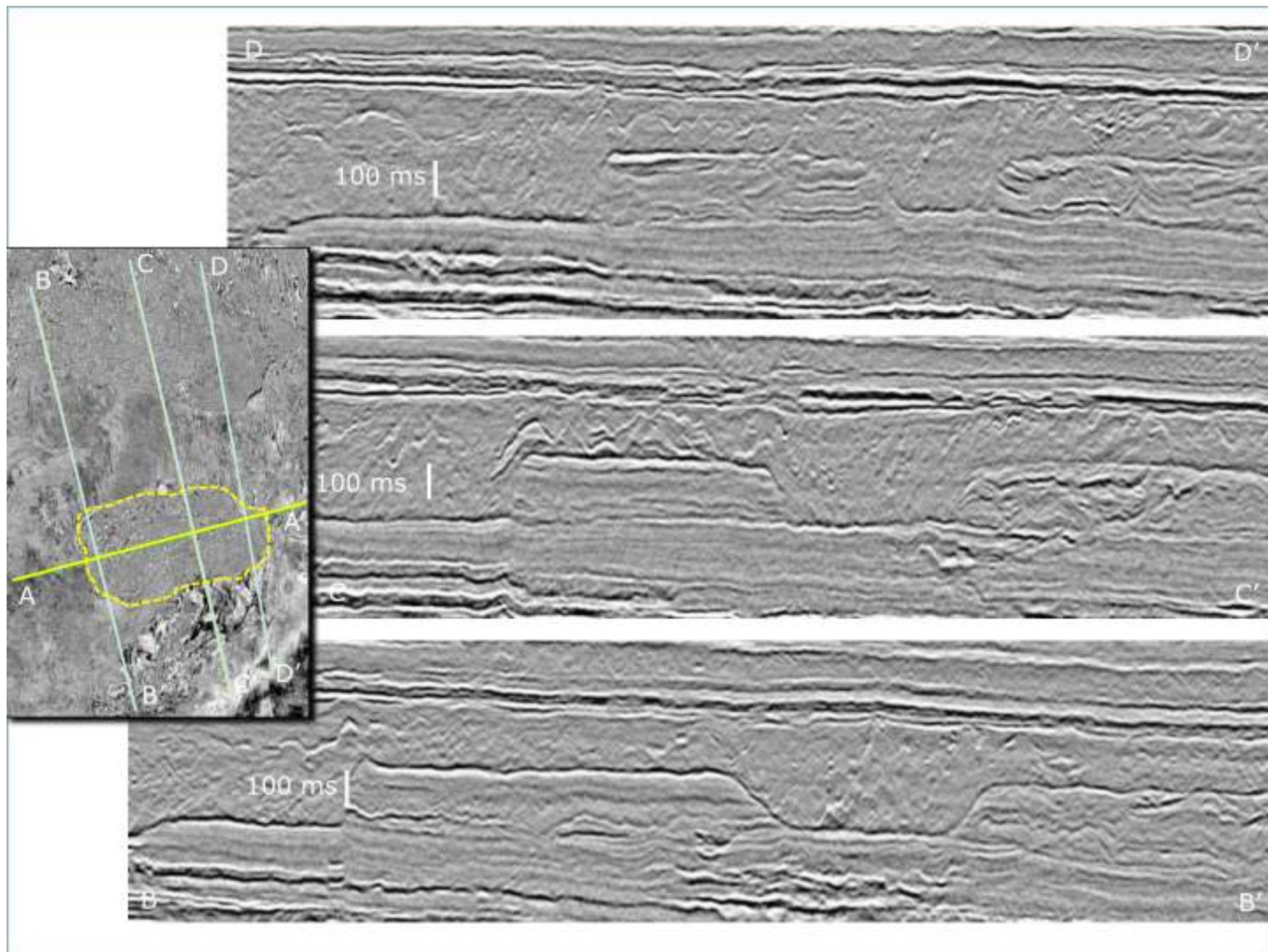


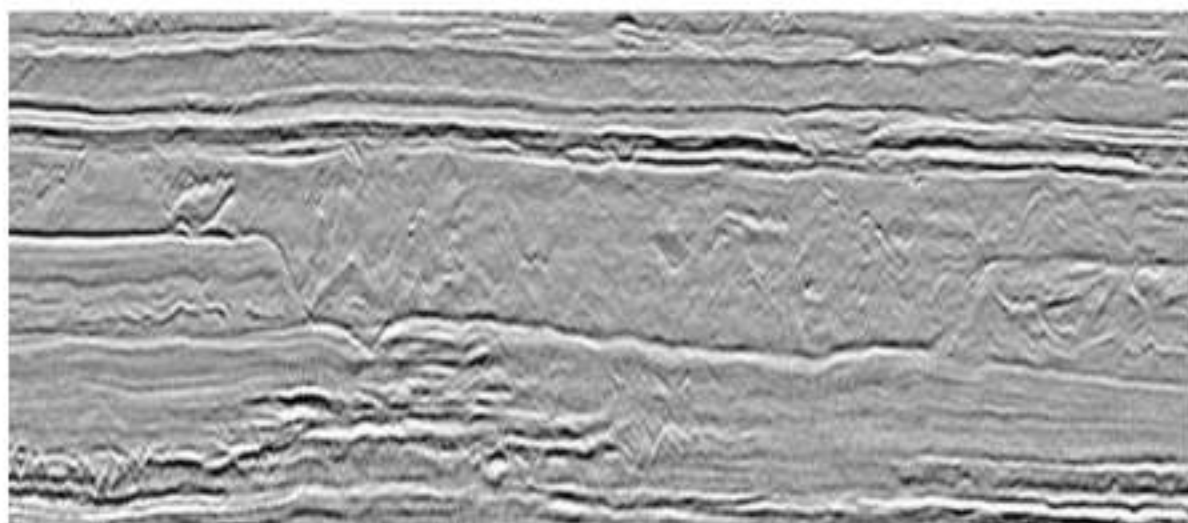
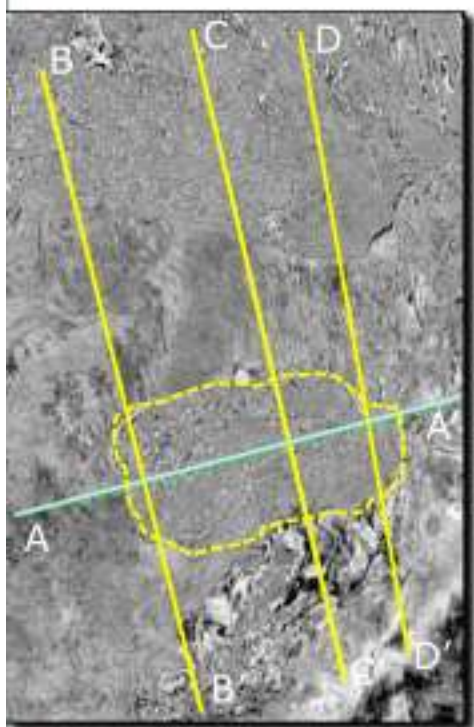
Sea-Floor "Plucking" by Mass Flows

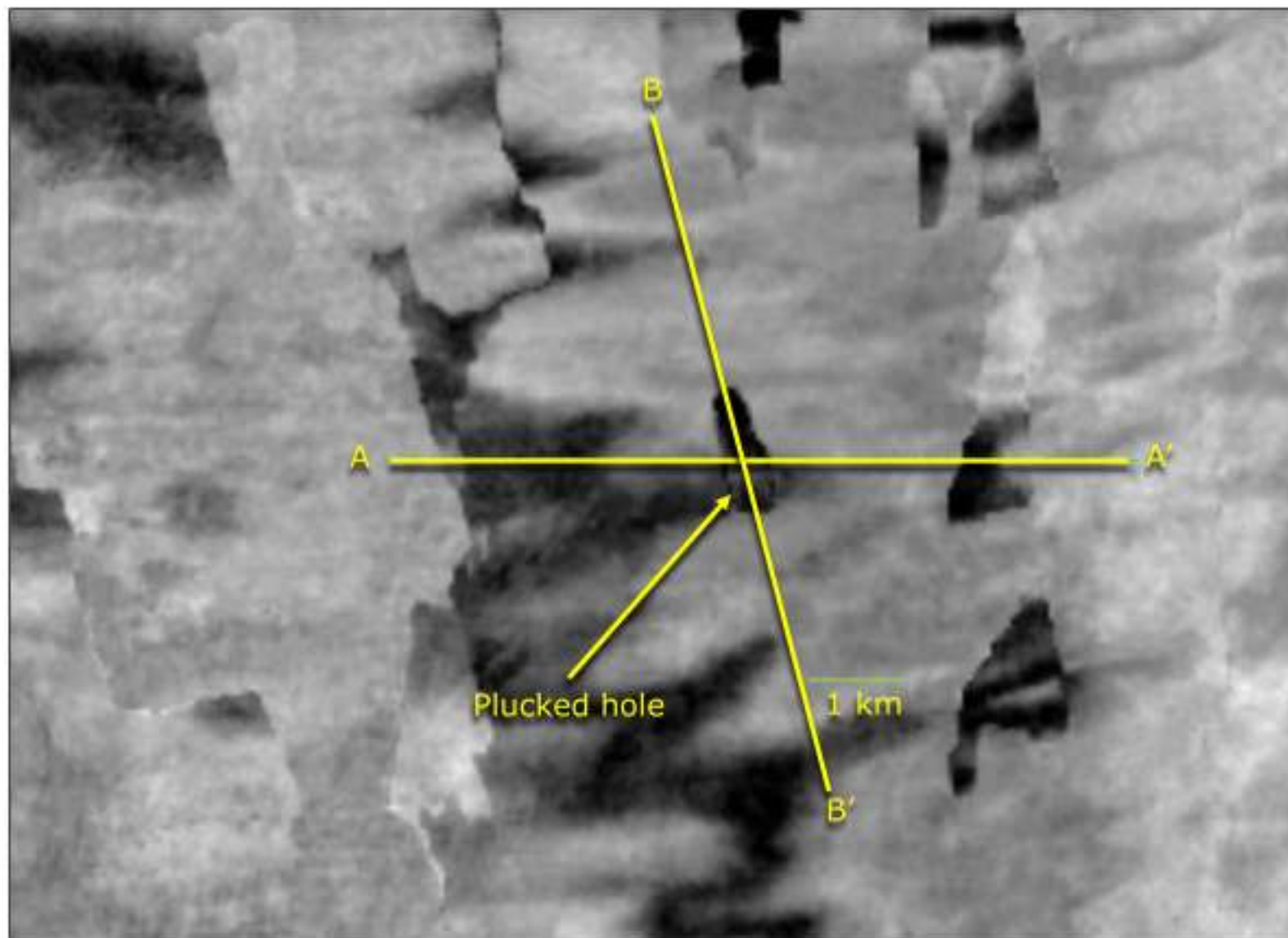


Sea-Floor "Plucking" by Mass Flows

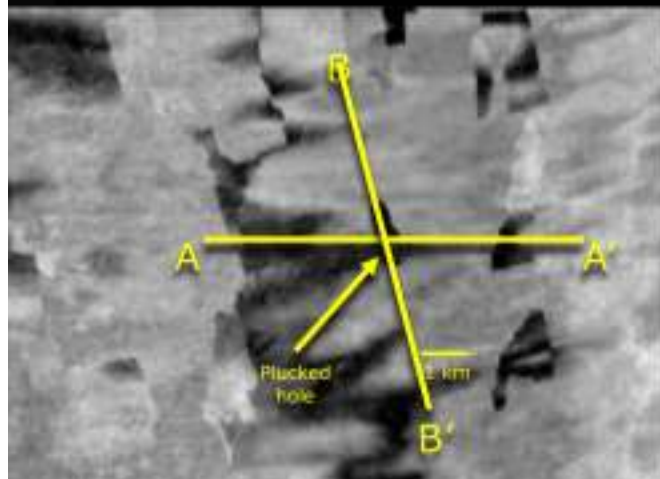
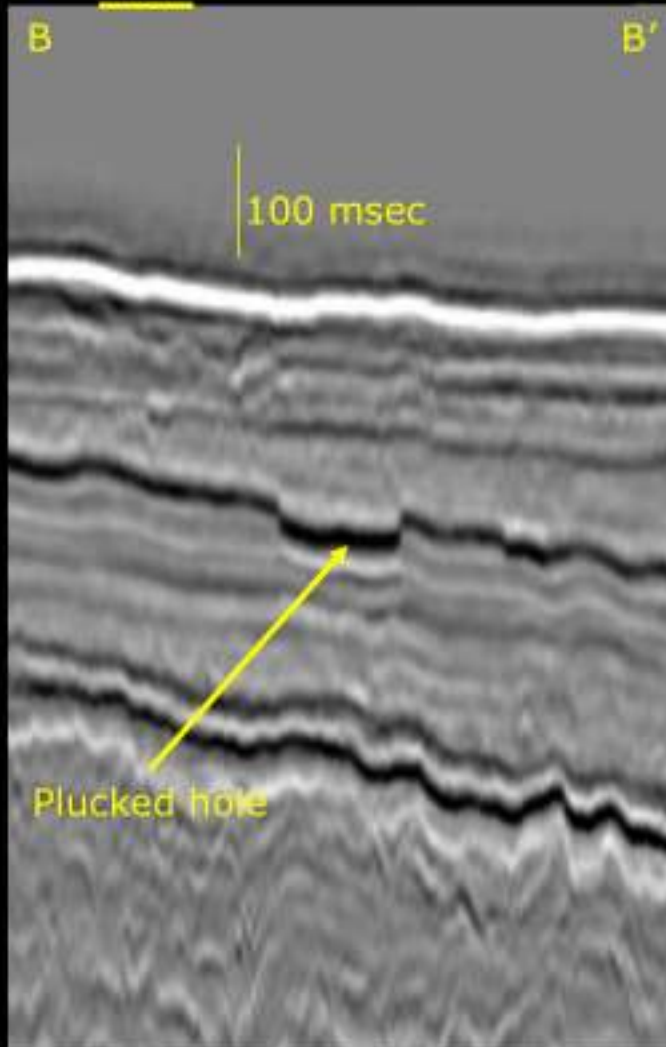








1 km



1 km

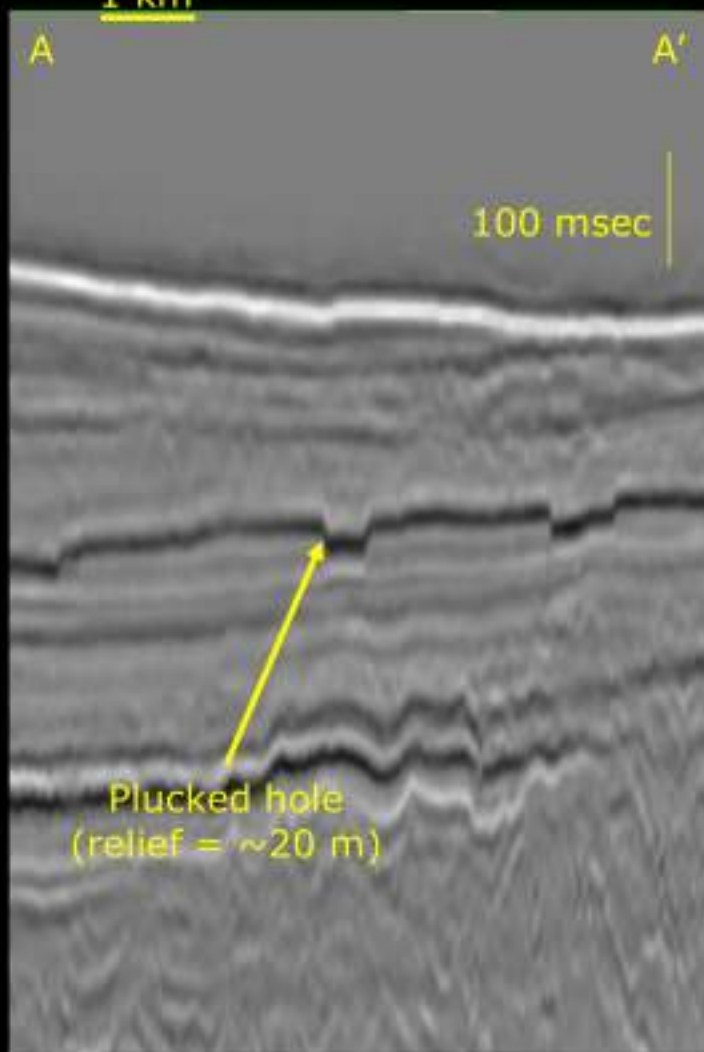
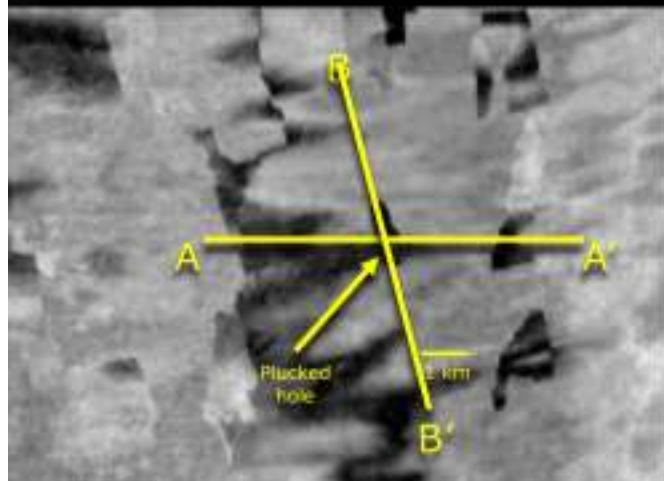
A

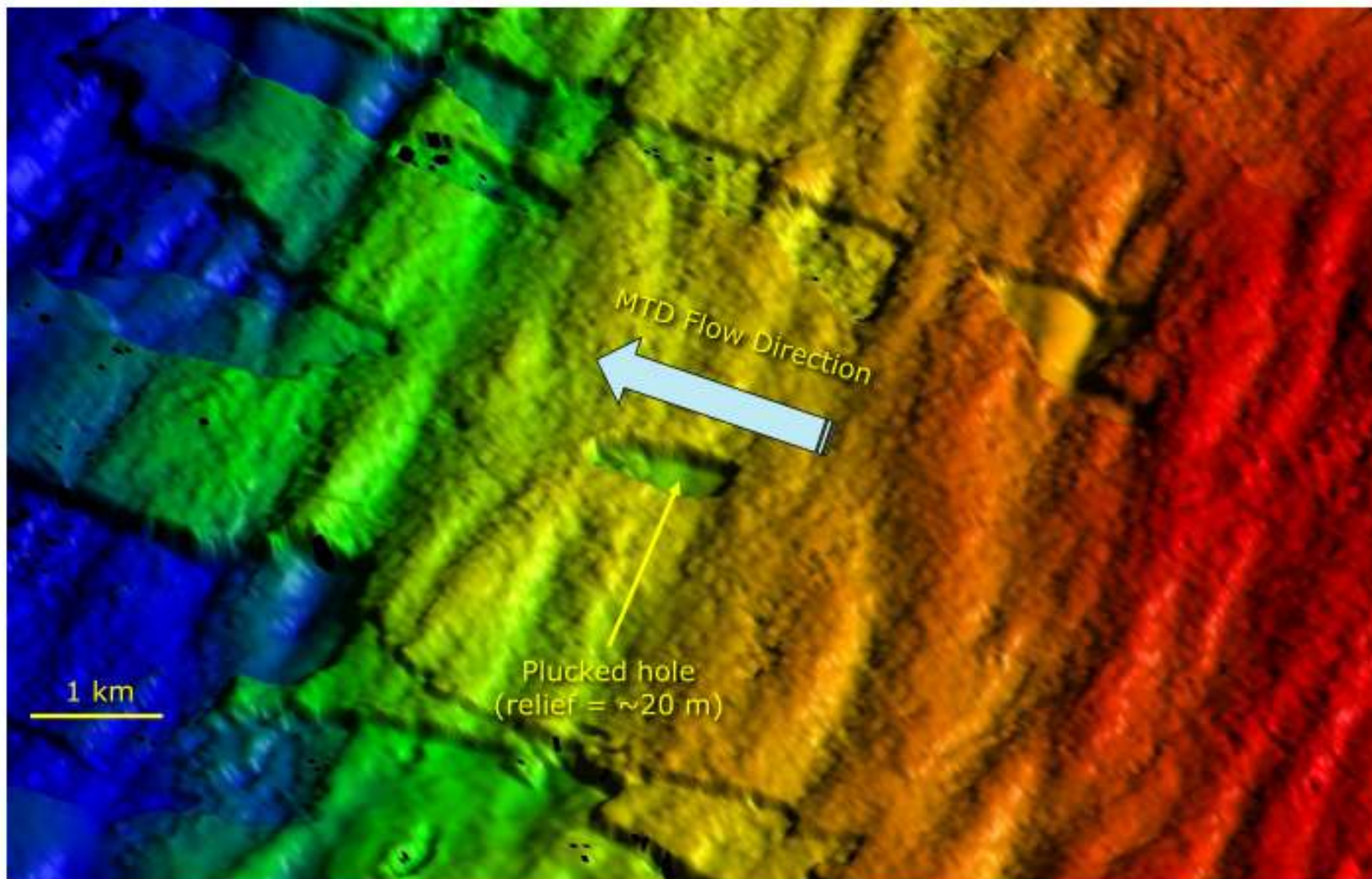
A'

100 msec

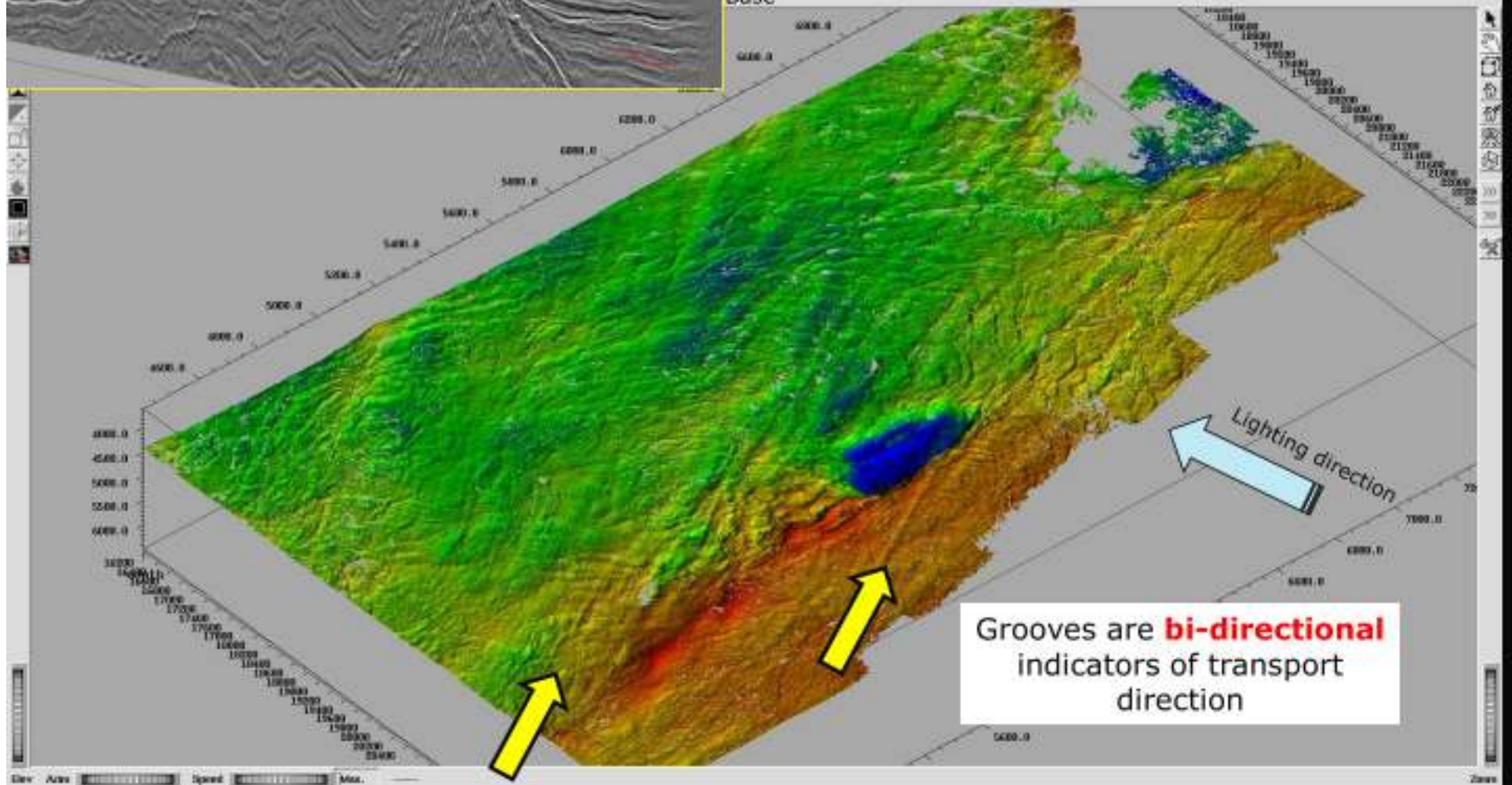
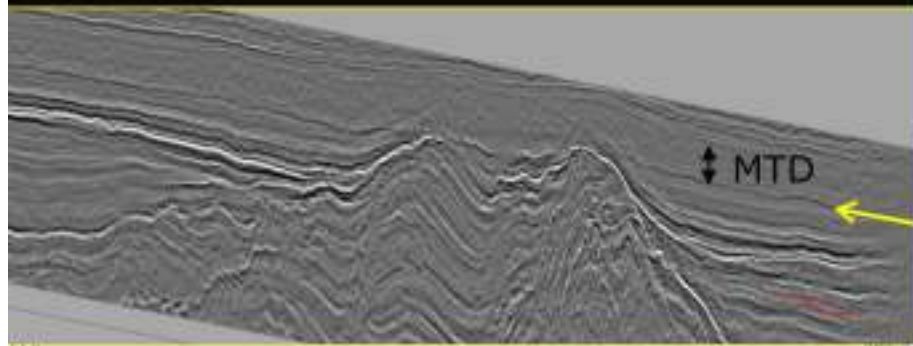
Plucked hole
(relief = ~20 m)

B
A A'
Plucked hole
B'
1 km

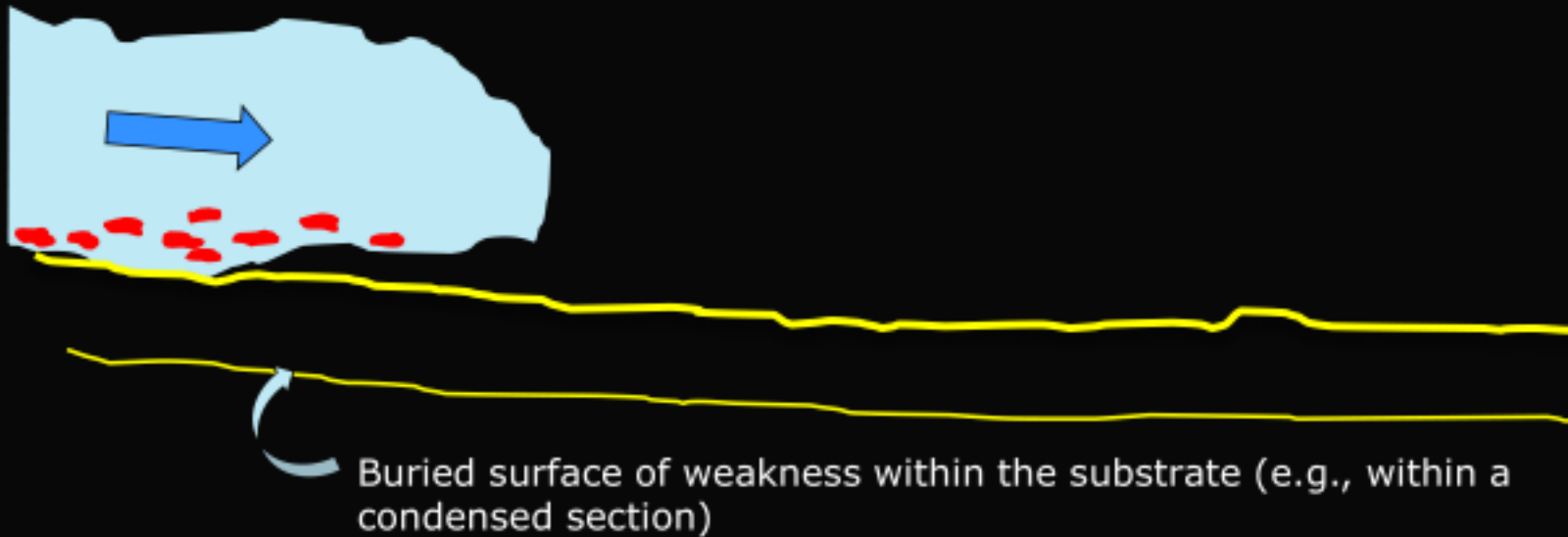




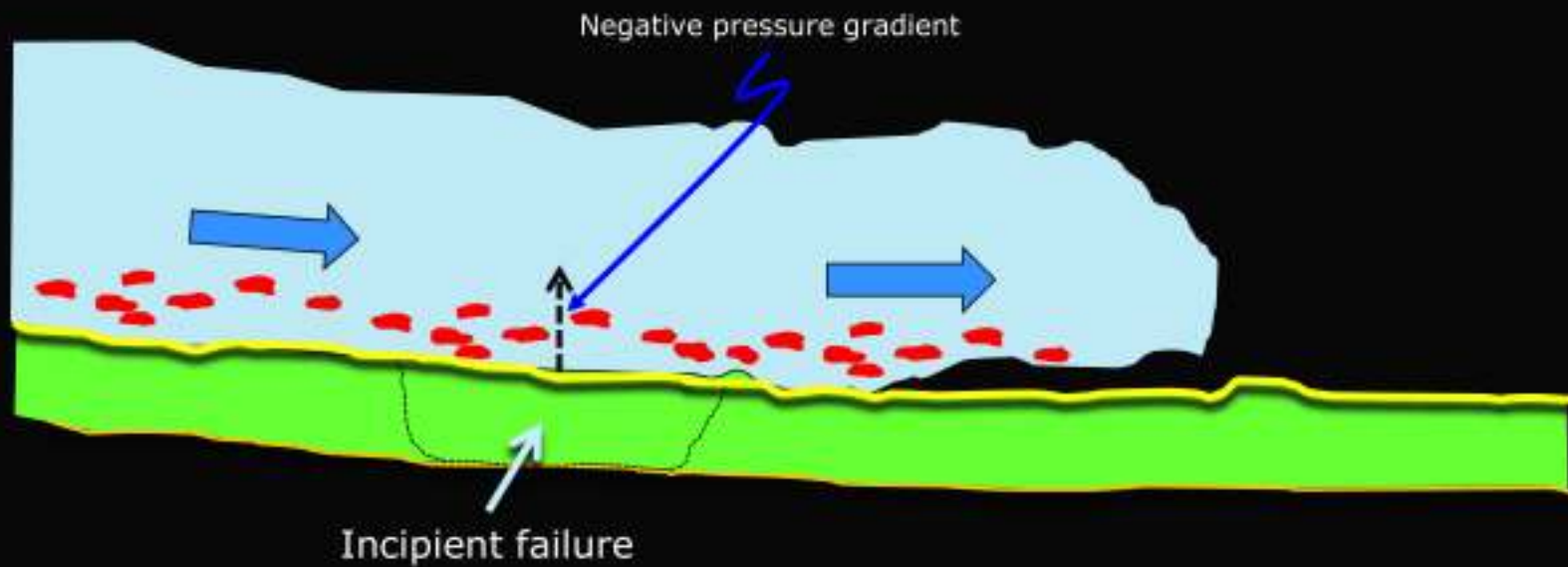
Evidence for basal erosion



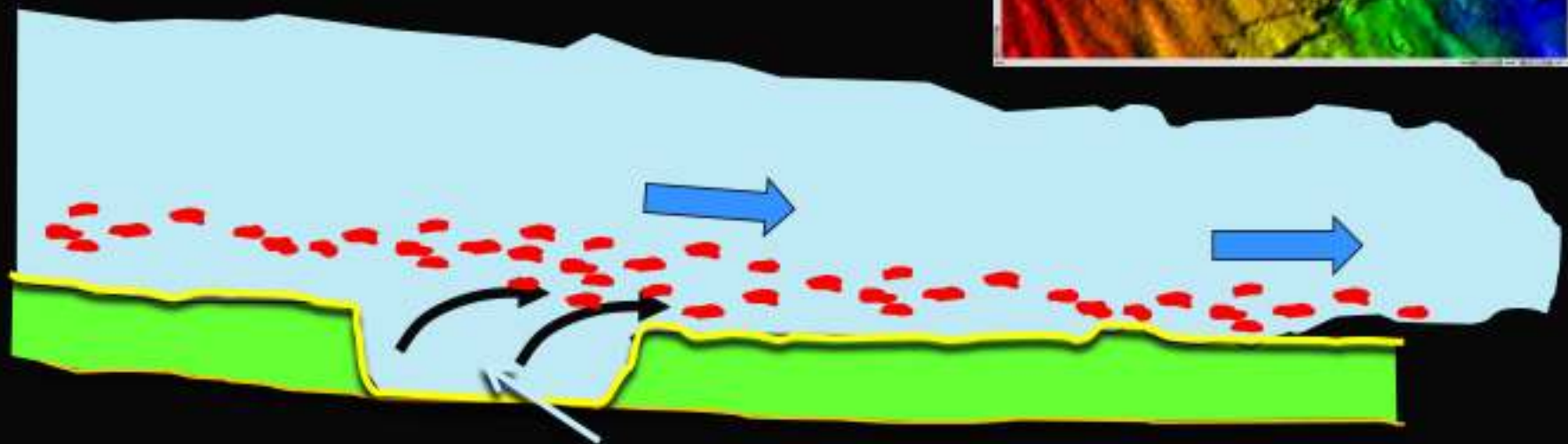
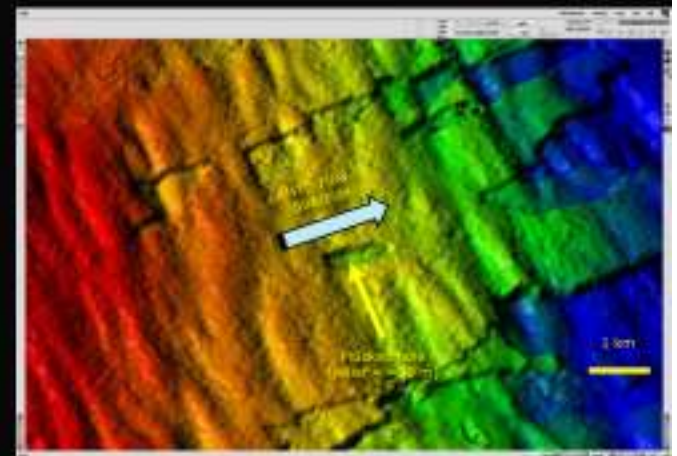
Sea-Floor "Plucking" by Mass Flows



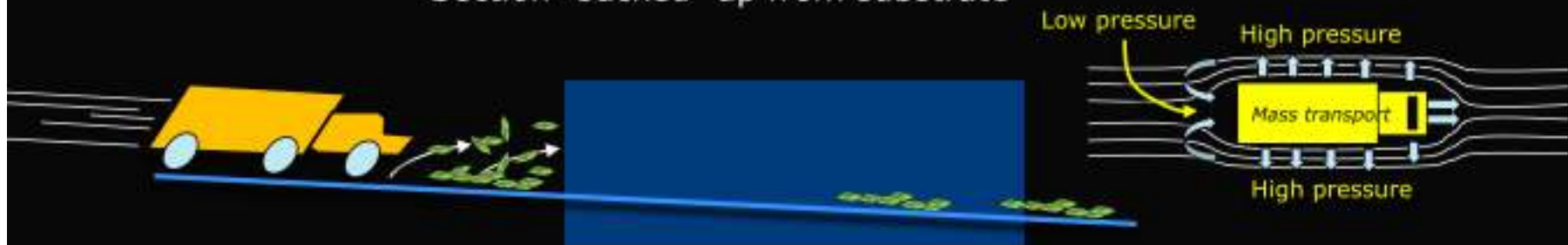
Sea-Floor "Plucking" by Mass Flows



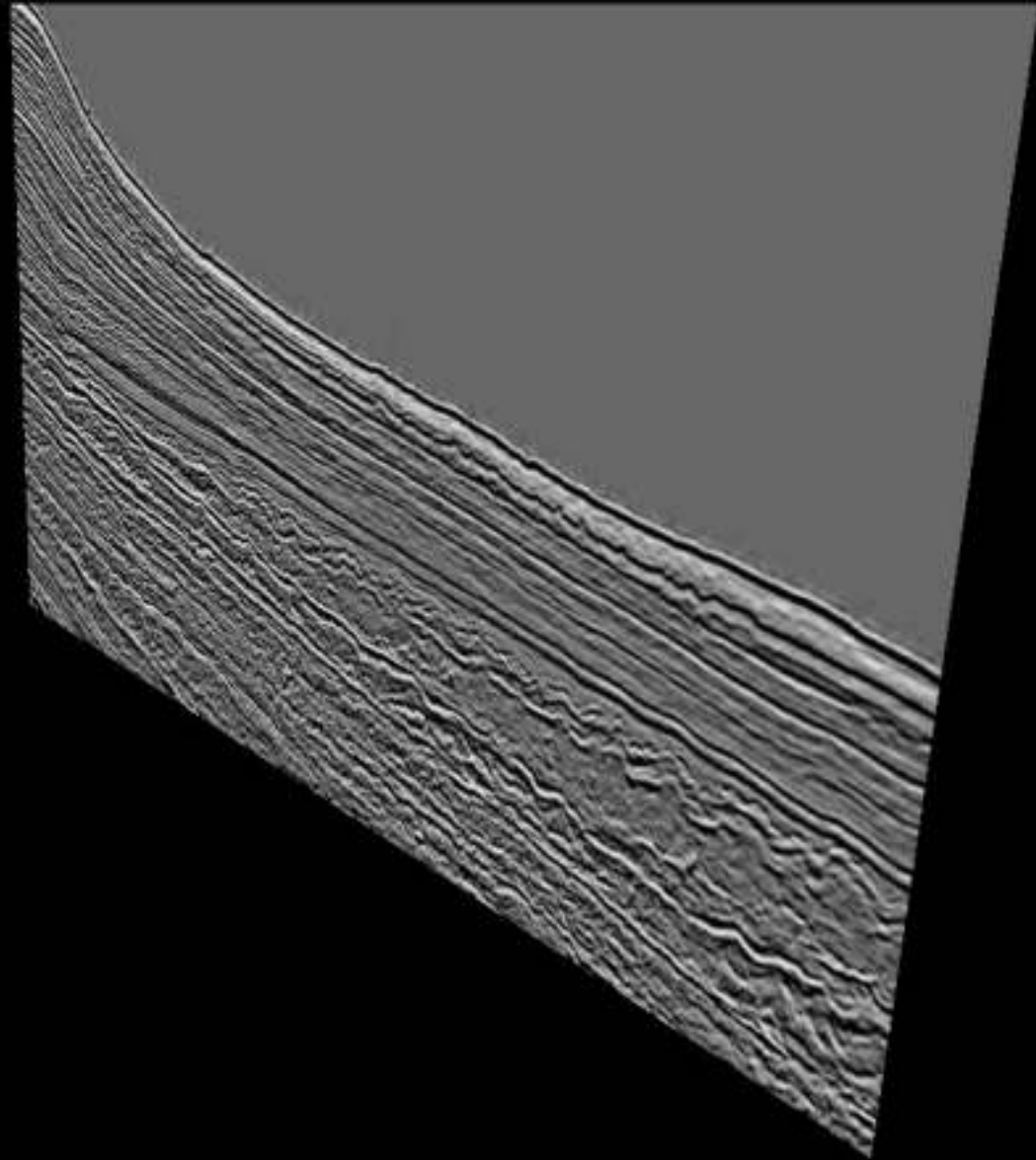
Sea-Floor "Plucking" by Mass Flows



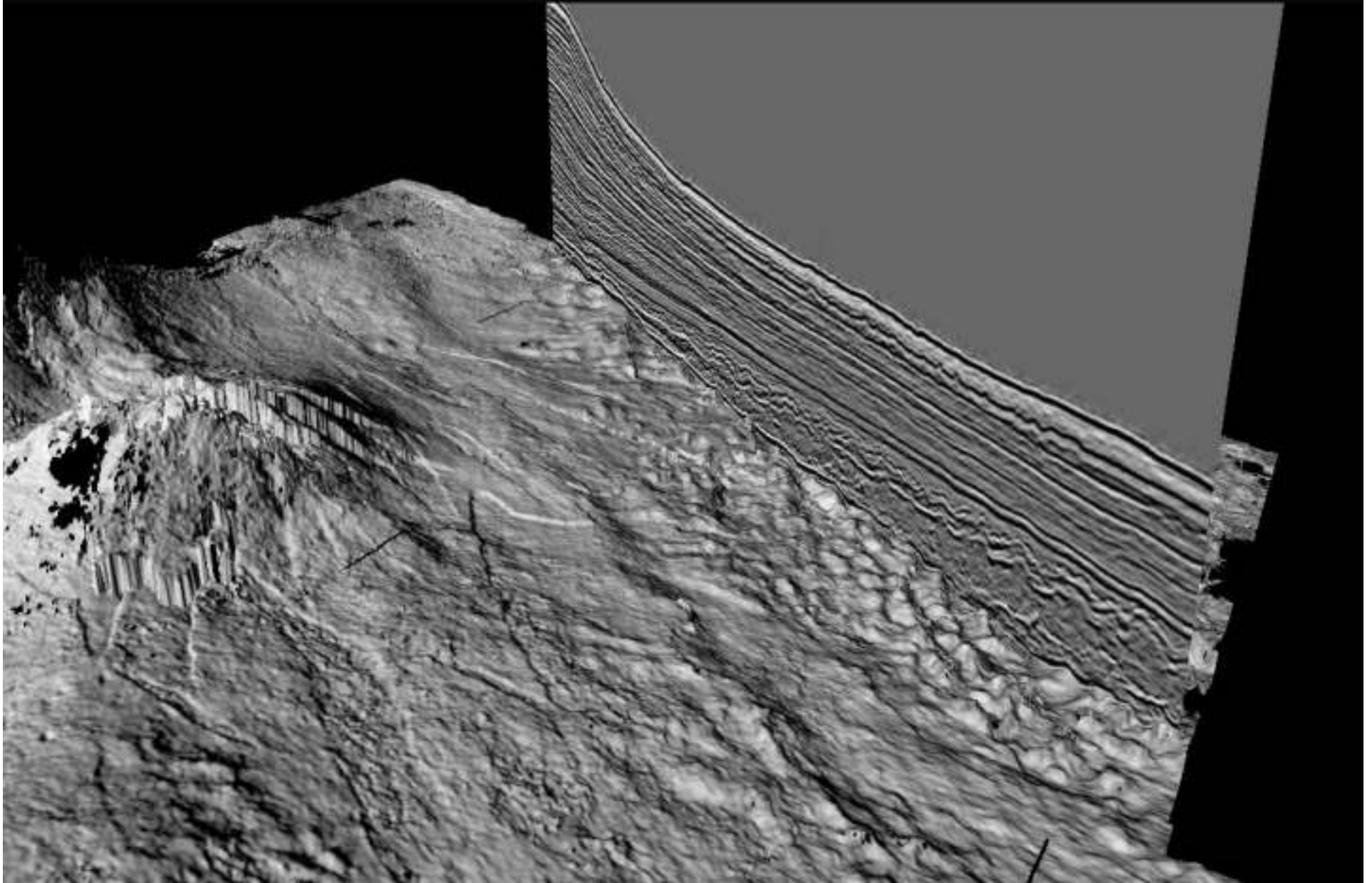
Section "sucked" up from substrate



Rugosity at Top of Mass Transport Complex

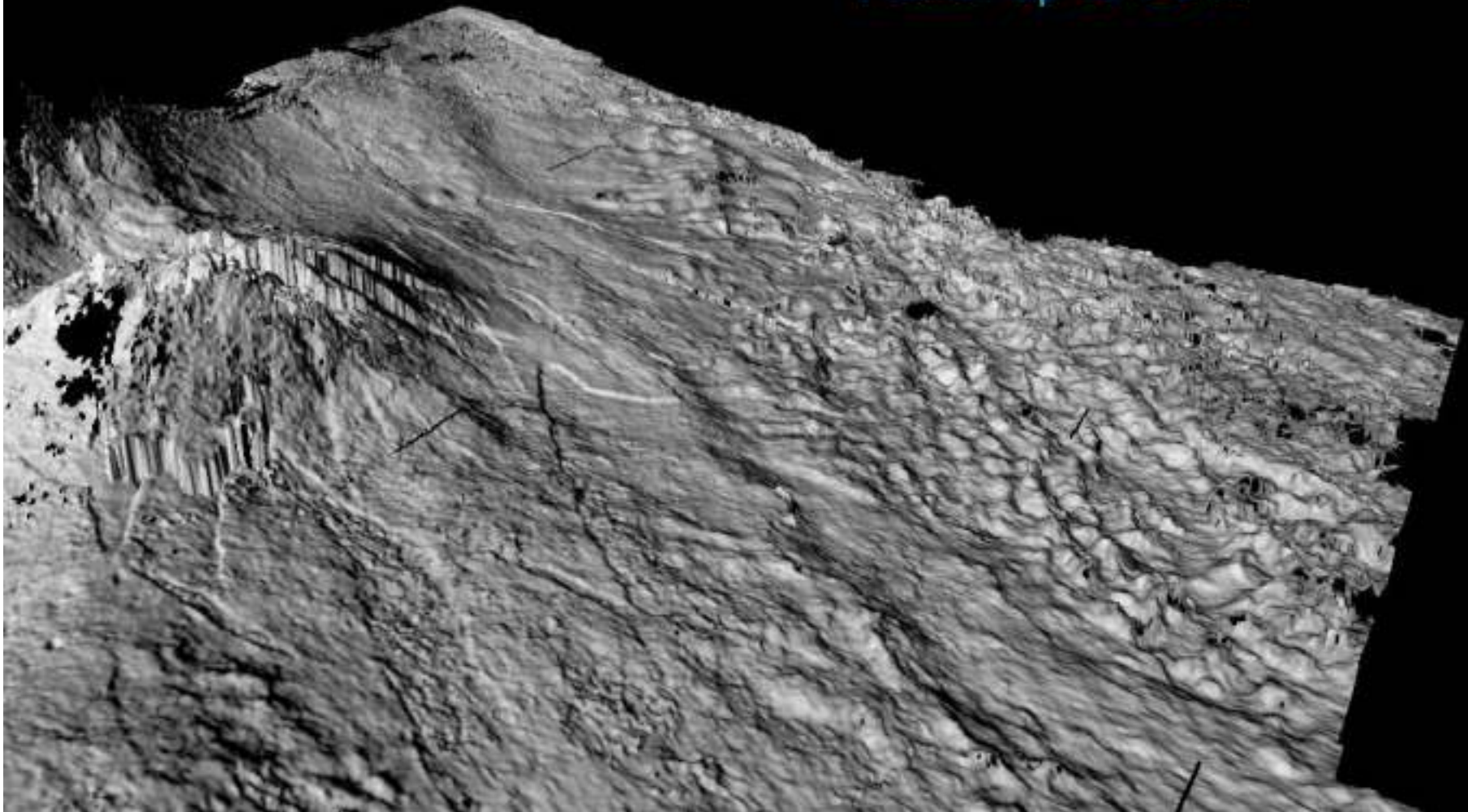


Rugosity at Top of Mass Transport Complex



Rugosity at Top of Mass Transport Complex

Relief up to 32 m

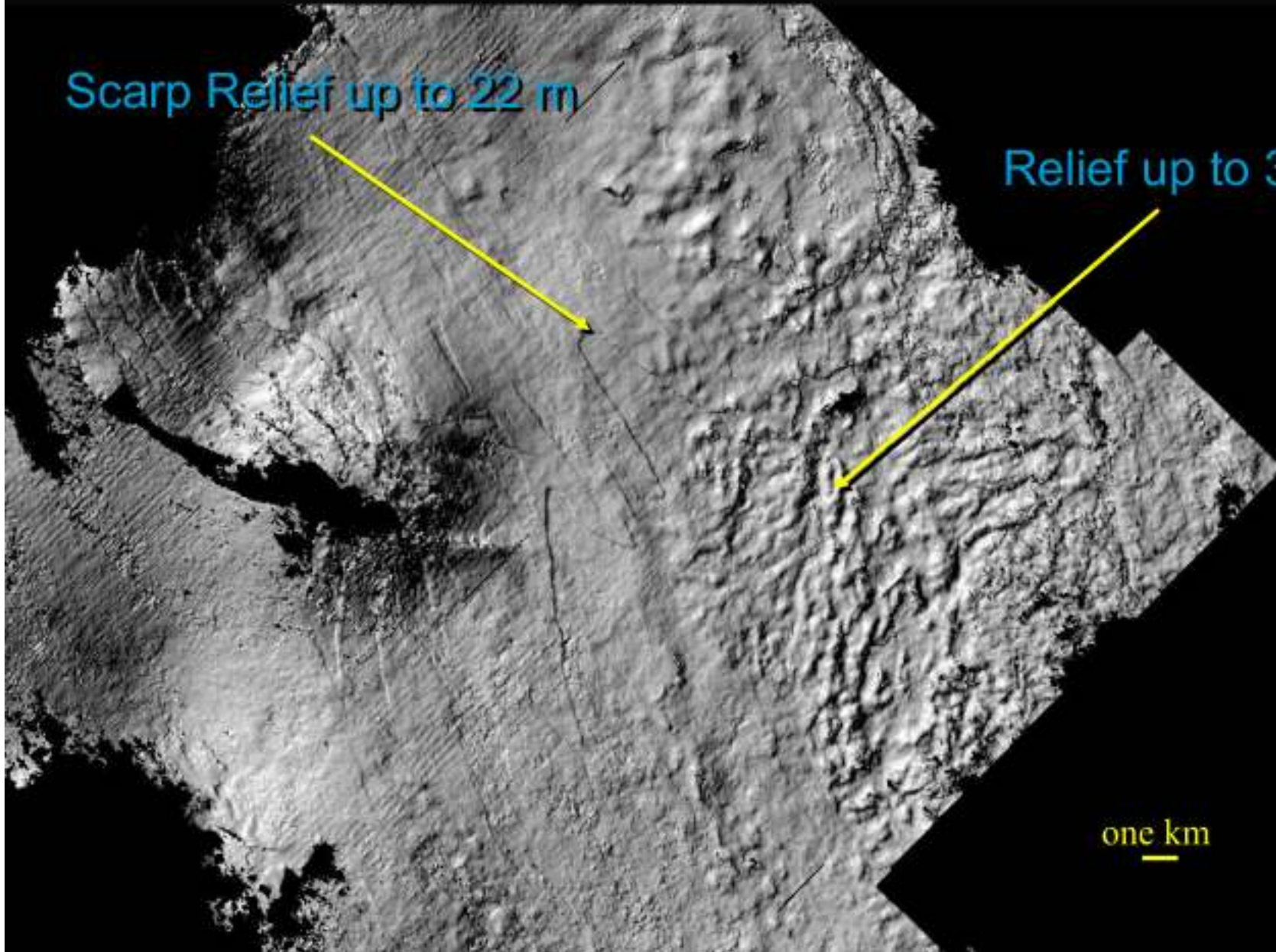


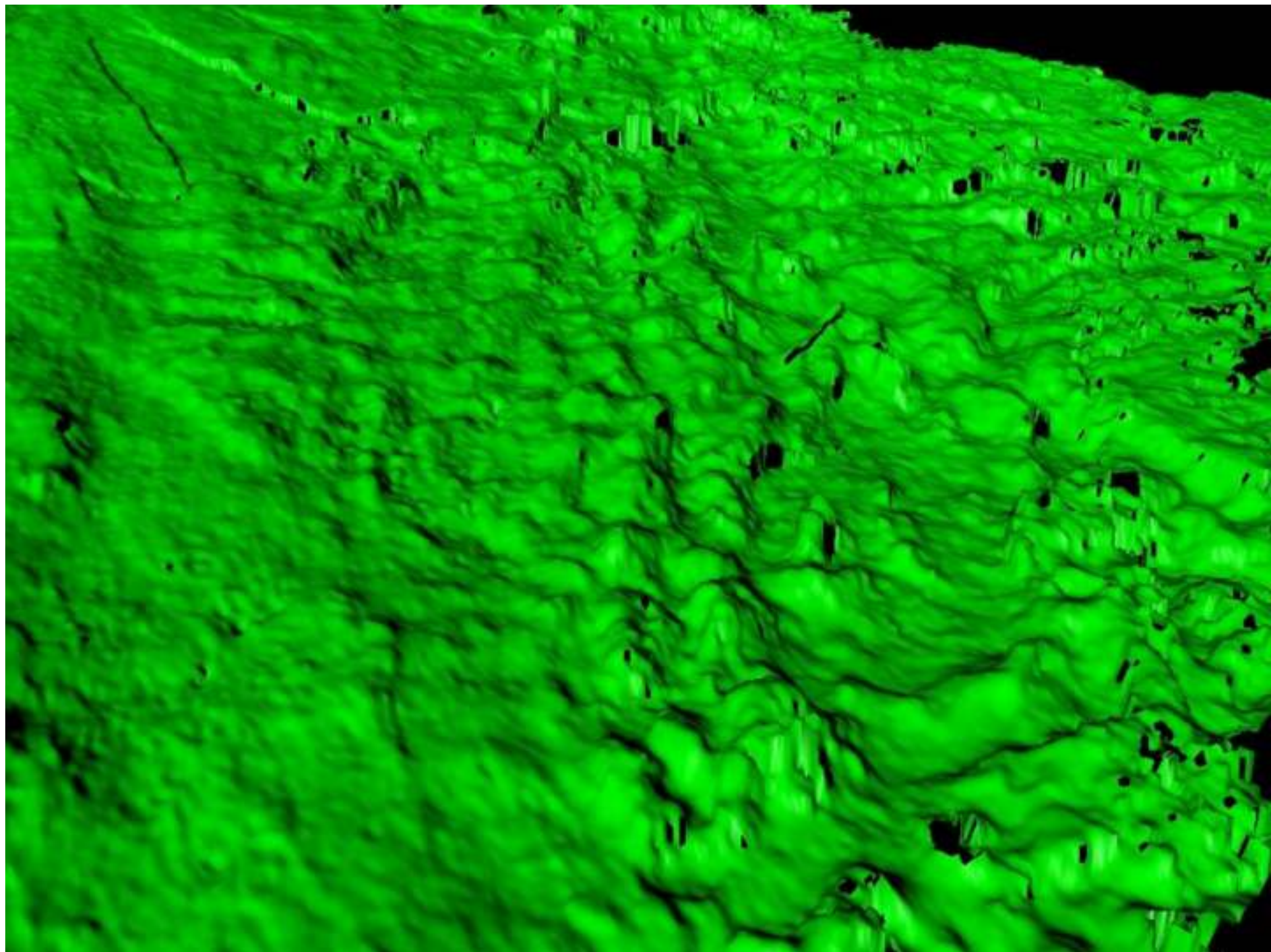
Rugosity at Top of Mass Transport Complex

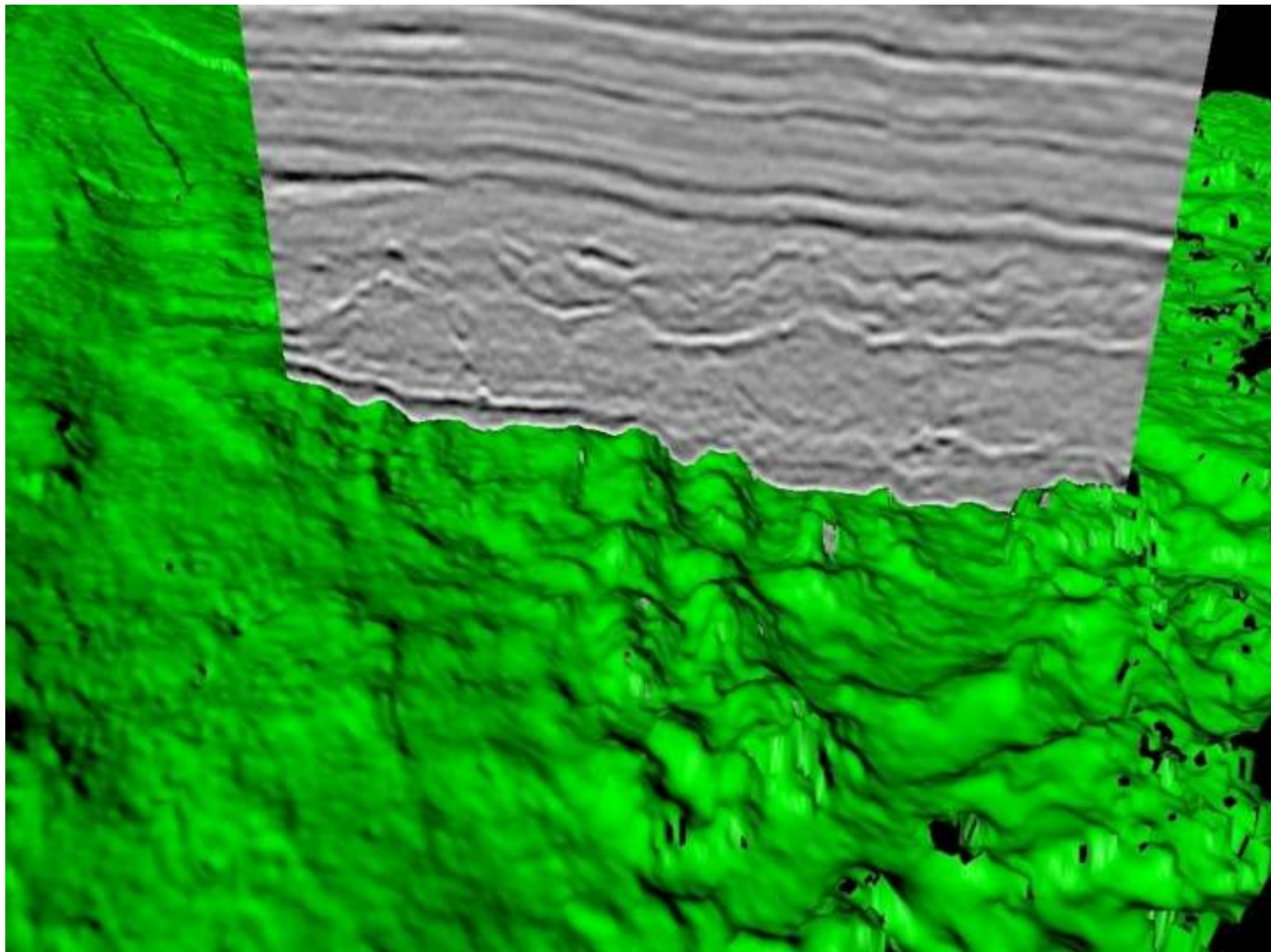
Scarp Relief up to 22 m

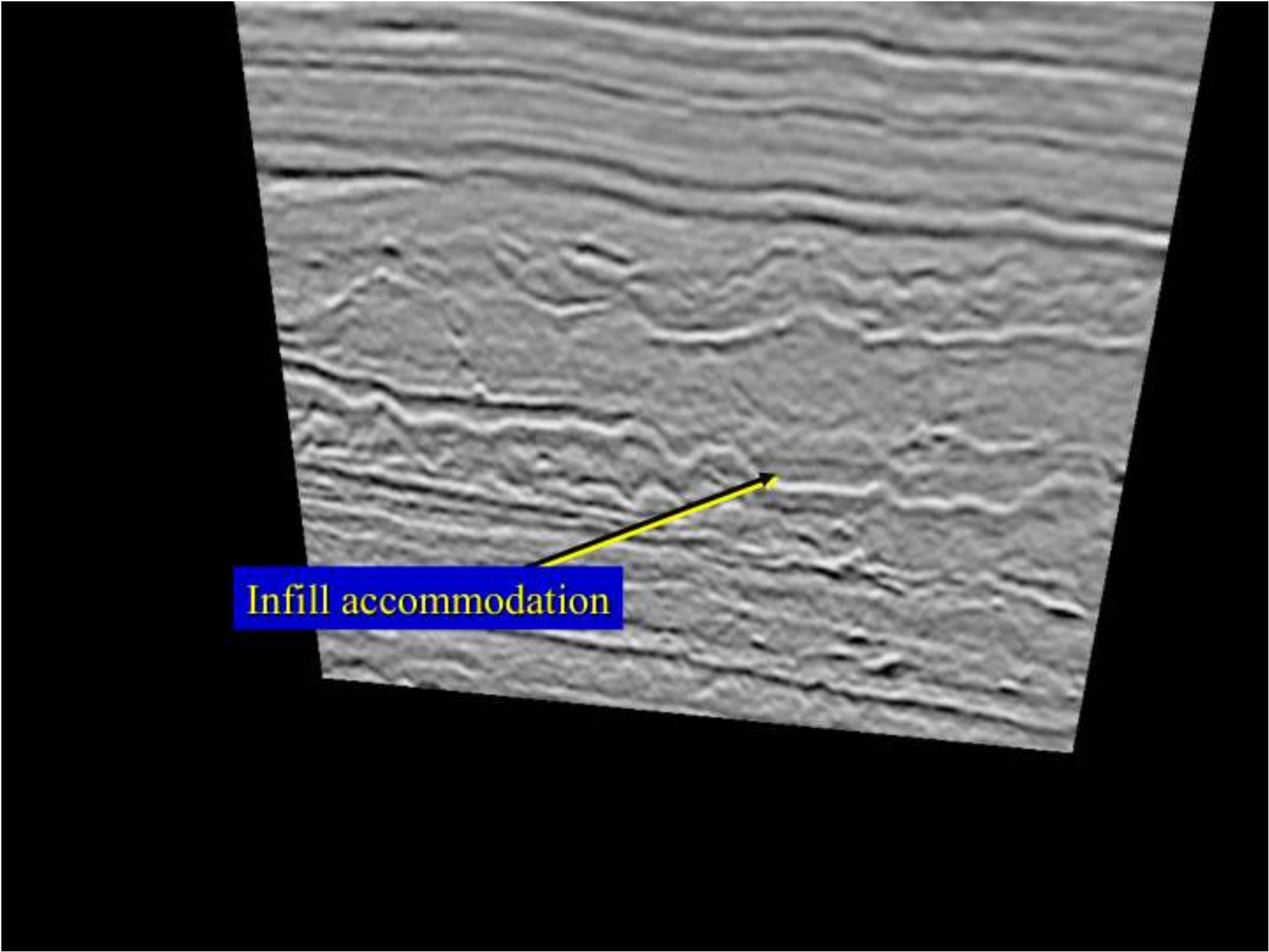
Relief up to 32 m

one km



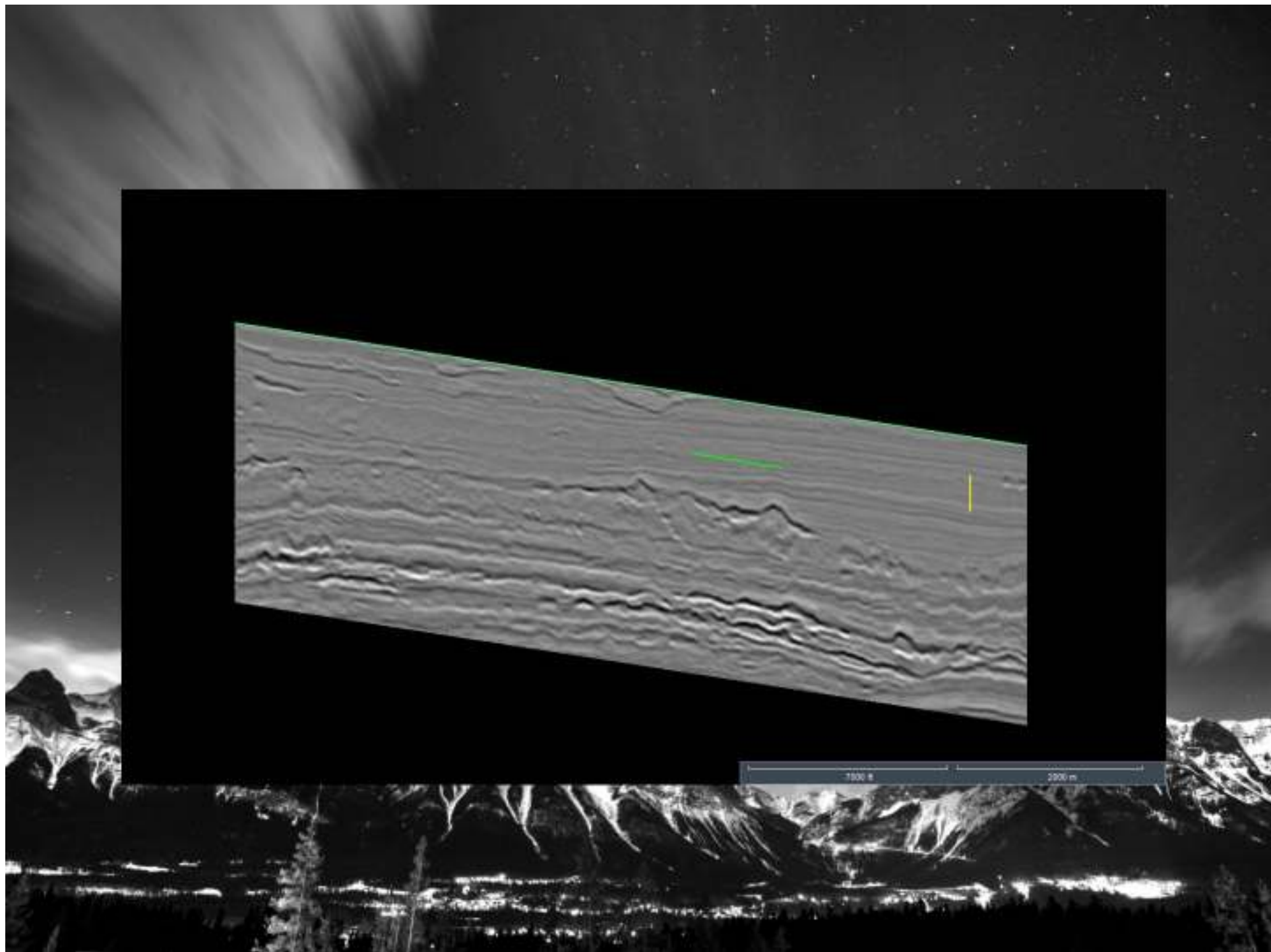


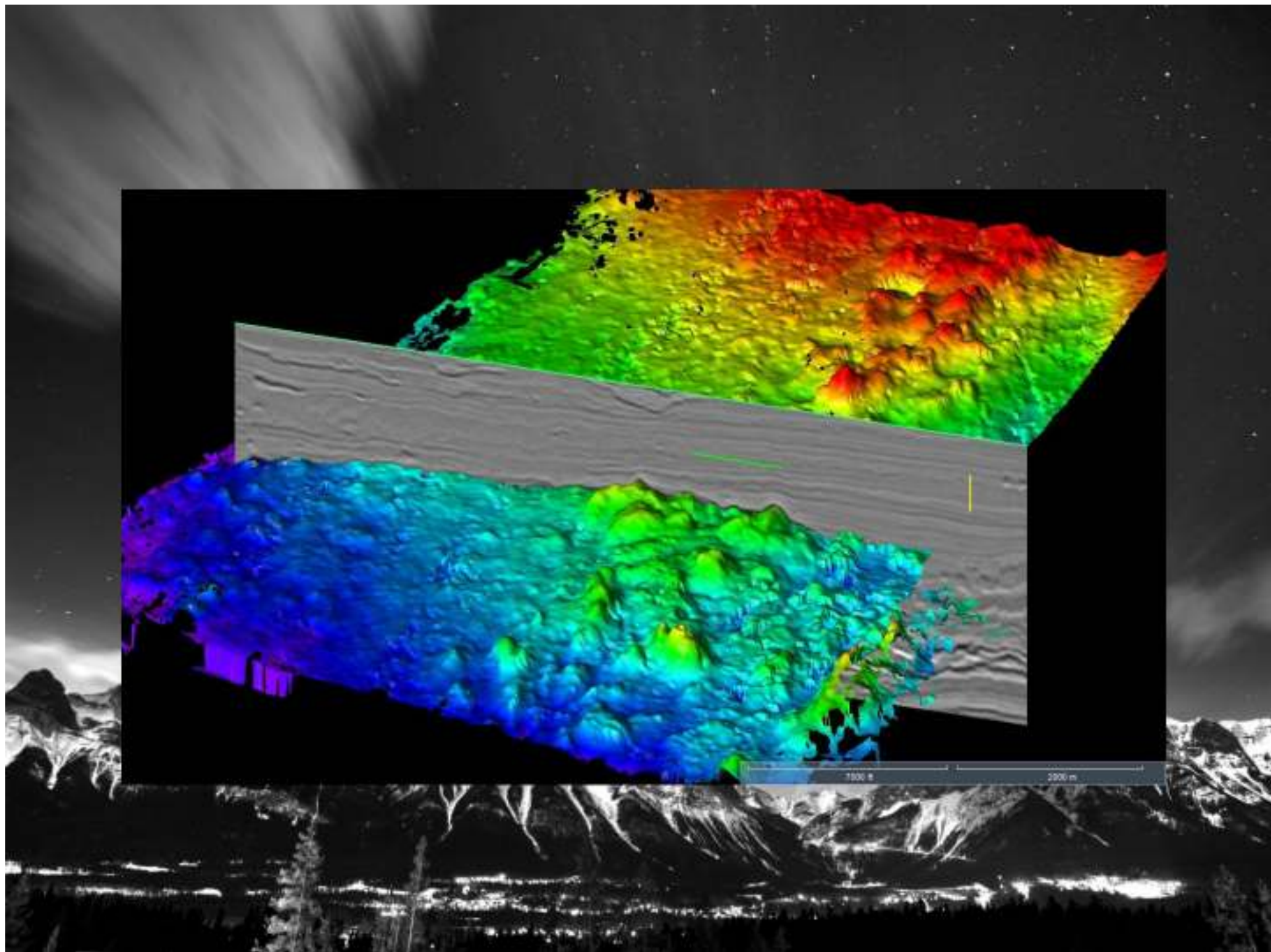


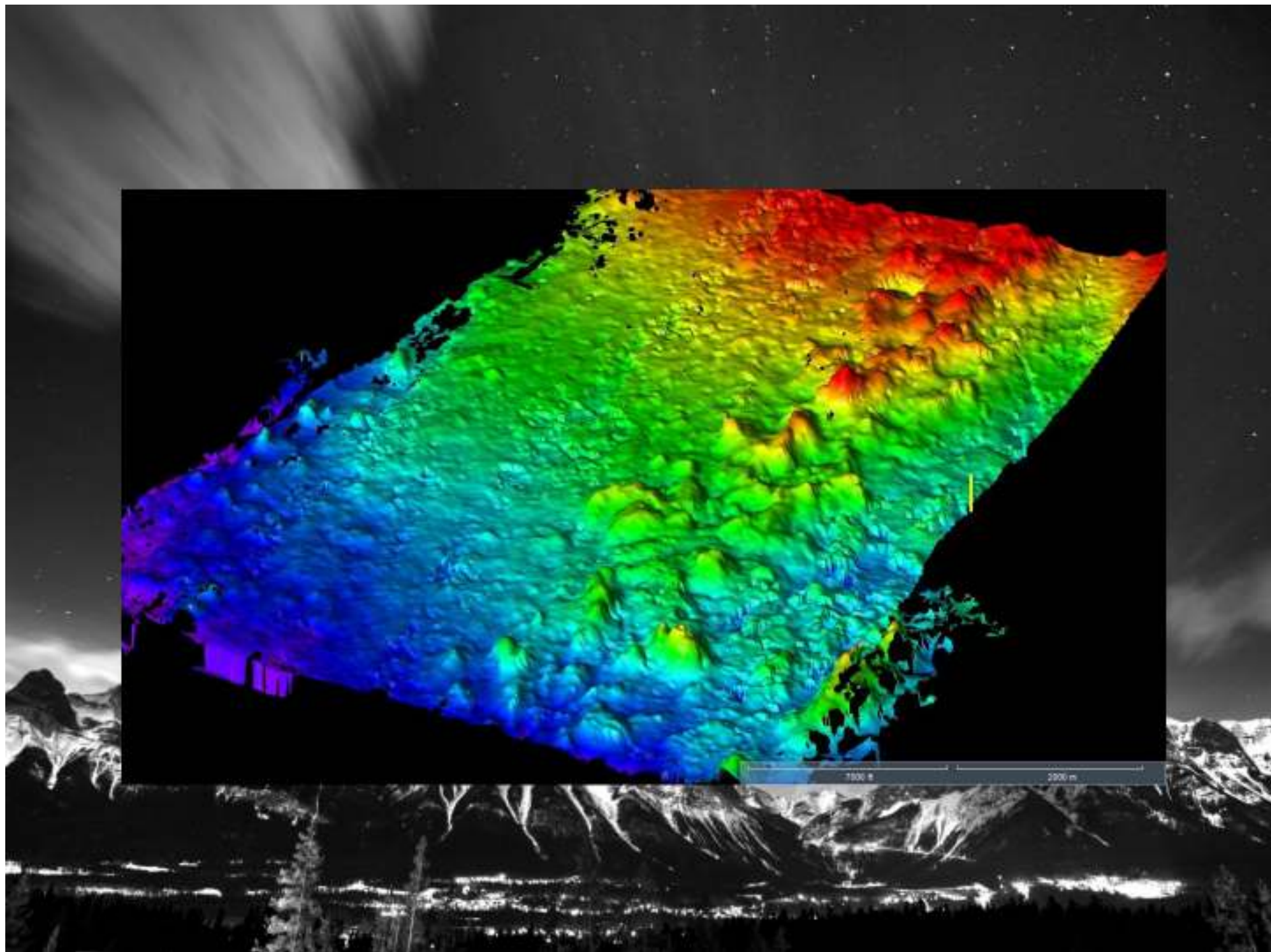


Infill accommodation

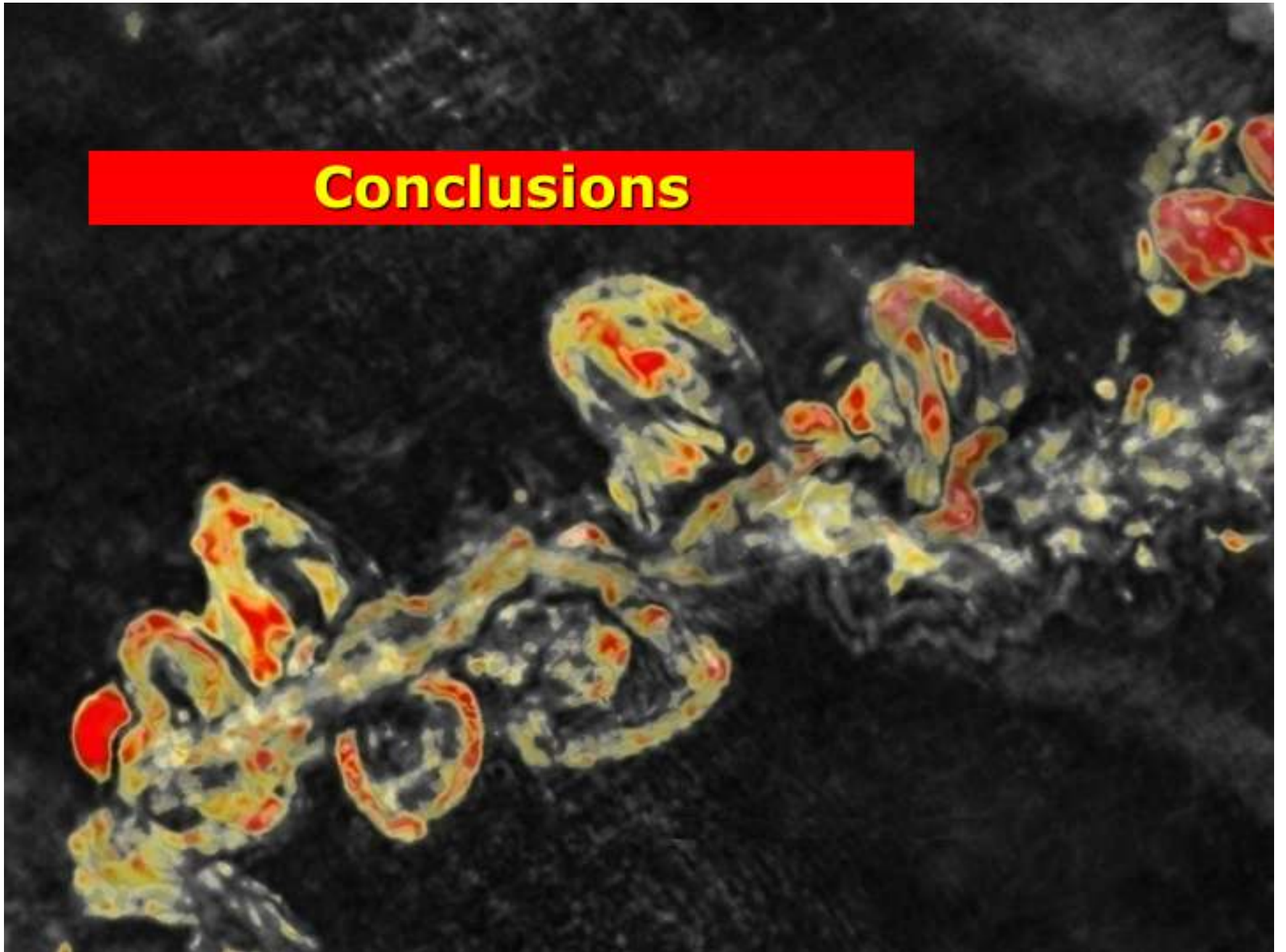
This is a seismic reflection image of a geological section. The image shows several layers of rock with varying degrees of reflectivity. A yellow arrow points from a blue text box labeled 'Infill accommodation' to a specific feature in the lower-middle part of the image. The feature appears to be a small, localized area of higher reflectivity within a larger, more homogeneous layer, possibly representing a point of sedimentary infill or a change in rock composition.



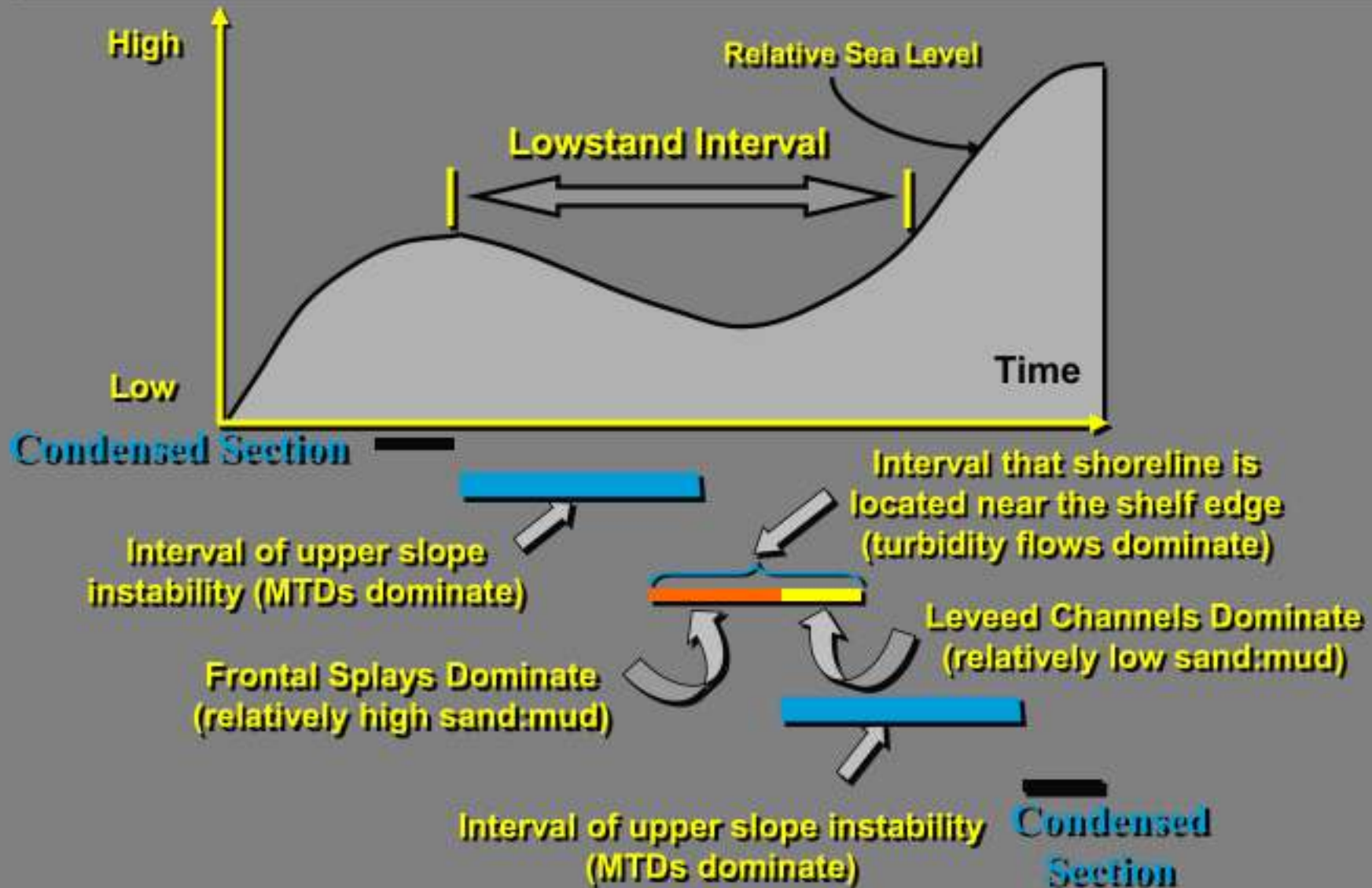




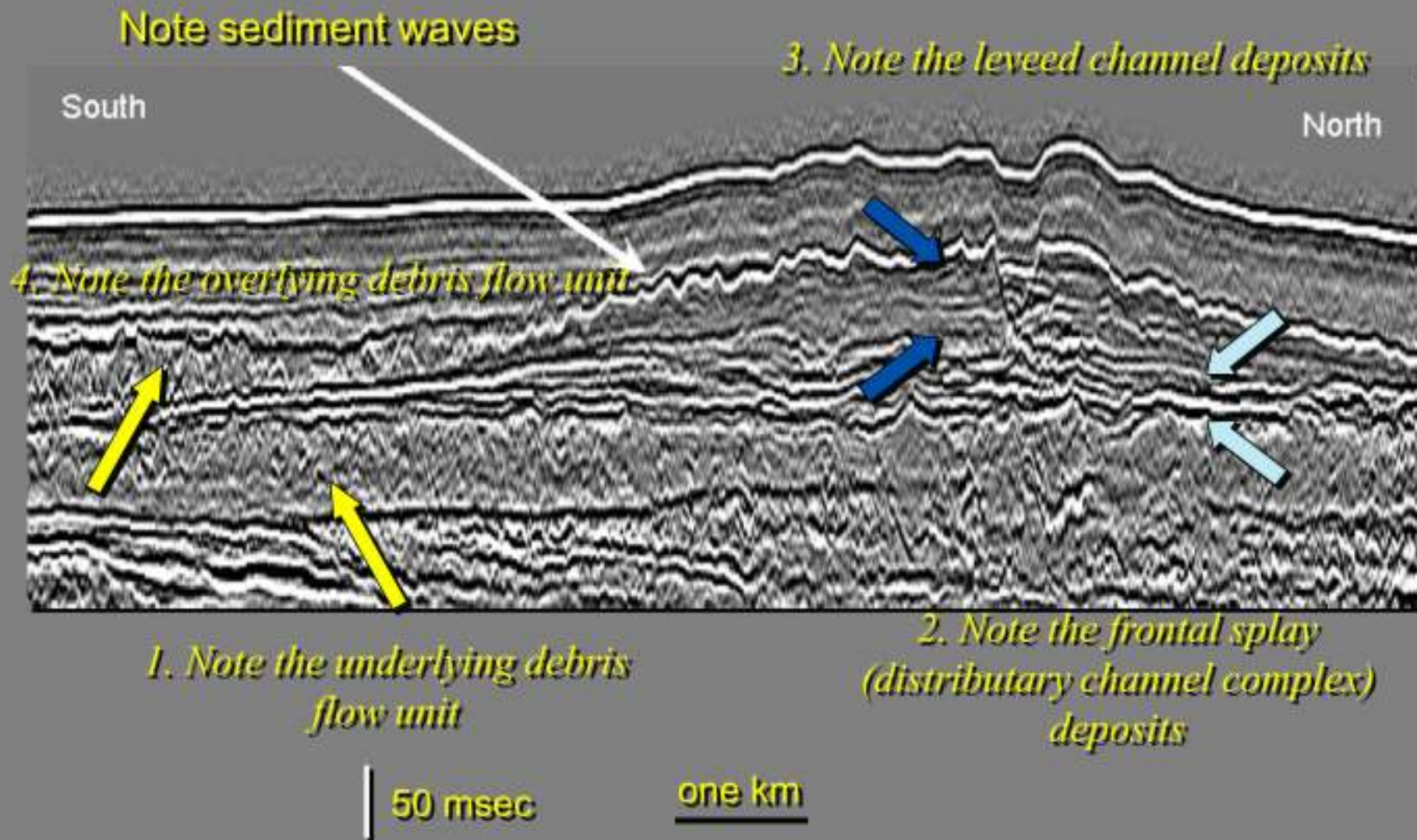
Conclusions



Relative Sea Level and Deep-Water Depositional Styles



In-Line Section 1314



Evolution of a deep-water sequence

Condensed section

Isolated high-sinuosity leveed channel

Frontal Splay/Lobe

