

# **Modern Examples of Mass-Transport Complexes, Debrite and Turbidite Associations: Geometry, Stratigraphic Relationships and Implications for Hydrocarbon Trap Development\***

**Fabiano Gamberi<sup>1</sup>, Marzia Rovere<sup>2</sup> and Michael Marani<sup>2</sup>**

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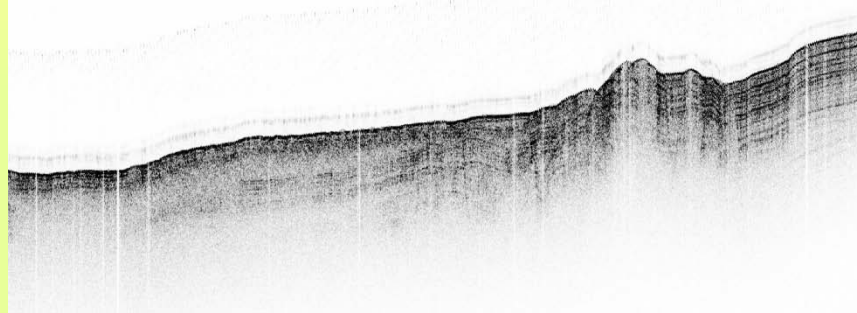
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## **Abstract**

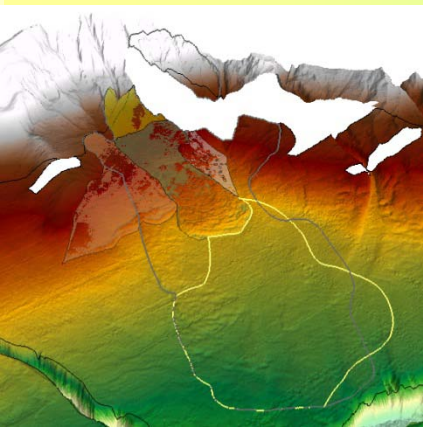
Two modern mass-transport deposits are present along the northeastern Sicilian margin in the Tyrrhenian Sea. They are the result of the failure of slope and channel-levee complex deposits. The eastern, Villafranca MTC occurred through repeated failures that resulted in the stacking of successive mass transport deposits. The main deposit is a frontally confined landslide with a basal shear surface exhibiting ramp and flat geometry. Thus, the geometry of the landslide provides a lateral seal of pre-landslide units both along the sidewalls and along the frontal region of the landslide. The headwall region of the Villafranca MTC is scoured by channels that are 1 km wide and are filled by thick deposits that are transparent in subbottom profiles. Since the shelf facing the headwall region is very narrow, they are likely the result of deposition from coarse grained sediment gravity flows fed directly from nearby rivers. The transparent deposits are also found downslope from the channel mouth where they pinch out against the relief behind the confined front of the MTC. The frontal elevated region of the MTC also serves as partial confinement to flows that are fed from a nearby actively building channel-levee system.

The main body of the western, Capo d'Orlando MTC also possesses a ramp and flat geometry but its front was able to spread above the paleoseafloor and thus represents an example of a frontally emergent landslide. Thus the MTC can represent a lateral seal to pre-landslide units along the sidewalls and a top seal in the distal toe region where it overlies basin plain turbiditic lobe units. Beside the large landslide, thick transparent layers are also present in the western part of the basin plain that can be interpreted as debrites on the basis of their blocky reflective character on the side scan sonar data. The debrites have central channelized areas that erode as much as 10 m into the underlying succession, as well as conformable, wing-like margins. In the eastern area on the contrary, a turbiditic lobe is fed by an actively growing channel levee system. Therefore in large parts of the basin plain debrites and turbidites alternate in the subbottom sedimentary column. The detailed side scan sonar and subbottom data capture a high resolution image of the character of their relationships and therefore have the potential to represent a good analog to help in the prediction of hydrocarbon trap potential in areas with a similar stratigraphic setting.



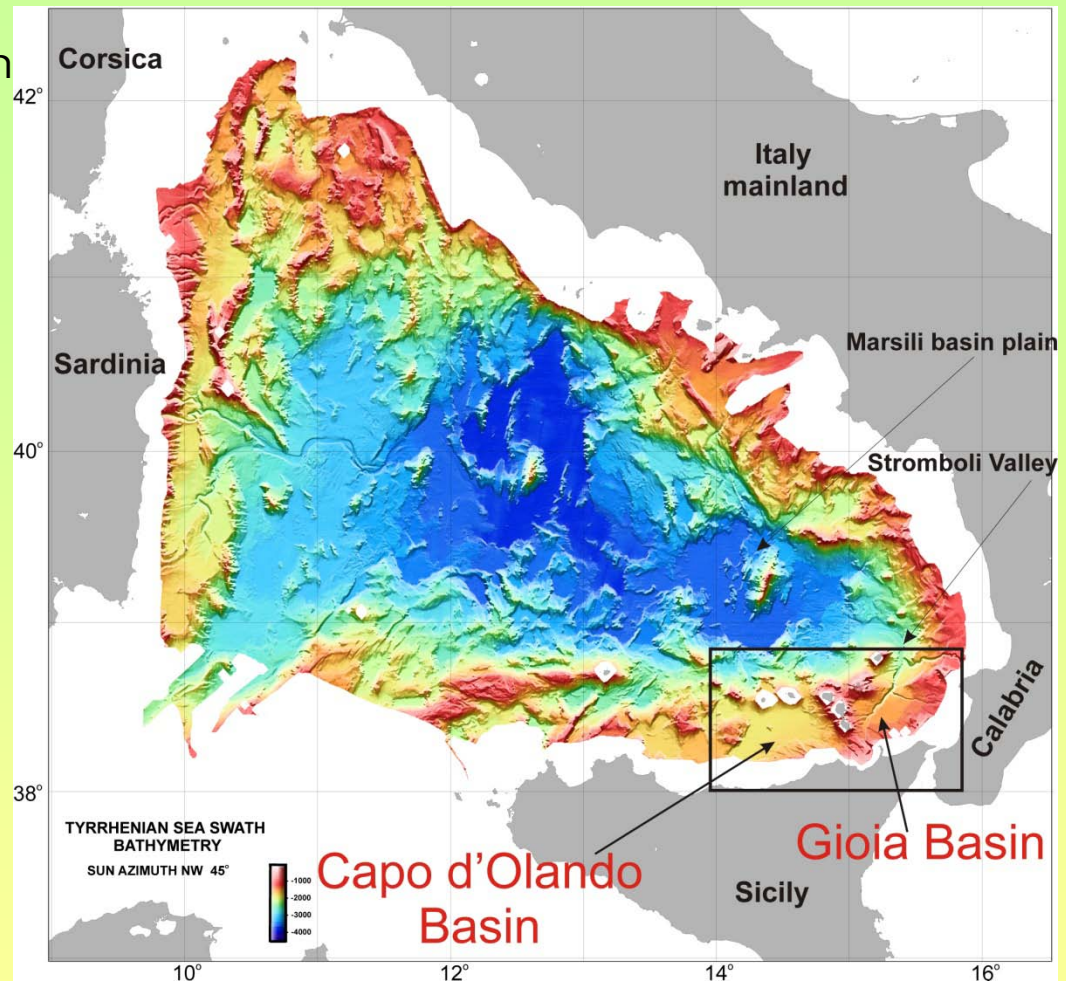
# Modern Examples of Mass-Transport Complexes, Debrite and Turbidite Associations: Geometry, Stratigraphic Relationships and Implications for Hydrocarbon Trap Development

Fabiano Gamberi, Marzia Rovere, Michael Marani  
ISMAR-CNR, Bologna Italy



# Southeastern Tyrrhenian Sea

- Rifting due to back-arc basin opening
- Extensional tectonics
- Seismicity
- High rates of differential vertical movements



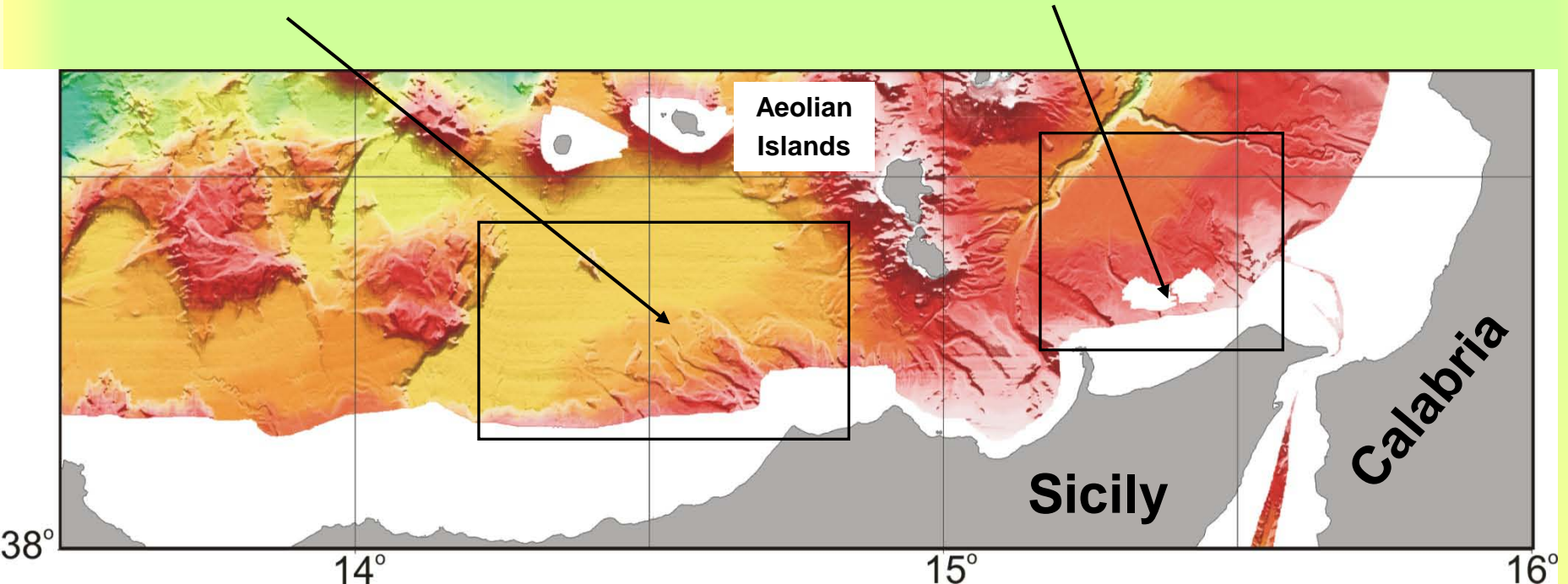
# Leveed channels and mass-transport complexes

## Capo d'Orlando basin

Basin plain confined by the Aeolian Islands

## Gioia Basin

Stromboli axial valley



## Data set

Multibeam bathymetry and reflectivity

Seismics

High resolution subbottom profiles

High resolution deep towed sidescan sonar



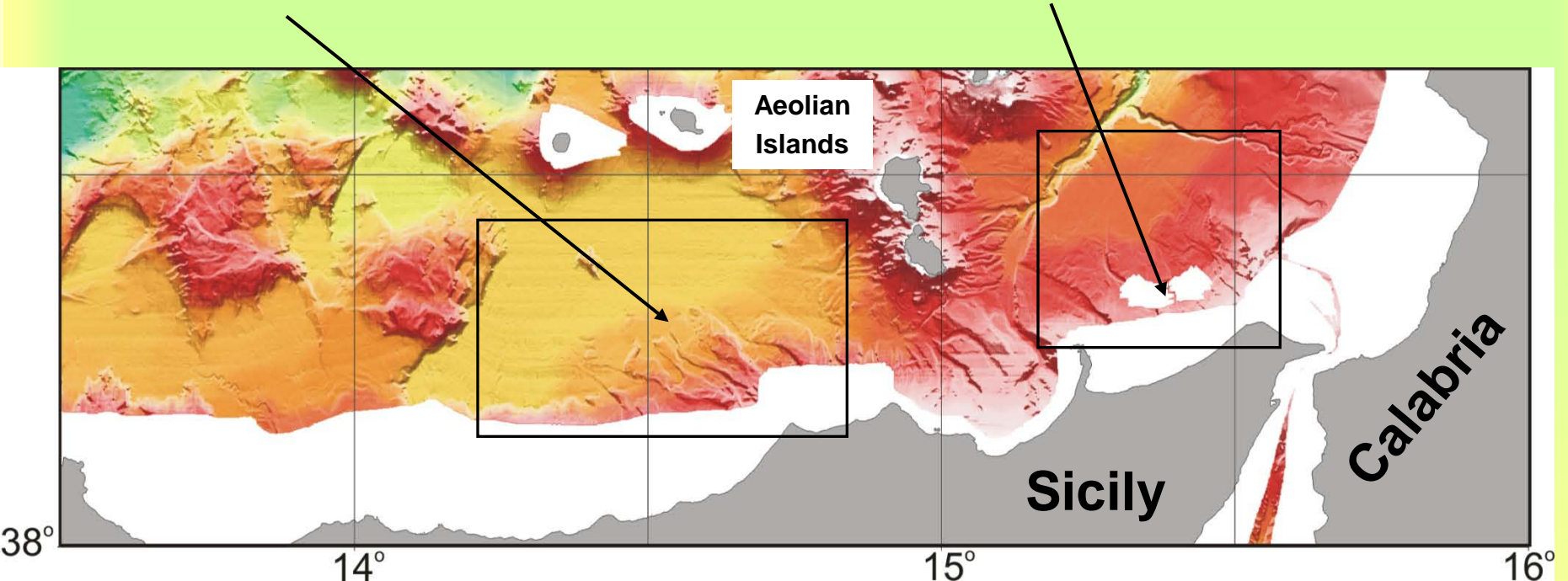
# Leveed channels and mass-transport complexes

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Stromboli axial valley

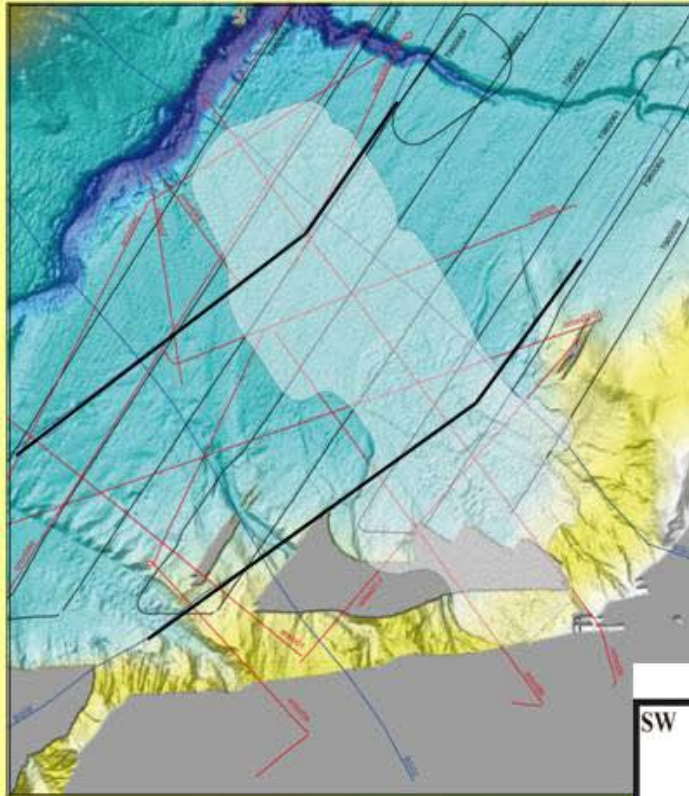


## Aims of work

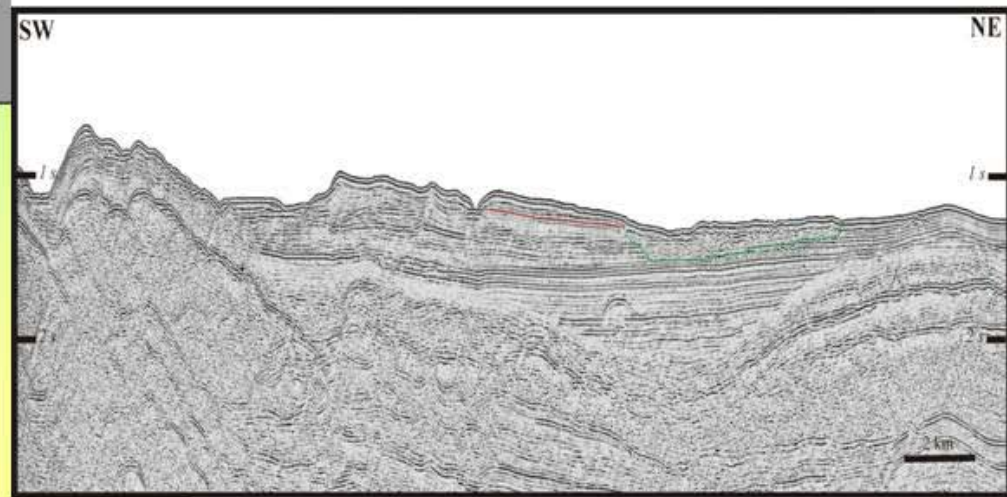
Large scale depositional architecture of the margin

Geometry of single depositional units

Debride-turbidite relationships

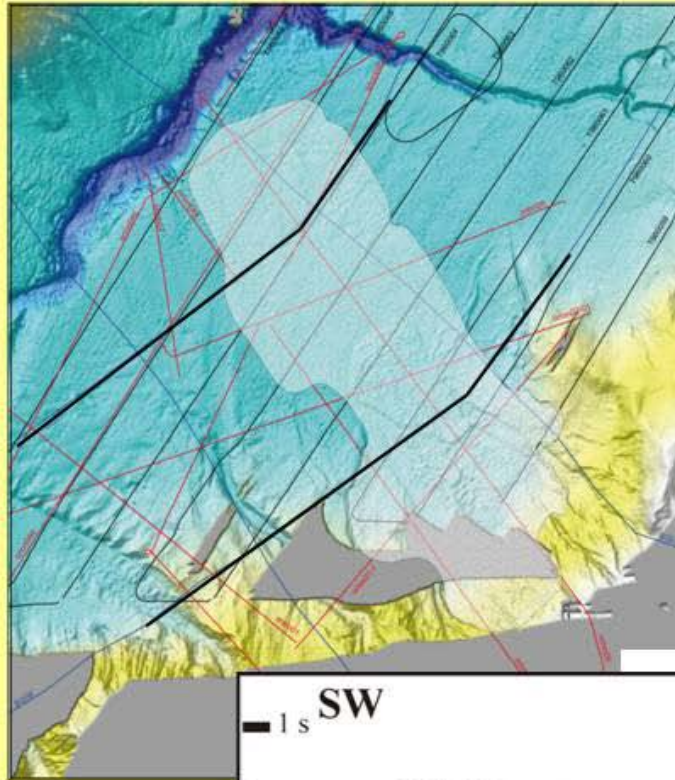


**In the Gioia basin, a relatively large, (250 m thick) frontally confined landslide is present in the eastern side of the basin.**

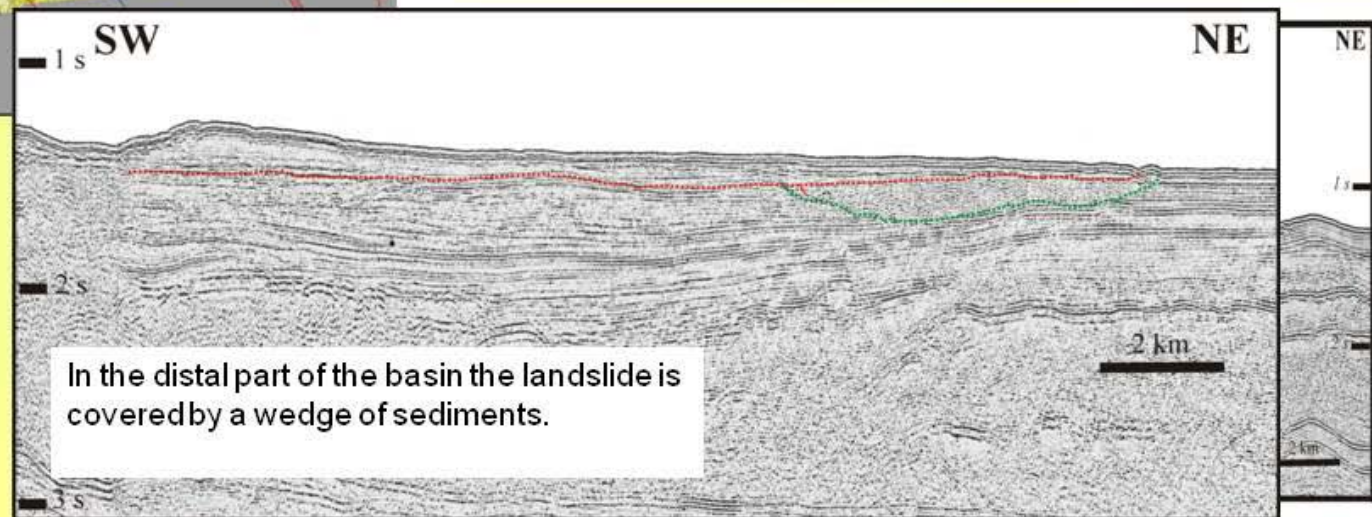


Notes by Presenter: Together with multibeam bathymetry data, also a network of seismic profiles are available, blue are depicted the old 30 KJ sparker lines acquired in the '70s by the institute for marine geology of bologna, in black the single-channel lines acquired together with the bathymetry, in red the more recent CHIRP profiles acquired during a pre-survey GEOSTAR deployment in 2003. The seismic data made possible to map two distinct events one the so called Nicotera slump and a frontally confined slide, defined as Villafranca.



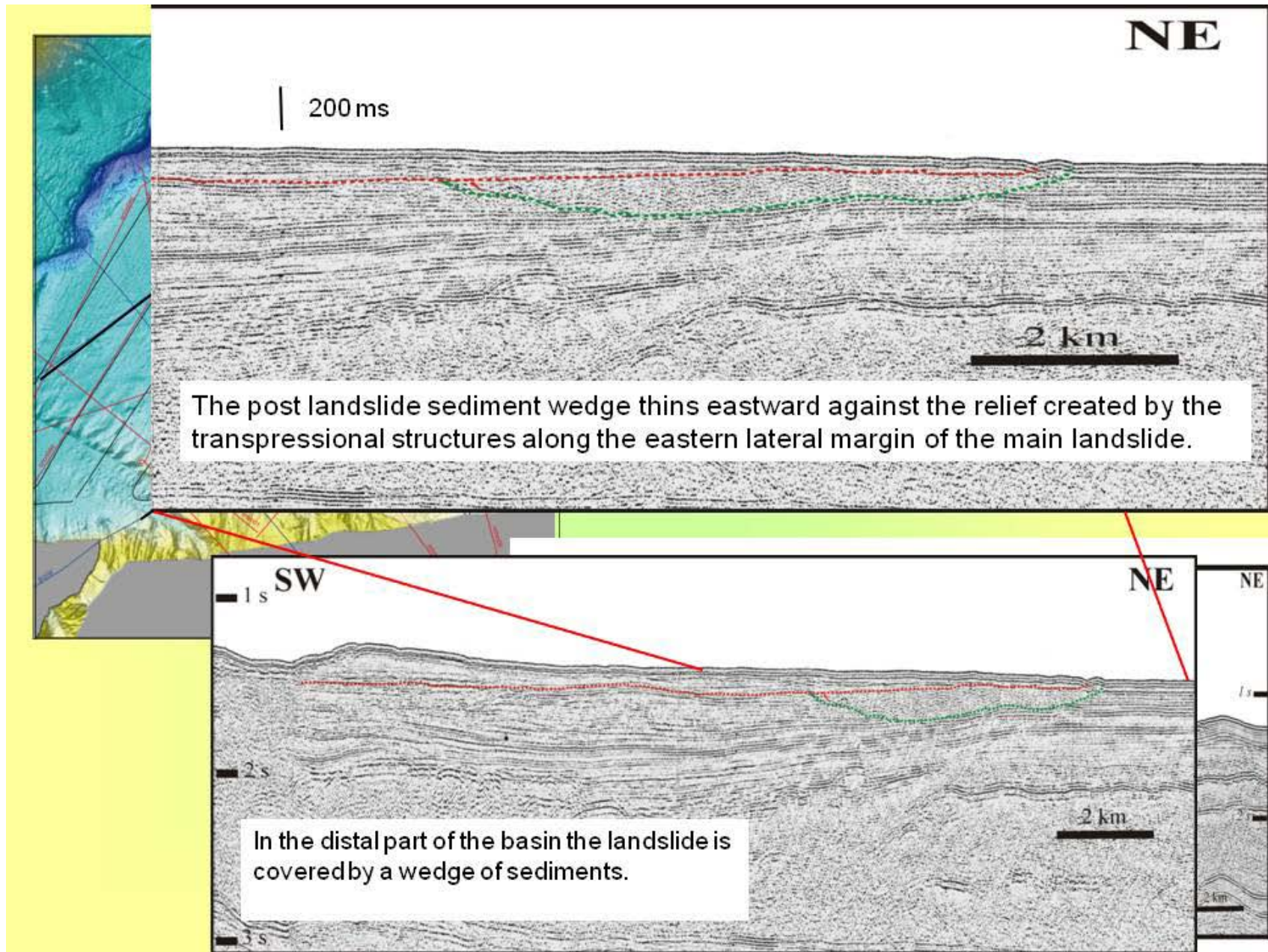


In the Gioia basin, a relatively large, (250 m thick) frontally confined landslide is present in the eastern side of the basin.



In the distal part of the basin the landslide is covered by a wedge of sediments.

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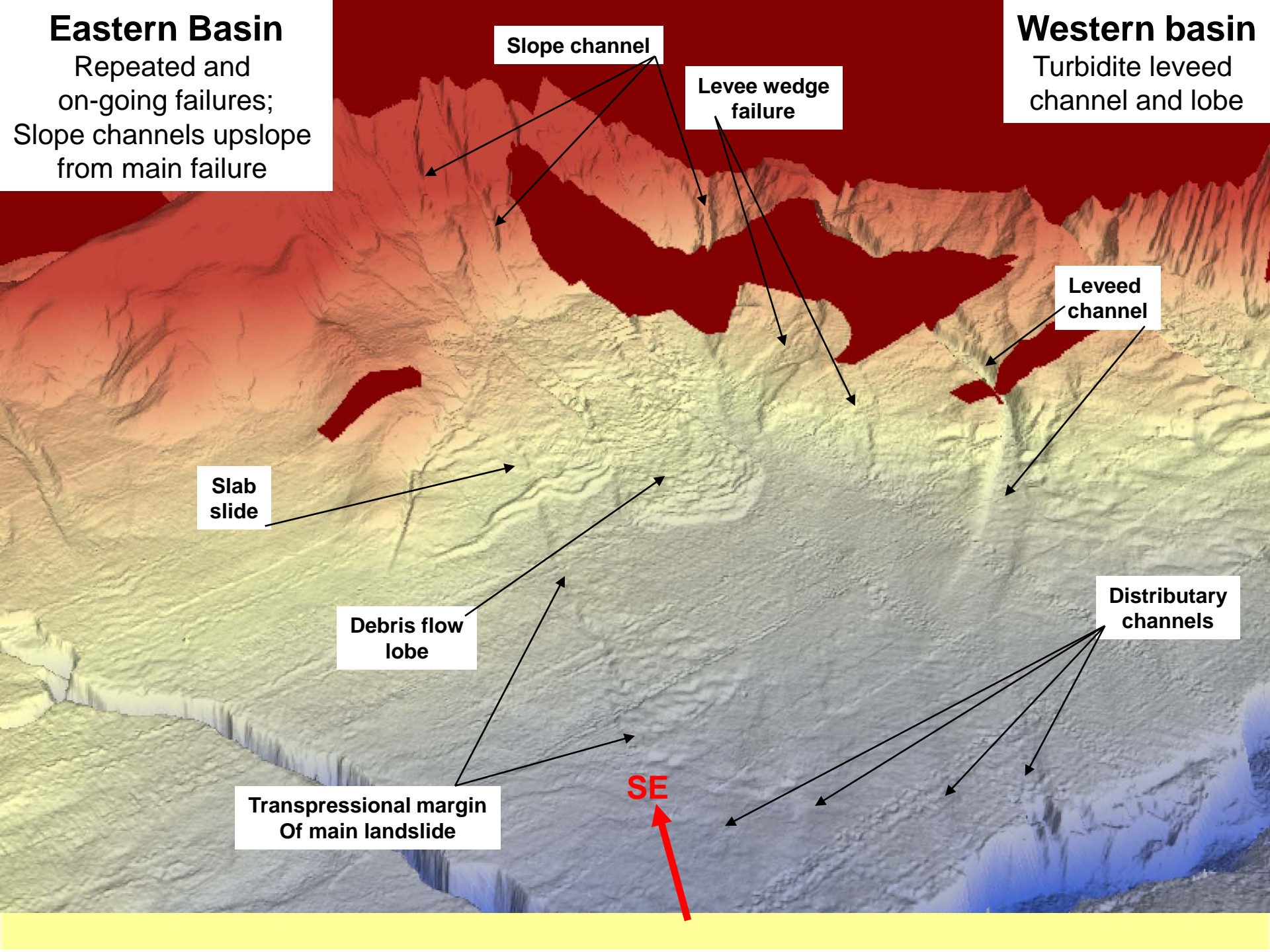


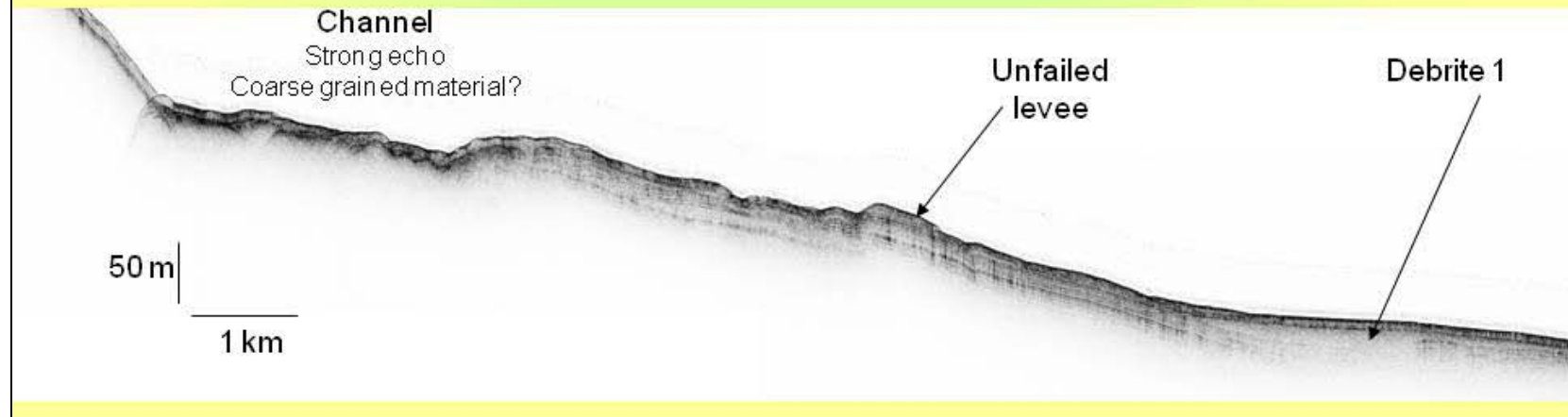
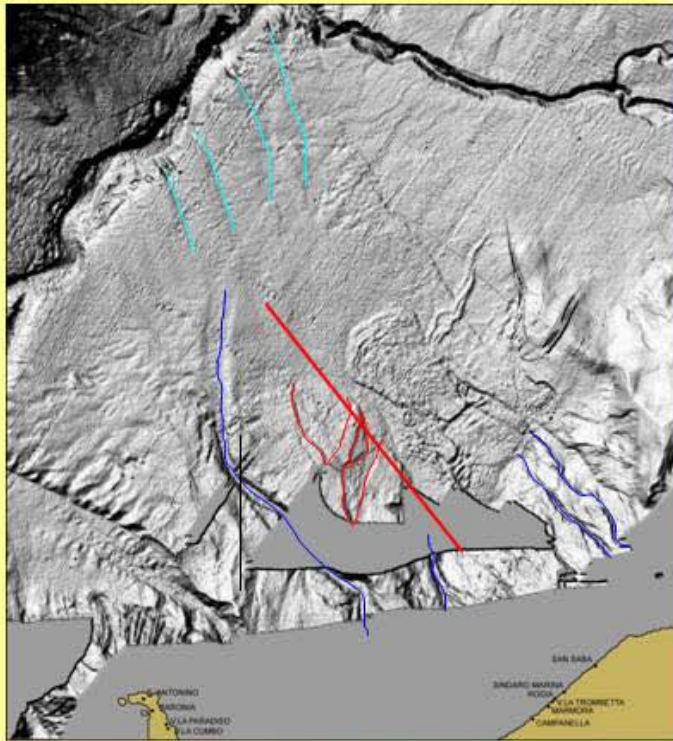
## Eastern Basin

Repeated and on-going failures;  
Slope channels upslope from main failure

## Western basin

Turbidite leveed channel and lobe



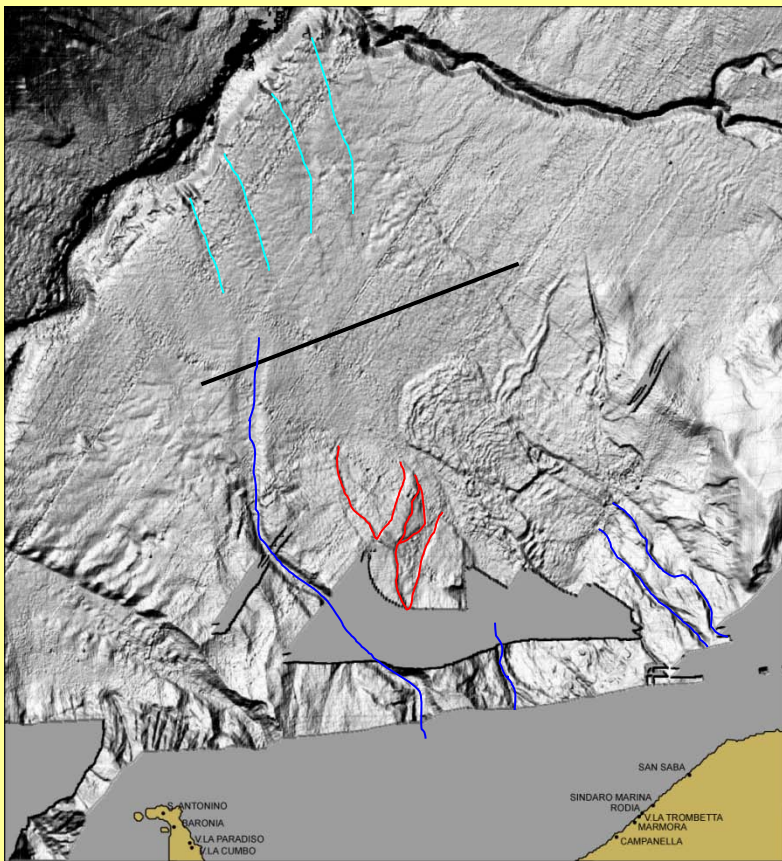


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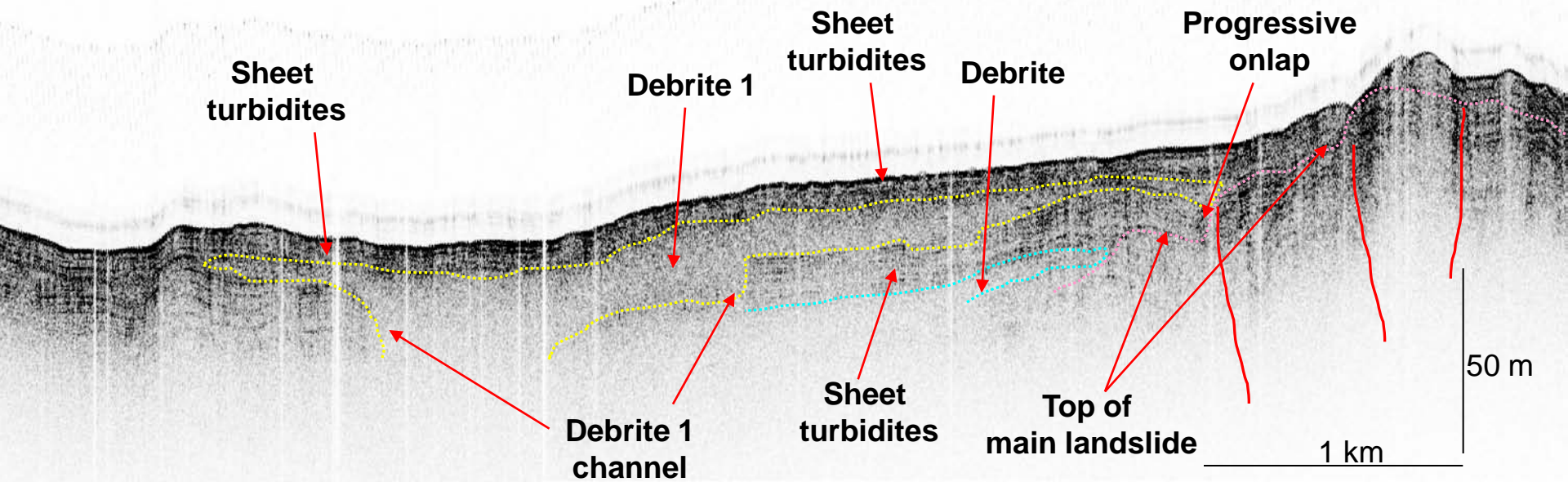
**Villafranca channel  
mouth**

The relief at the eastern transpressional margin of the main  
landslide is overlapped by turbidites and debrites.

**Debrite 1**

50 m

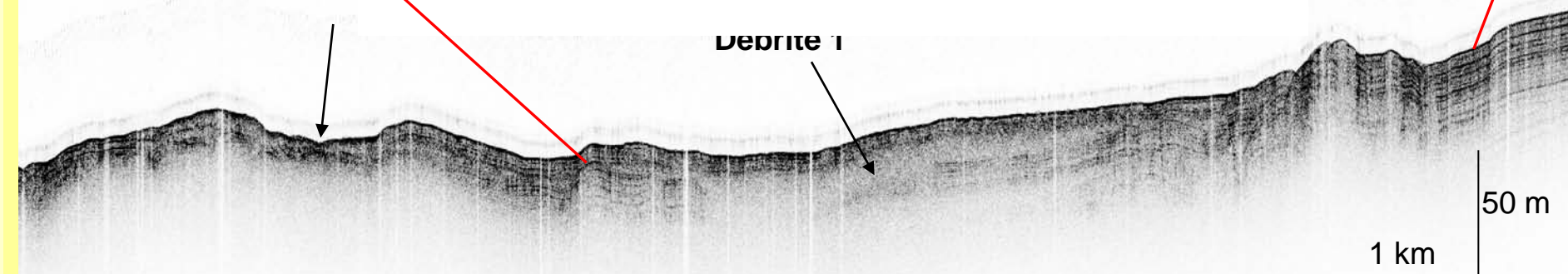
1 km



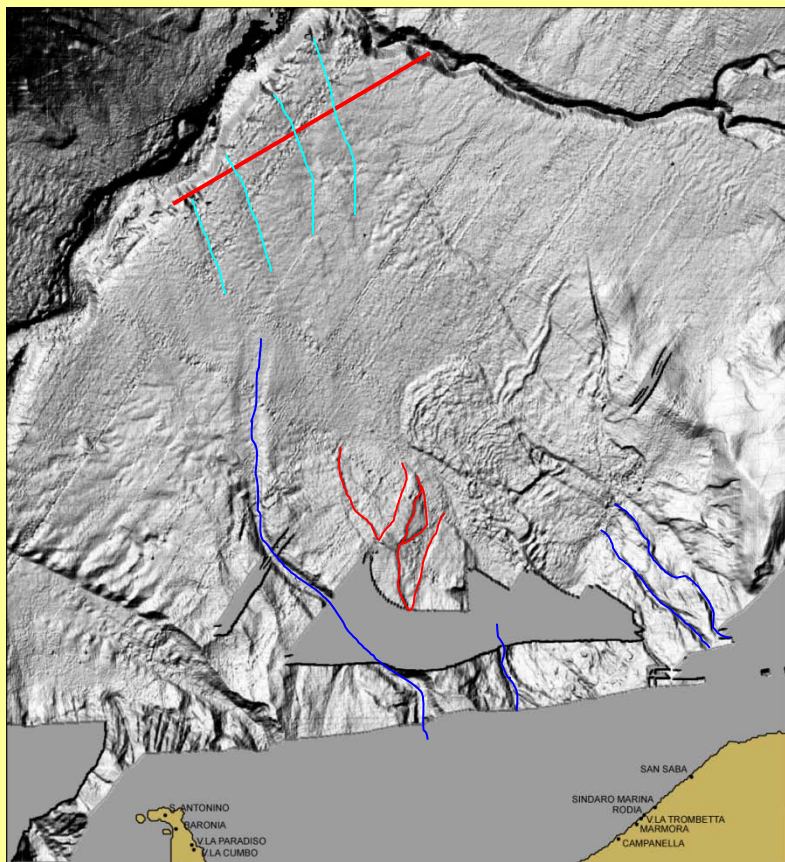
Debris 1 has an erosional basal surface that cut underlying turbidites. As a consequence, a package of turbidites with a thickness of 12 m is sandwiched between debris 1 and onlaps against the main landslide blocks.

Villafranca chs  
mouth

Debris 1



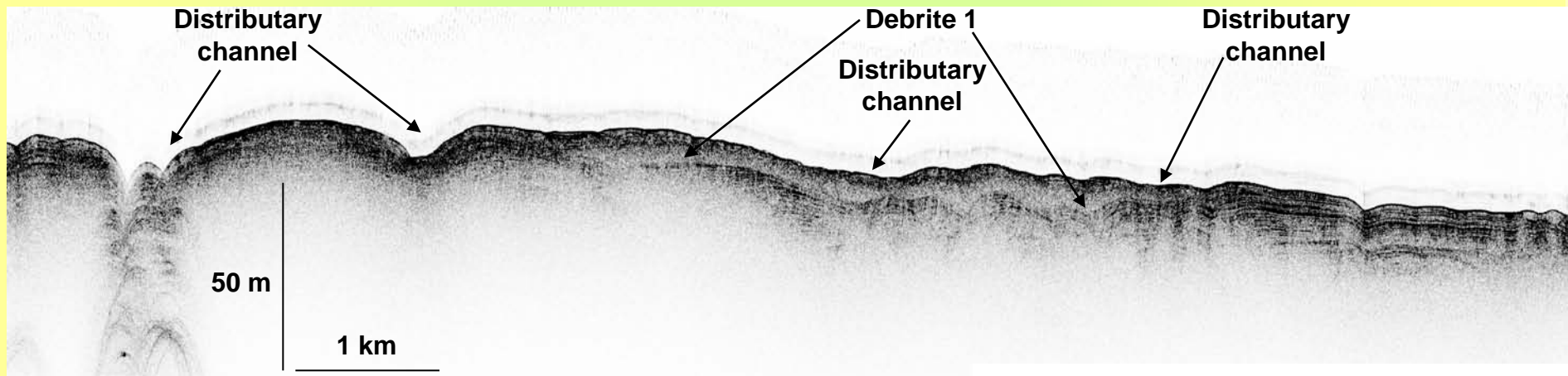




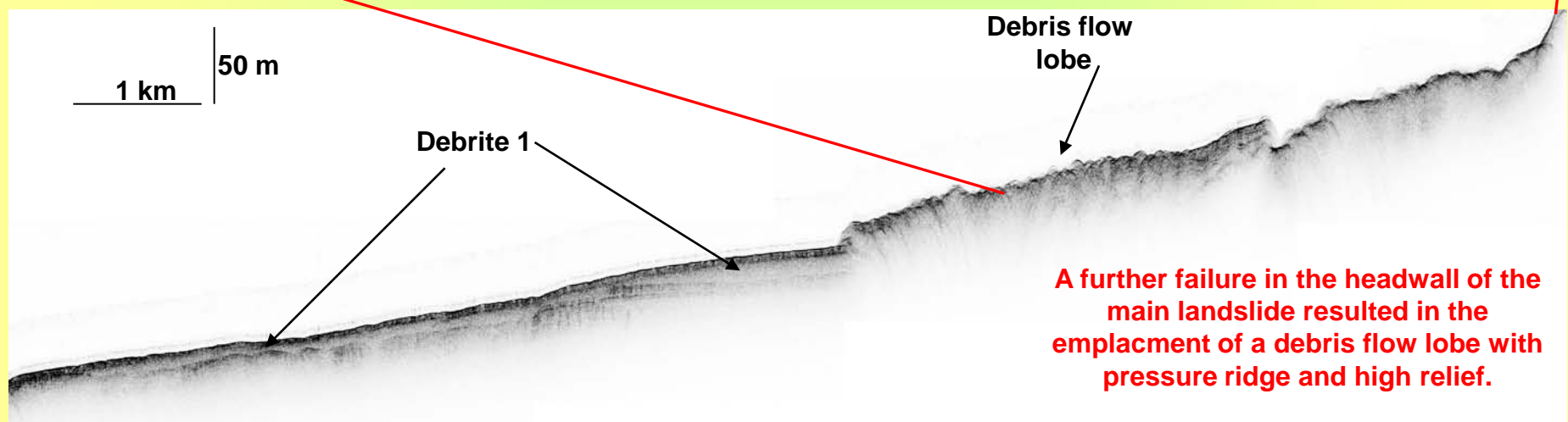
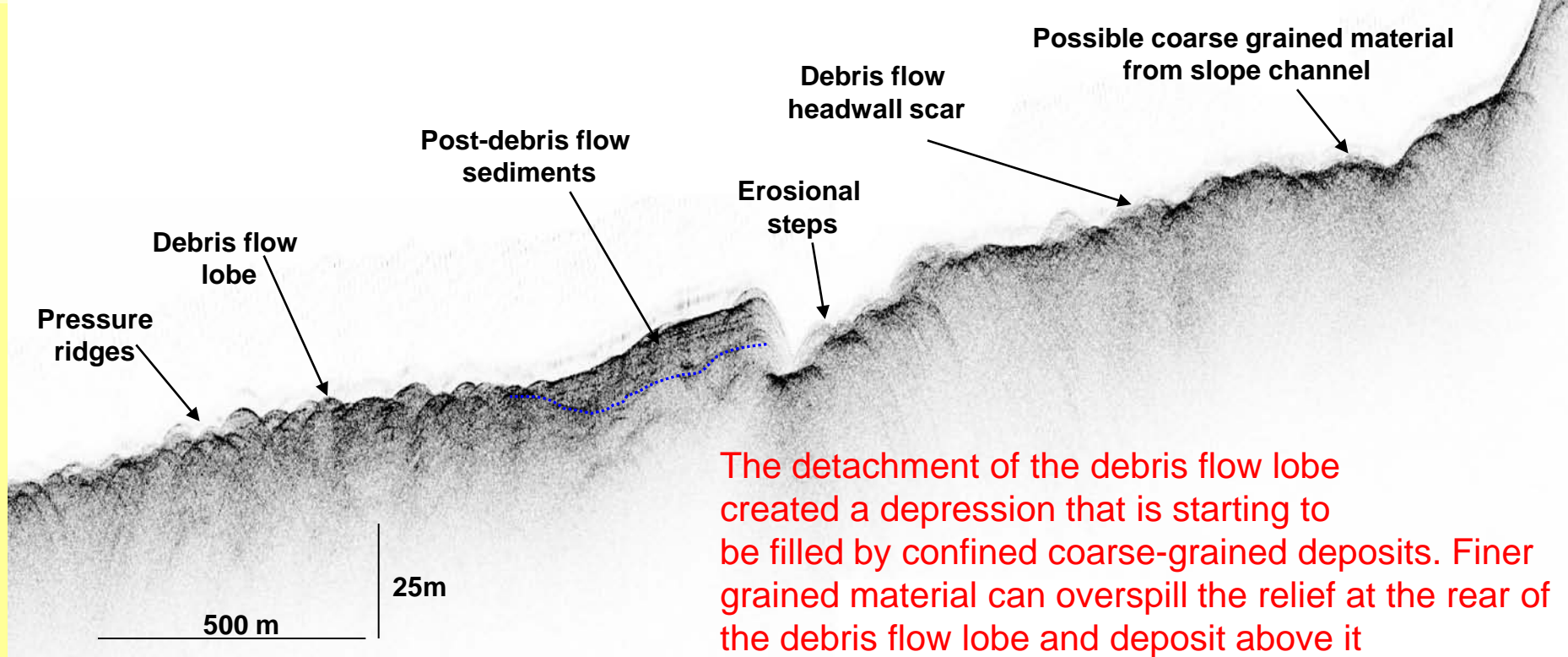
Further downslope Debrite 1 has a conformable base. It is present to the east of the main depositional relief created by the distributary channels.

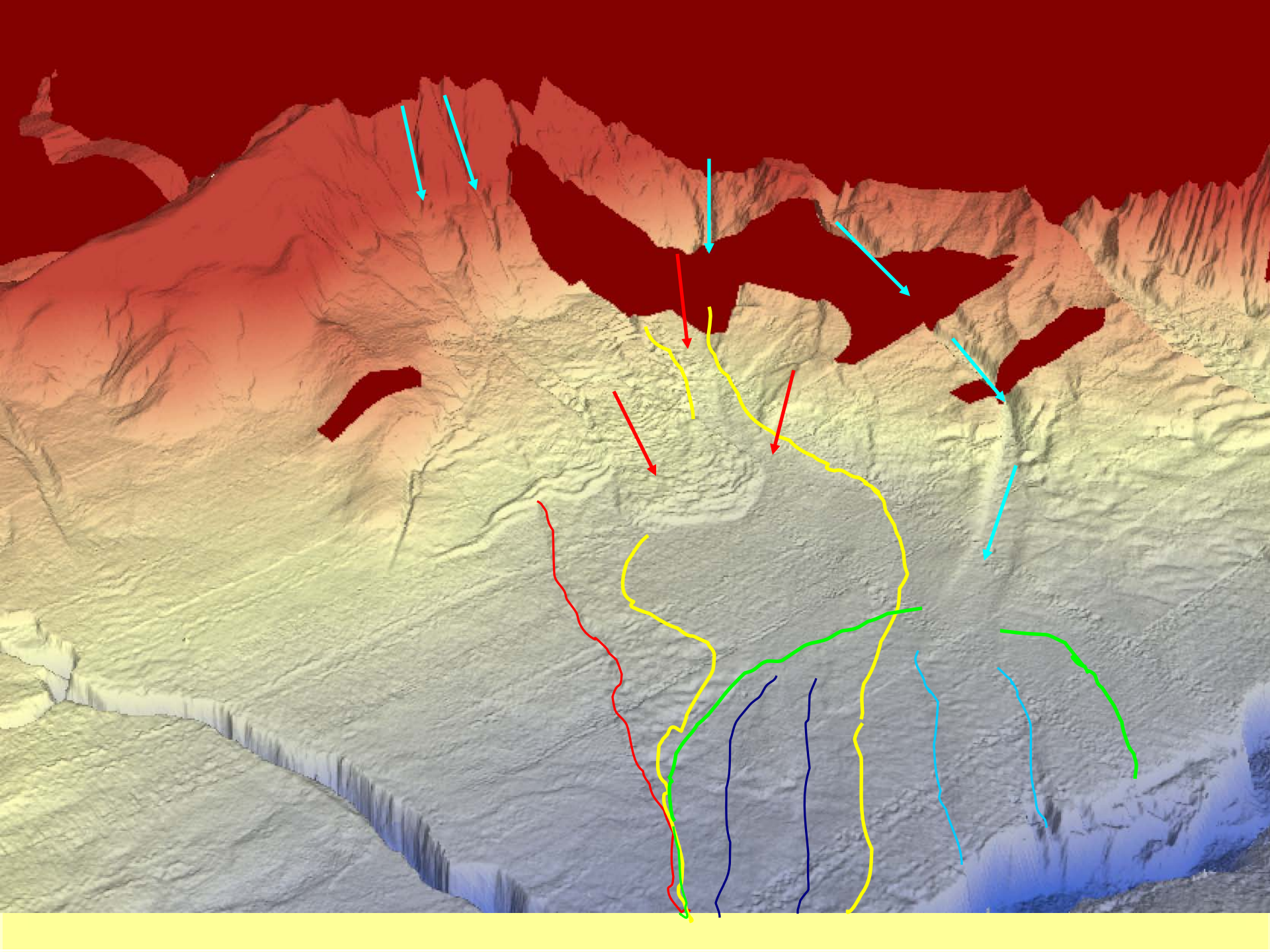
Debrite 1 heals the topography of the lobes and seals turbidite deposits formed in the distributary channel area of the Villafranca fan.

In turn, to the north, the debrite is eroded in places by successive channelized flows that, otherwise deposit sheet turbidites.





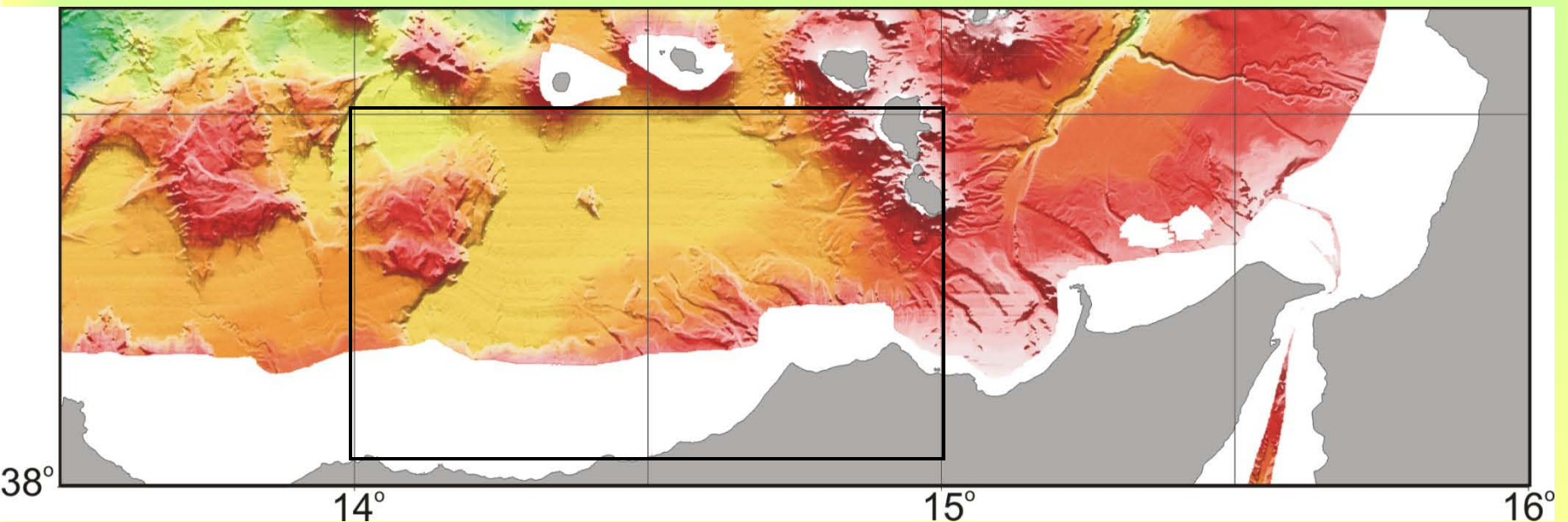




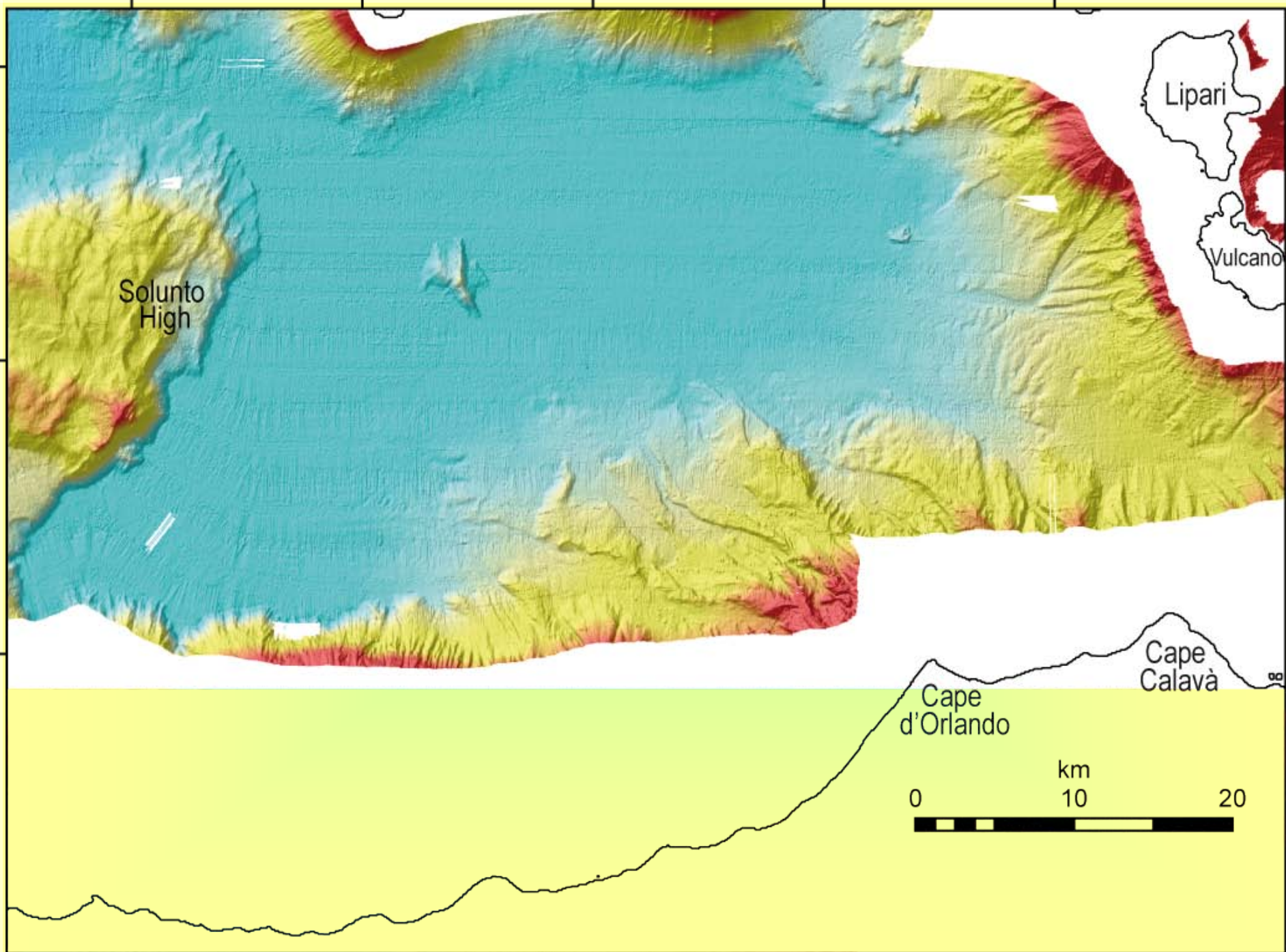


# Leveed channels mass-transport complexes

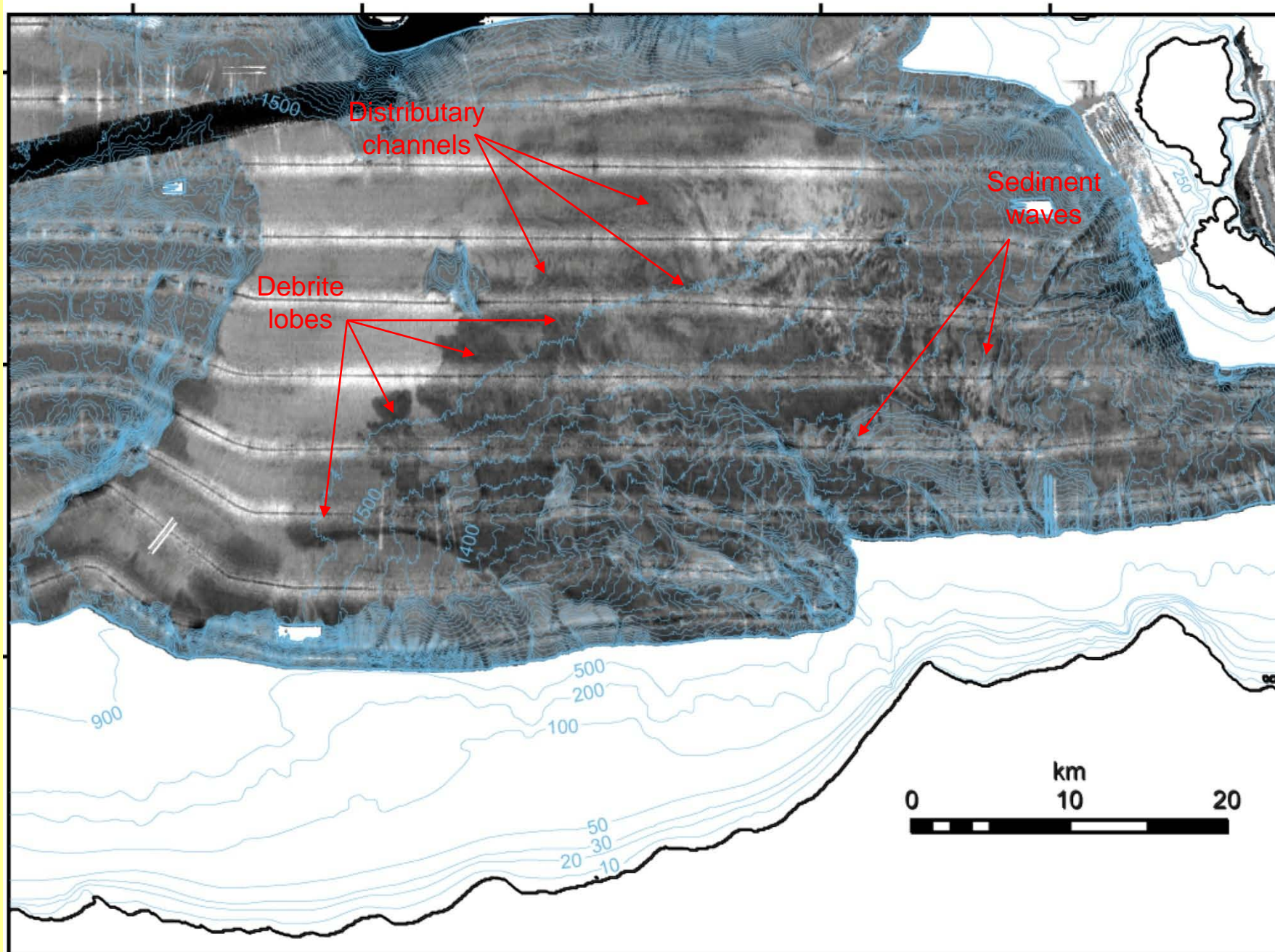
- Capo d'Orlando basin: seaward confined basin plain fans



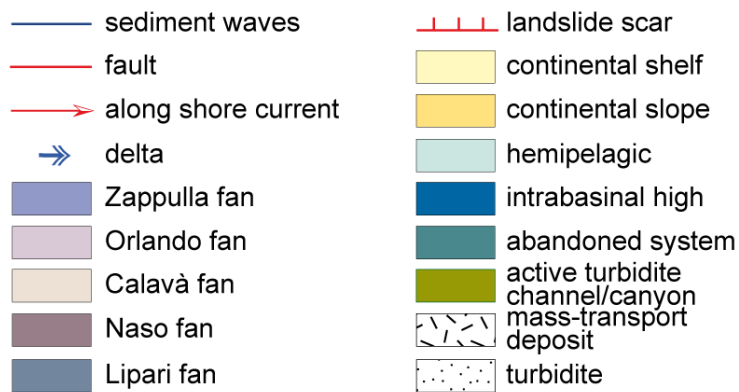






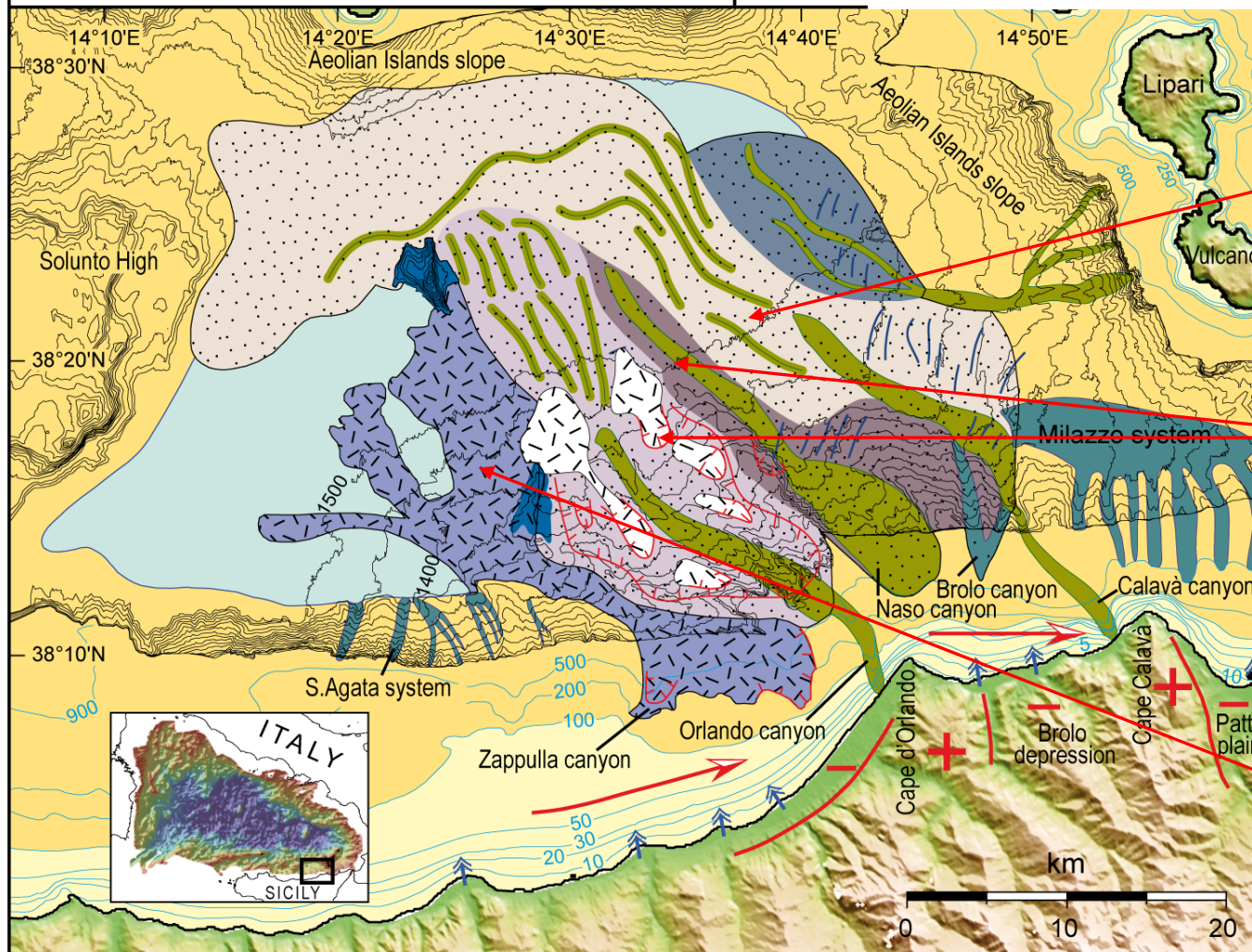






Channels connected with the coastal areas are mainly fed by shelf derived turbidites. Channels not connected with the coastal area are mainly fed by landslides.

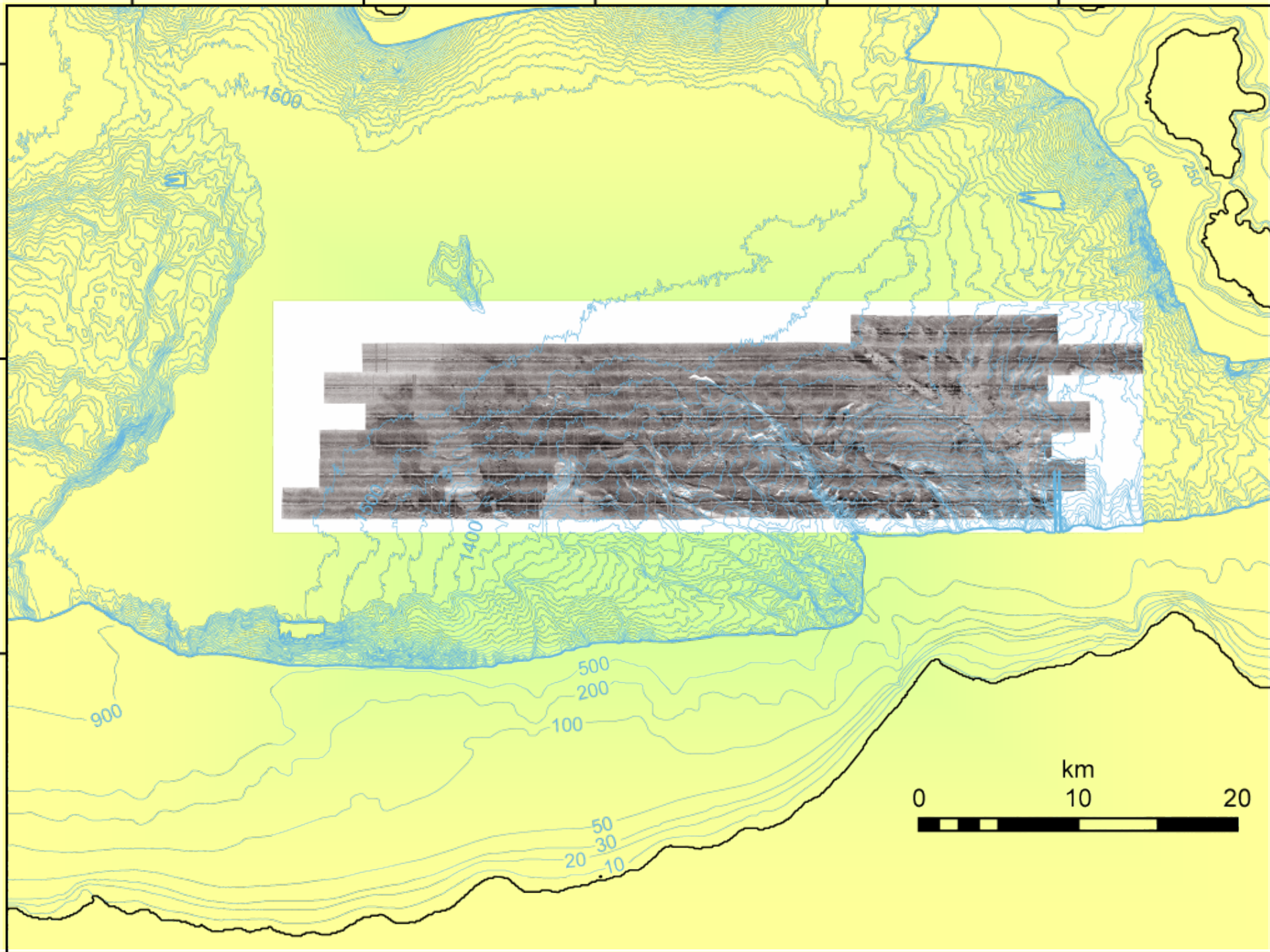
As a consequence, turbidite and debrite fans are developed. A mixed facies occurs where levee failures is occurring adjacent to turbidite channels or where landslide can evolve into turbidites within the channels.



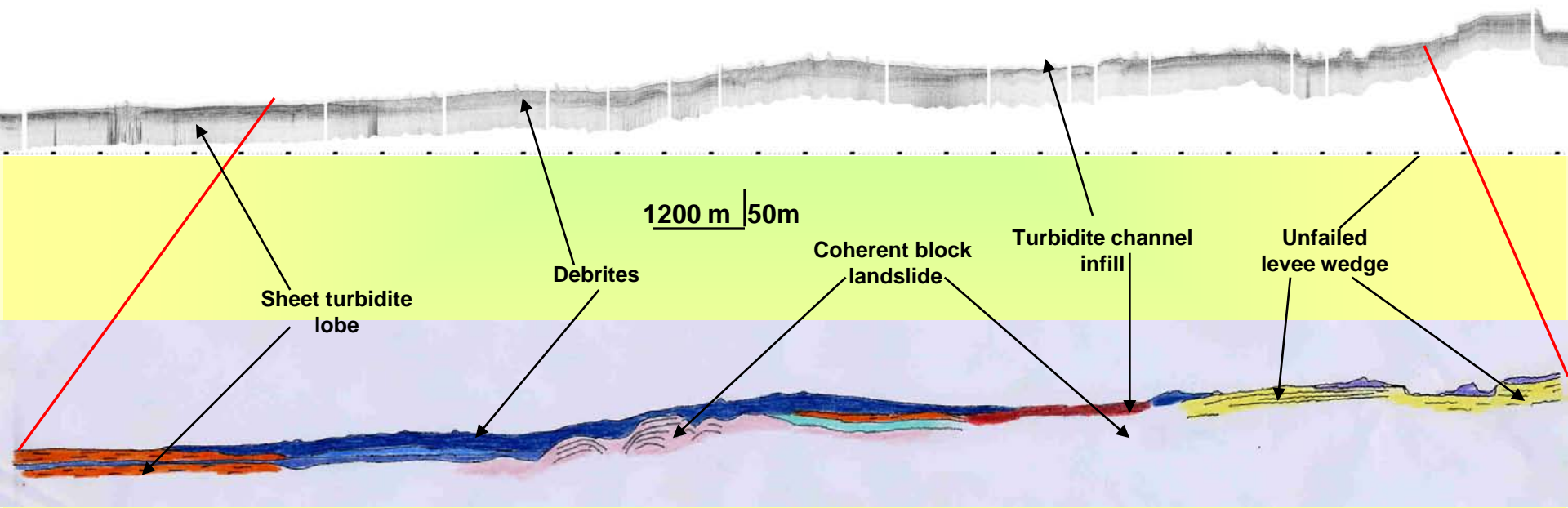
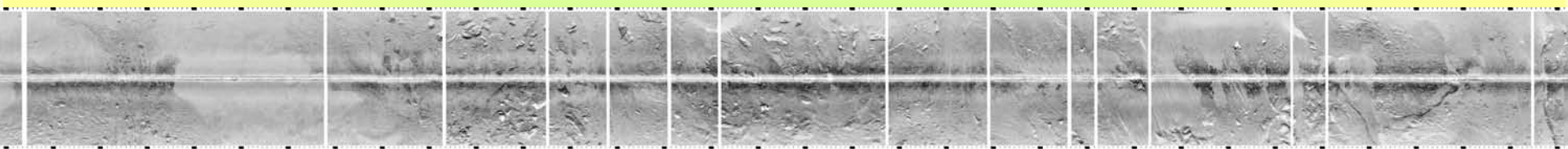
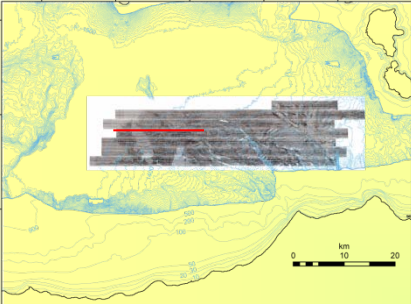
Turbidite fan

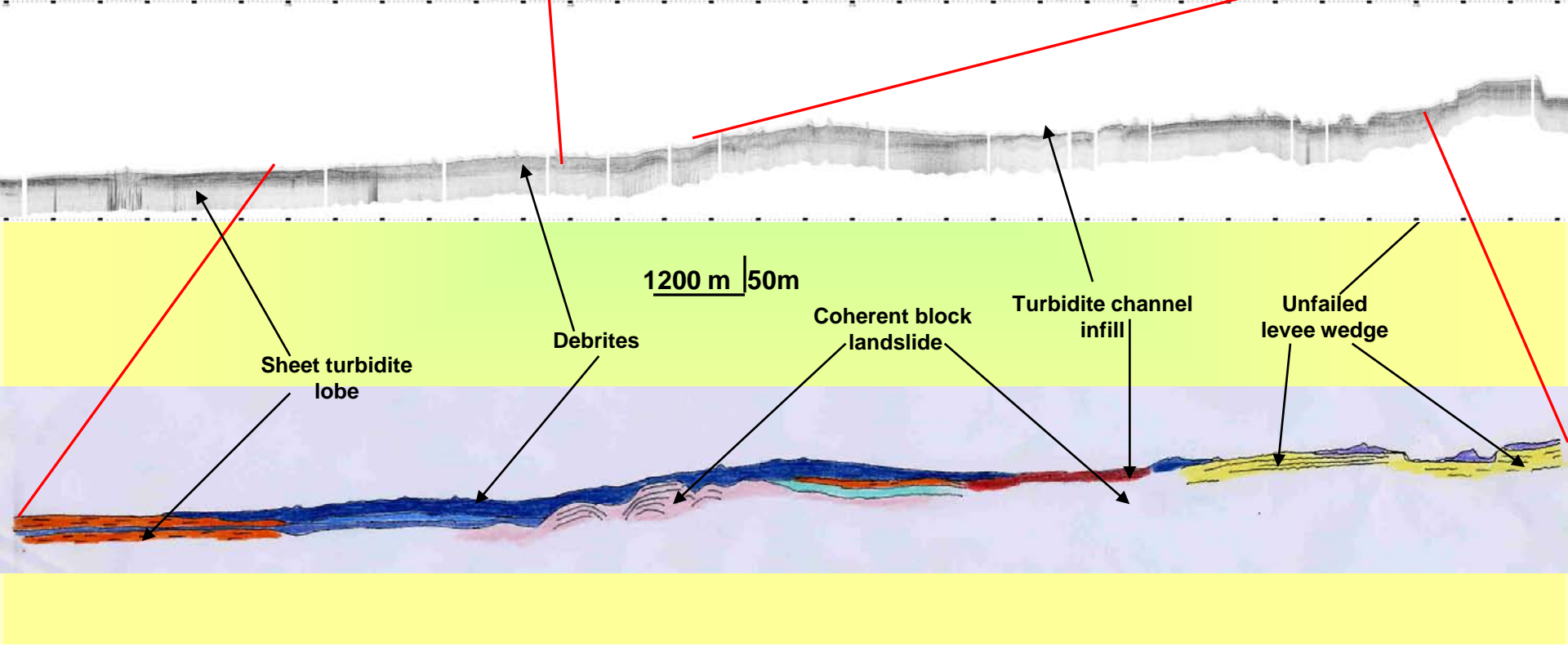
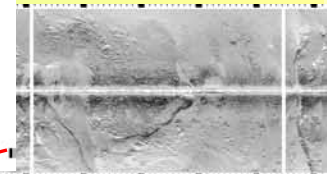
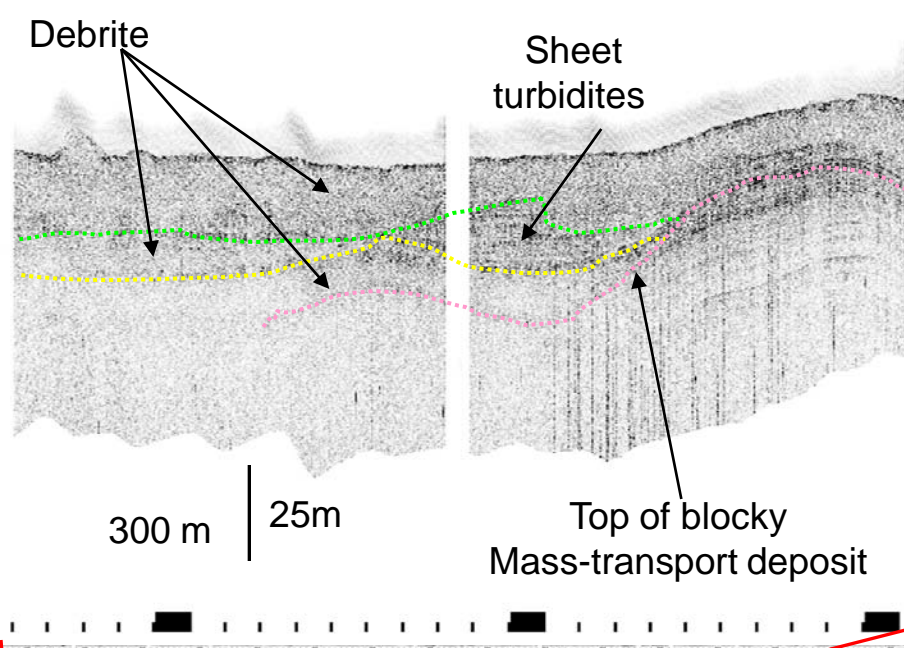
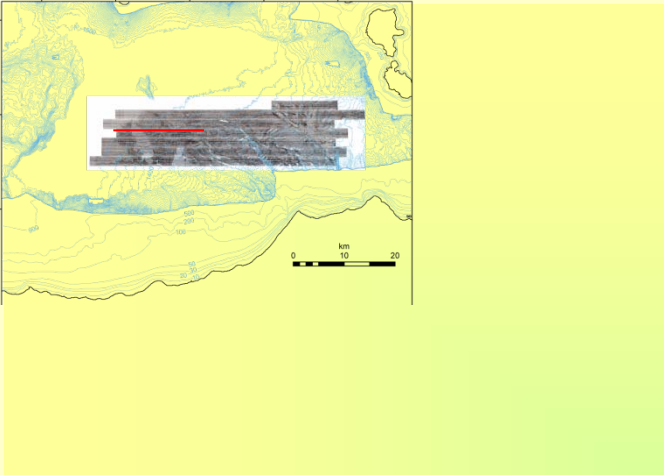
Mixed fans

Debite fan

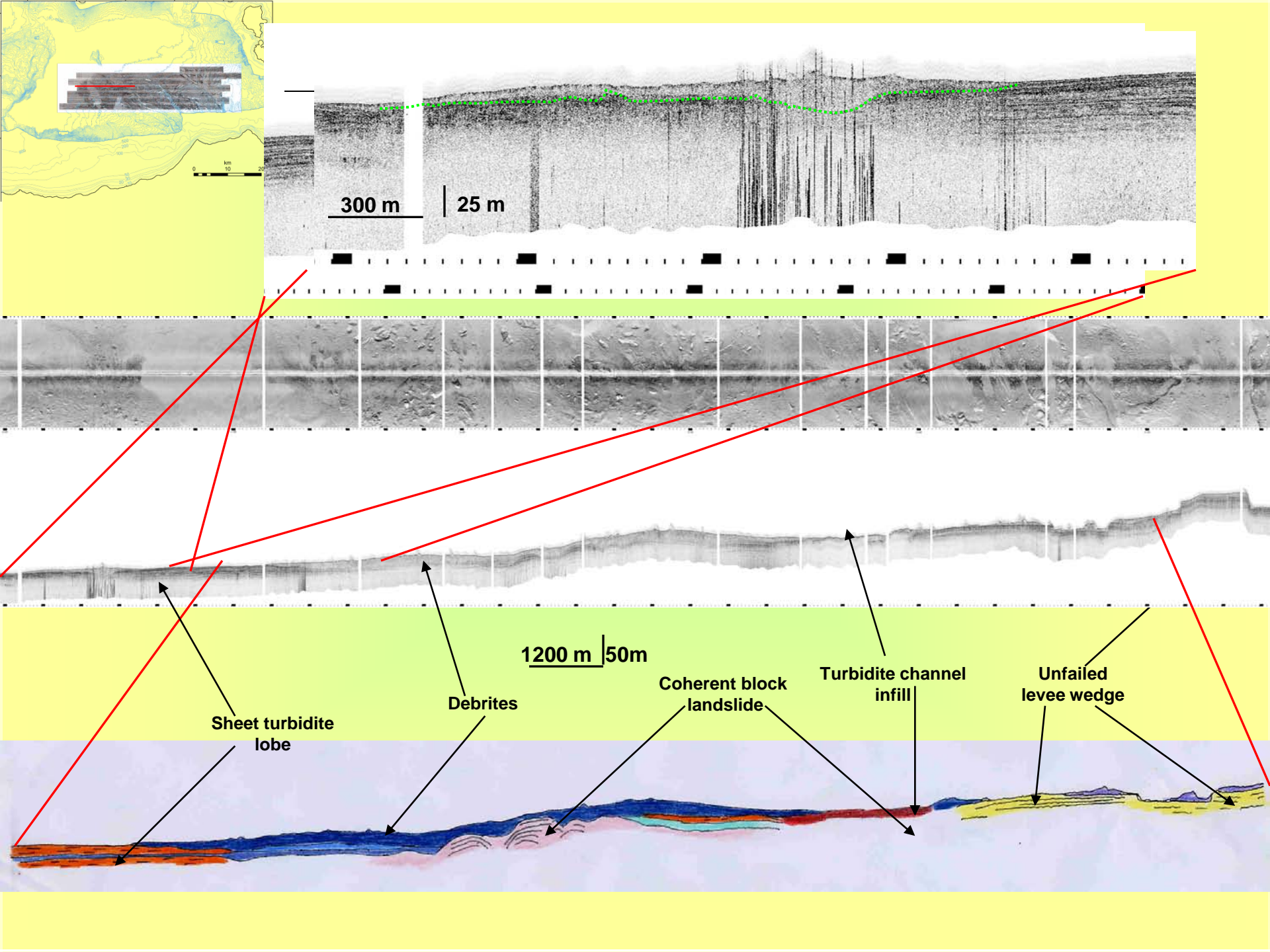


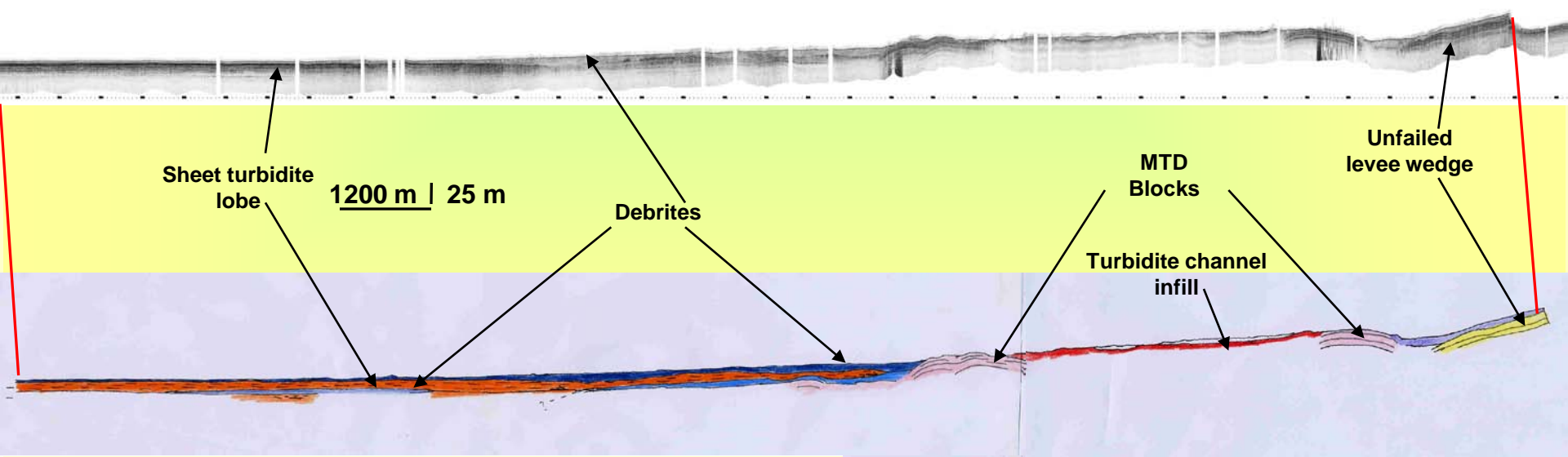
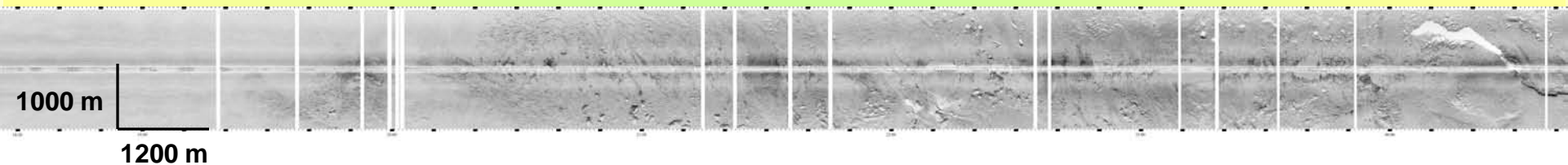
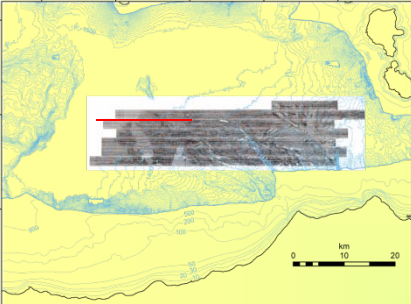




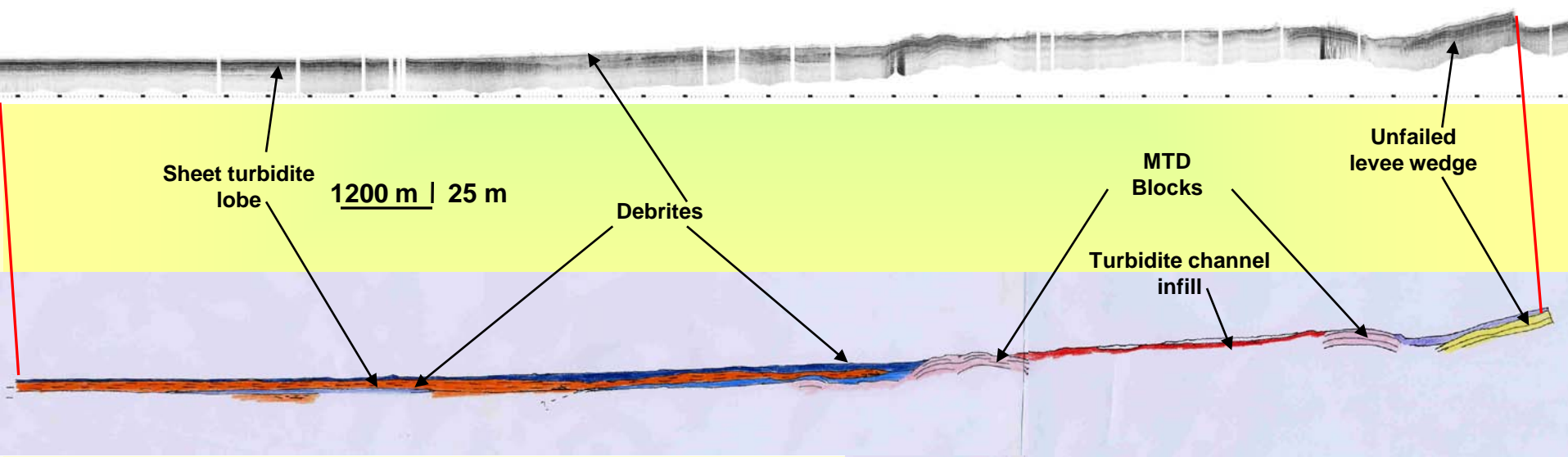
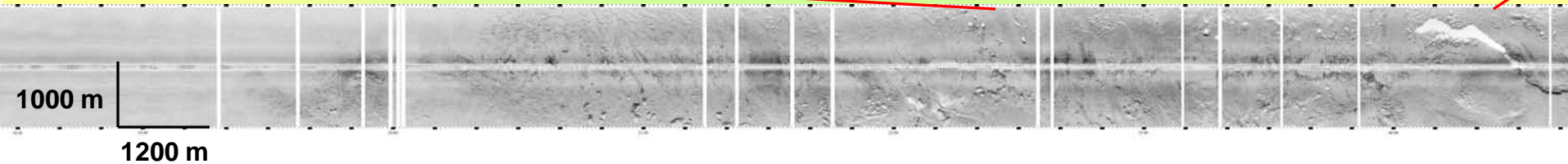
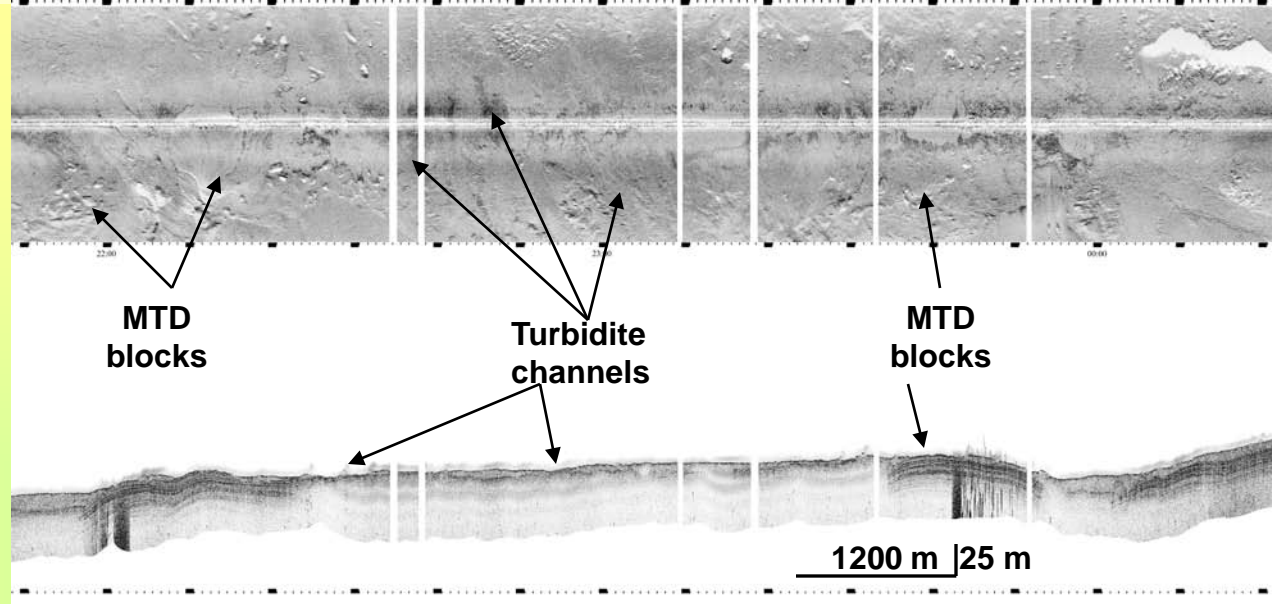
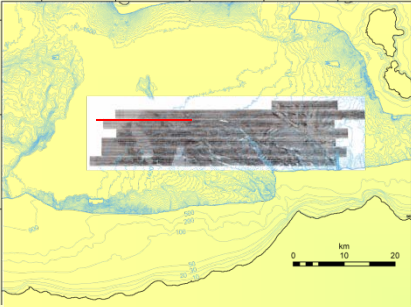


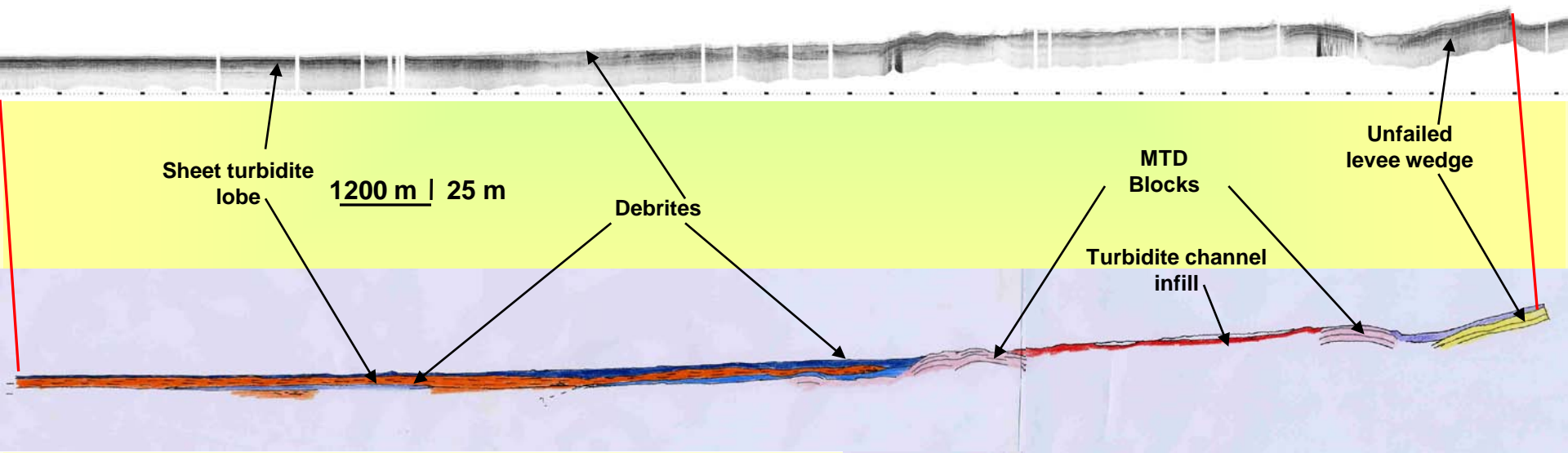
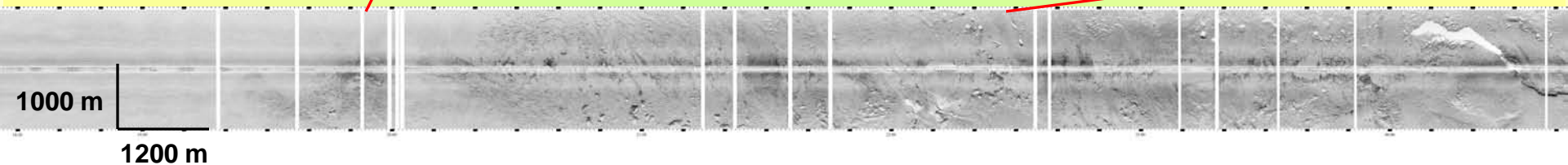
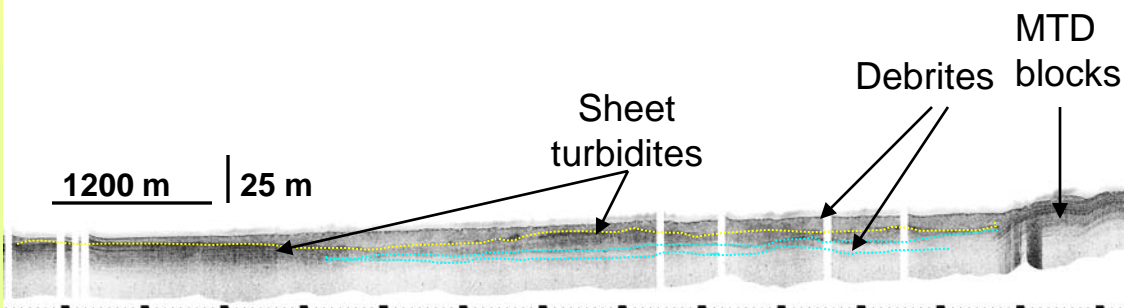
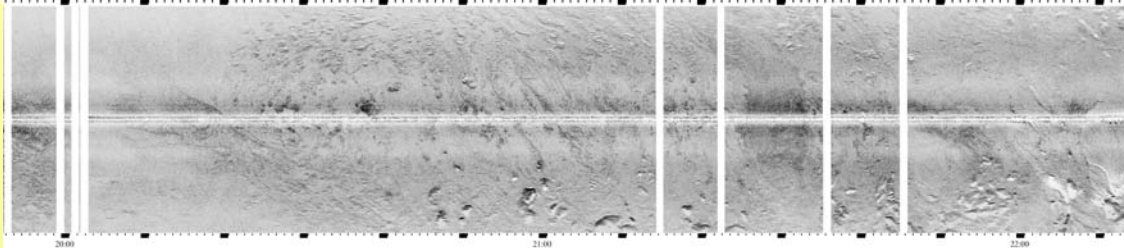
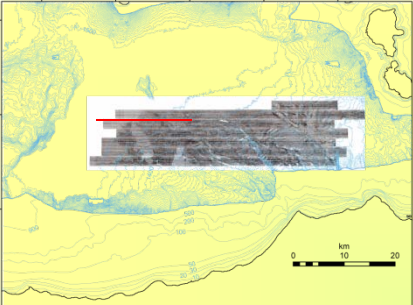




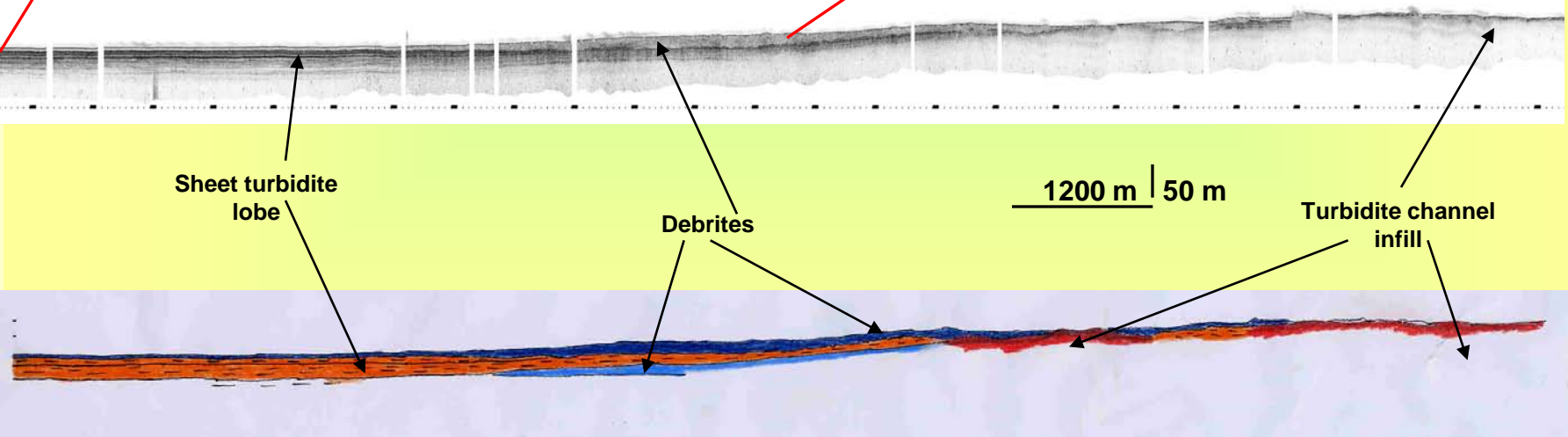
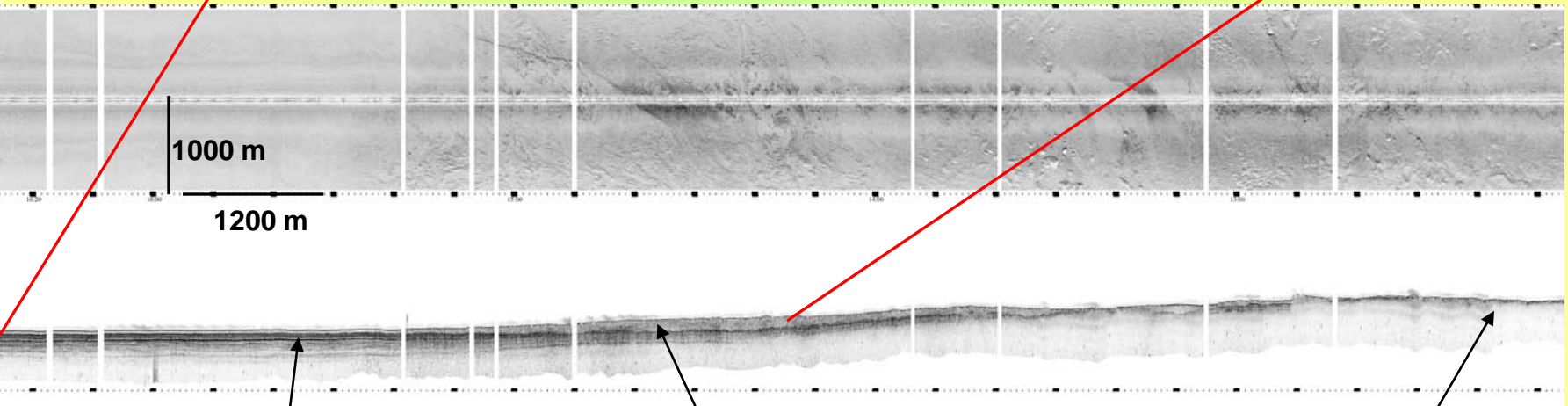
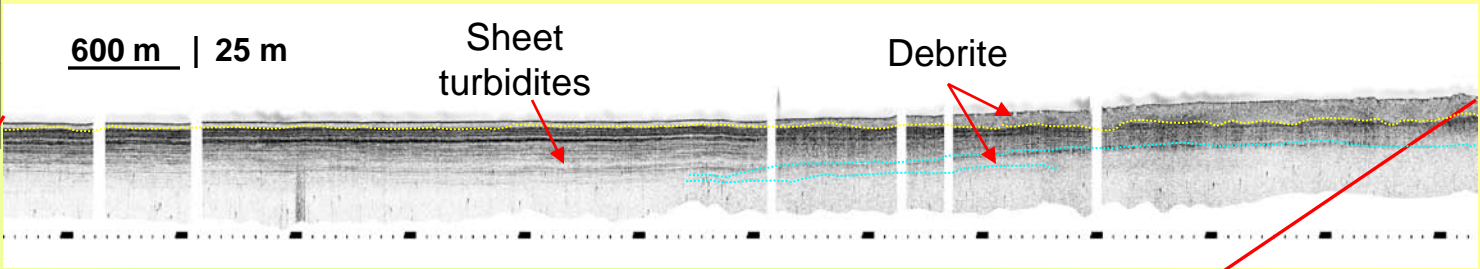
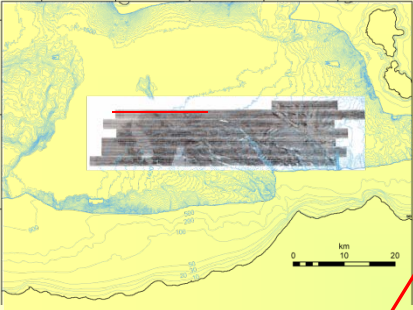








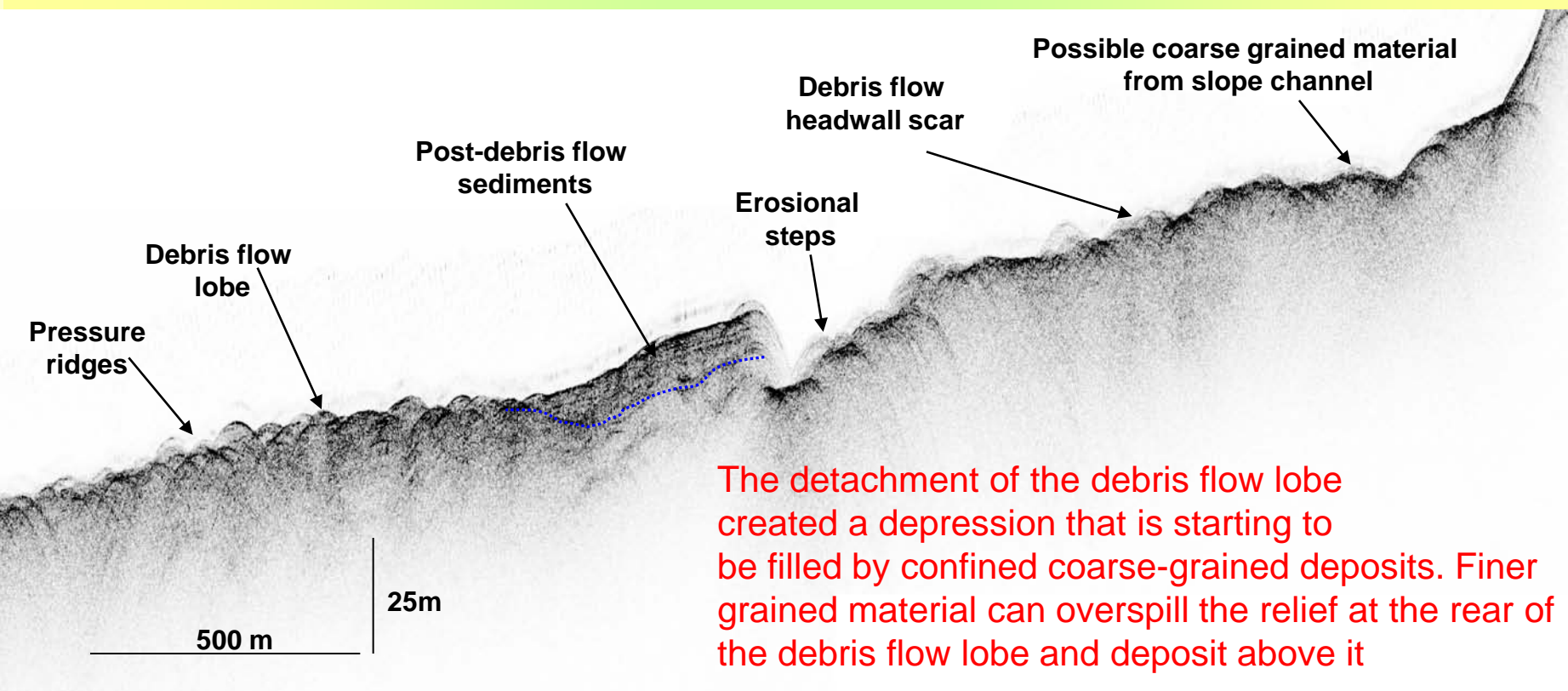




# Summary and conclusions:

Relatively large-scale mass-transport deposits create seafloor topography

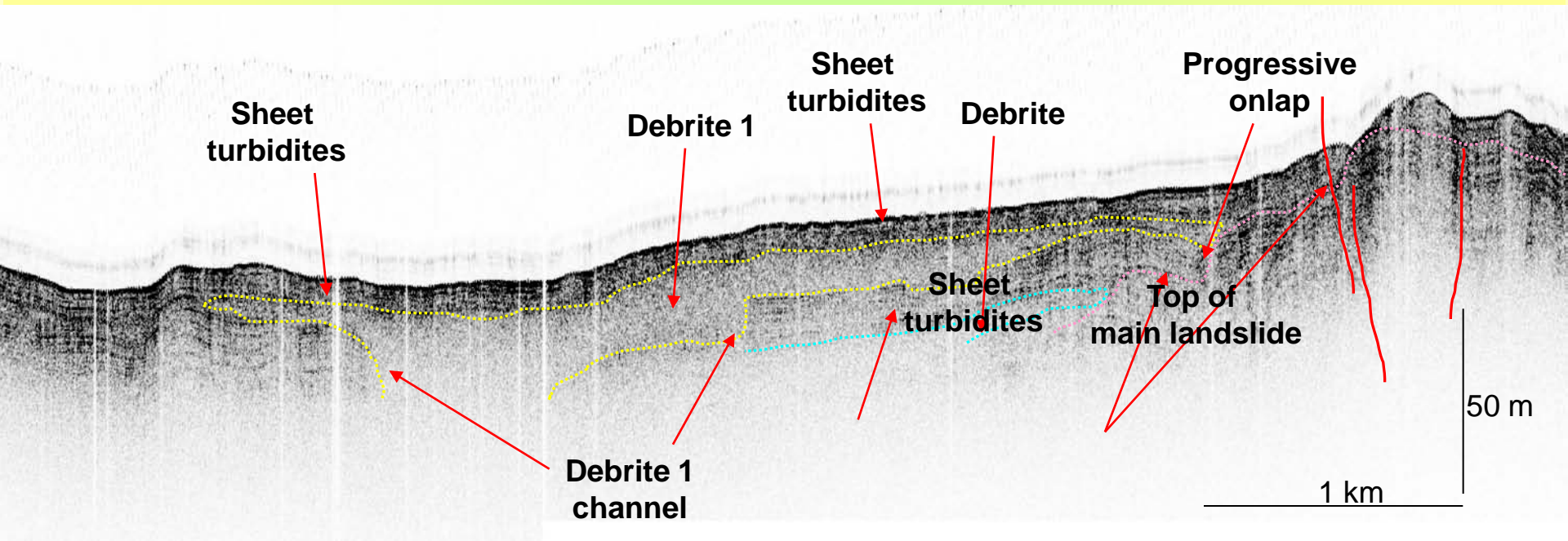
In the evacuation area negative relief is infilled by coarse-grained deposits fed by slope channels.



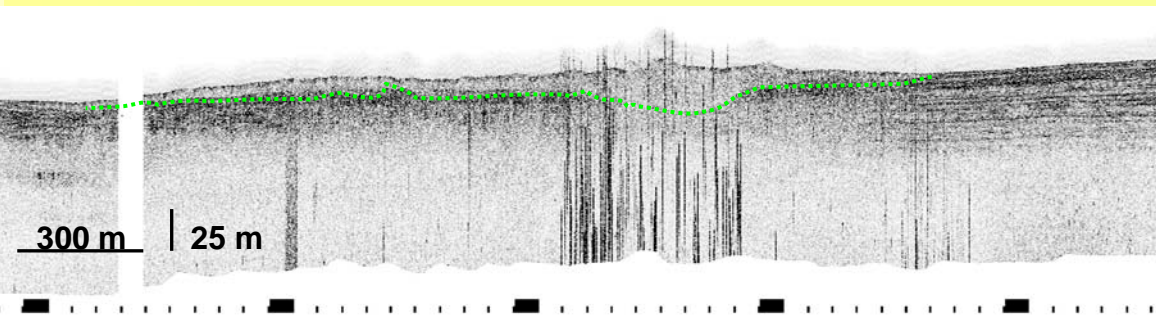


## Relatively large-scale mass-transport deposits create seafloor topography

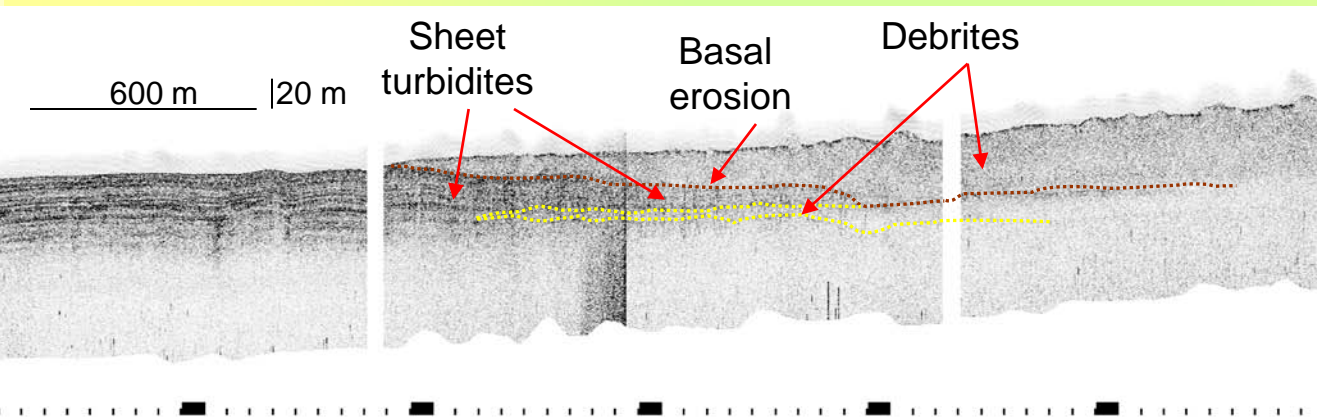
In the distal area the positive relief is overlapped by packages of turbidites and by debrites. As a result, sandy lobe deposits with thickness up to 30 m and with 3 km of lateral extent are sandwiched between debrite deposits.



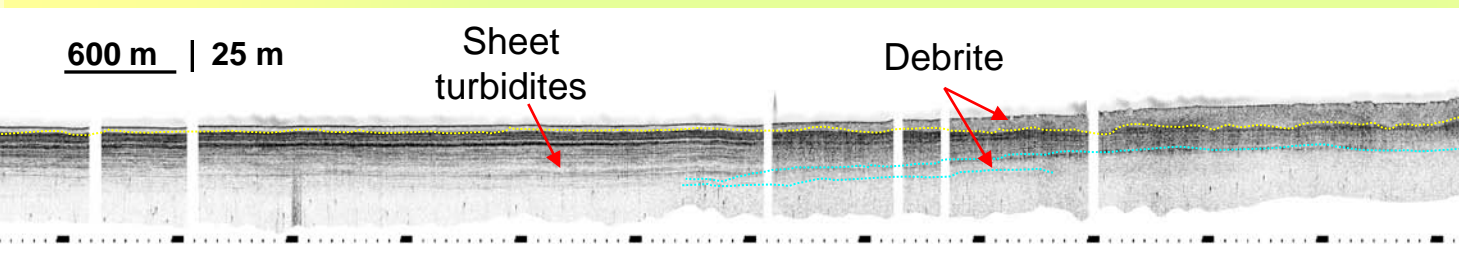
# Debrite lobes are characterized by a variety of shape



**Narrow channelized portion with steep margins deeply ploughing into the underlying sediments and lateral conformable wings.**



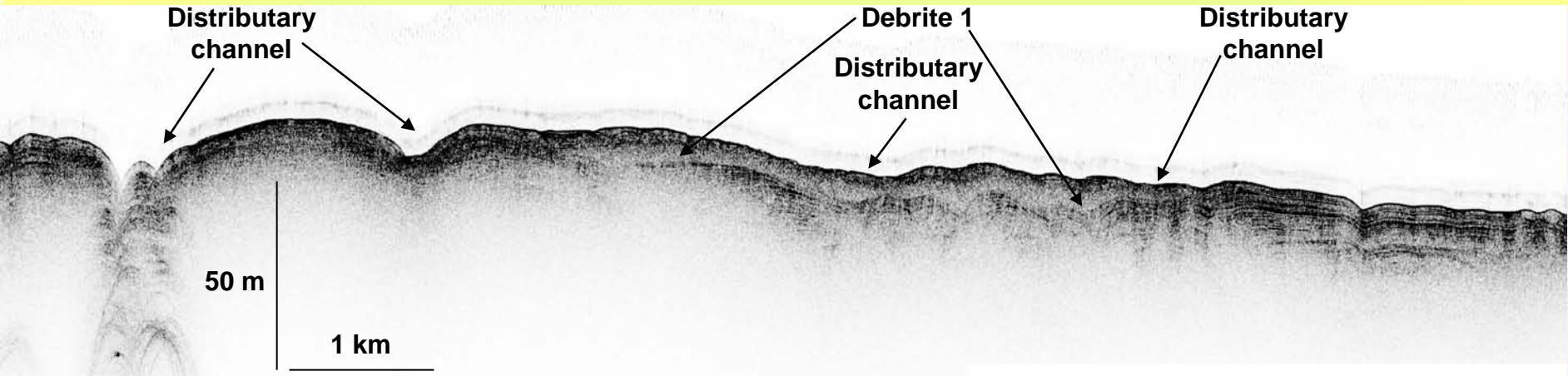
**Gently dipping basal erosional surface without lateral conformable wings**



**Gently dipping basal erosional surface and widespread lateral conformable wings**



When conformable, debrites can seal turbidite lobe deposits due to the preexisting topography



**A large variety of relationships between sand-prone turbidite units and clay-rich sealing debrites is thus to be expected.**

## General points:

In tectonically active areas mass-transport processes and turbidity currents can create favourable conditions for the development of stratigraphic traps, with lobe turbidites that are sealed by thick debrite bodies. However, the large variety of geometry of the resultant depositional bodies can make reservoir characterization difficult. High resolution studies of modern examples can greatly help in deriving models.

The concomitant growth of turbidites- mass transport deposits- and mixed fans demonstrate that models that predict changes in submarine fan facies on the base of sea-level cycles hardly apply to systems developed along tectonically active margins.

