EGU 2012

# Salt Glaciers in the Red Sea

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The Jeddah Transect

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# Onshore

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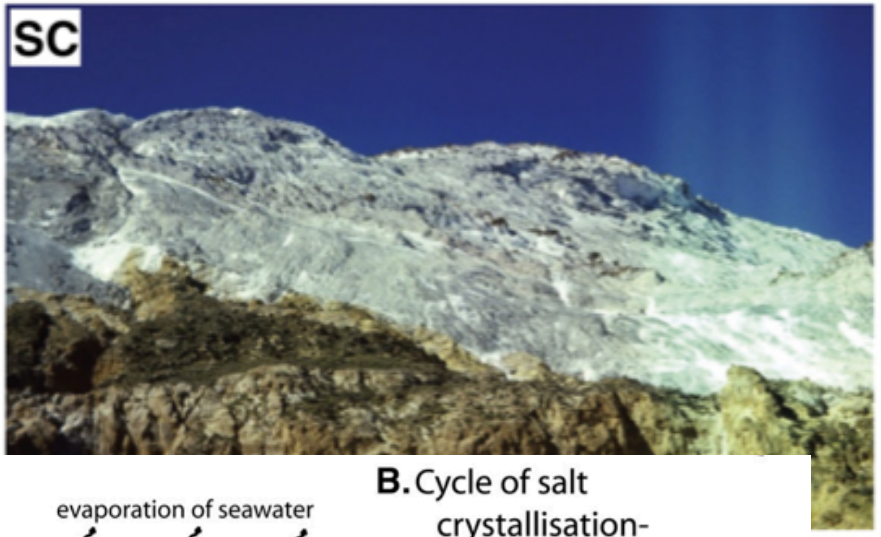
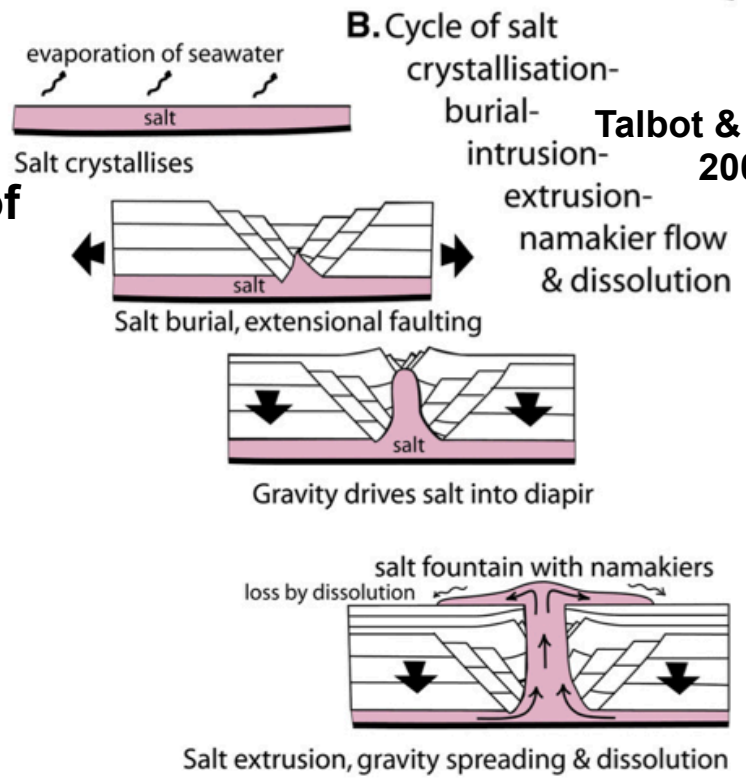
Ice


Salt




Talbot & Pohjola 2009

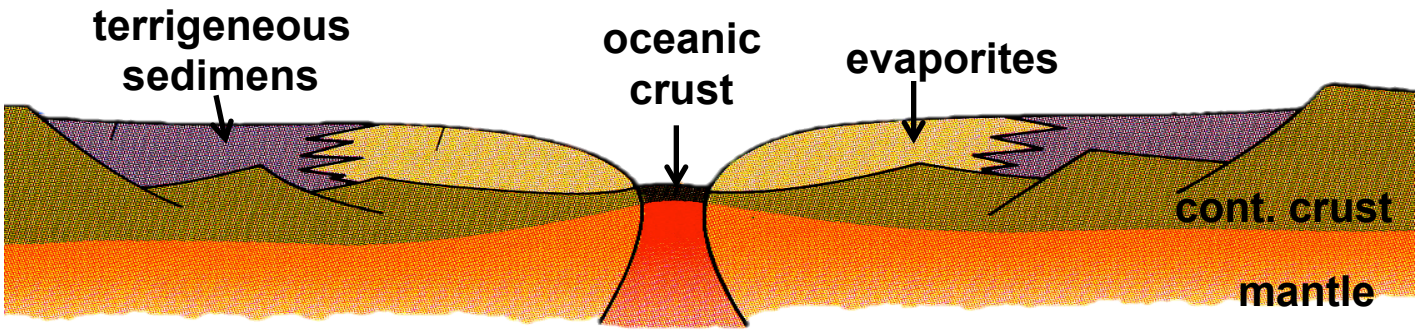
**Onshore salt glaciers form the distal part of extrusive diapirs.**

**Thickness: few hundred m**

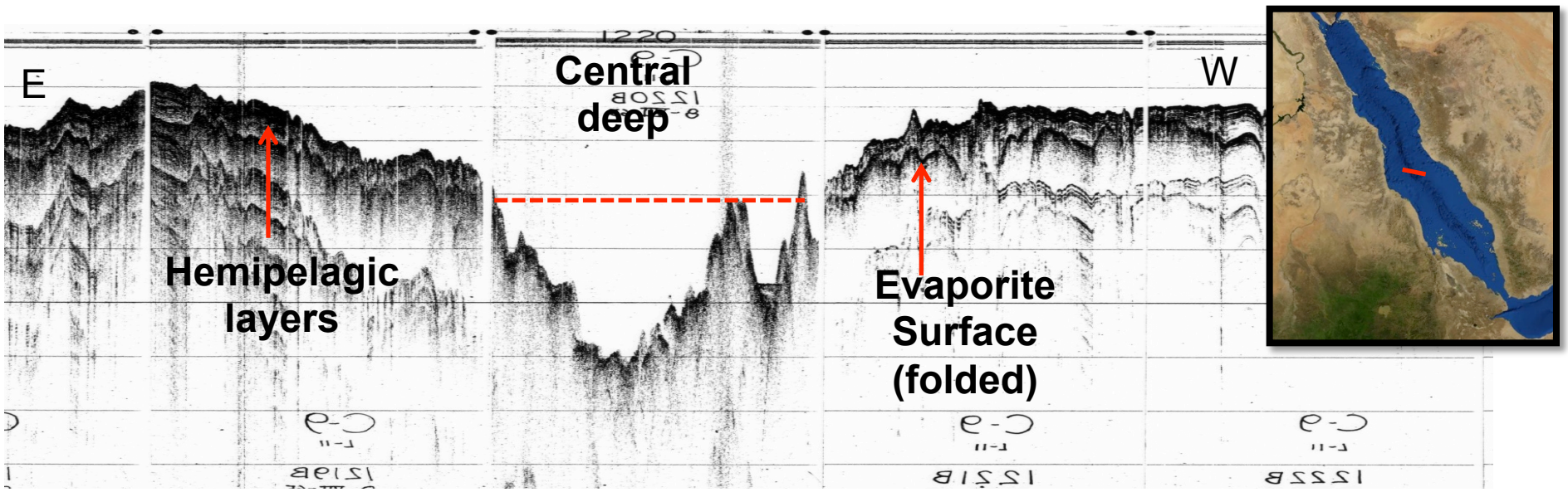
**Surge flow (dry/wet surface conditions): 1-10 m/a, up to dm/day**

# Offshore in the Red Sea

**Evaporites were deposited during the Miocene, kilometres in thickness (happened also during opening of other ocean basins)**

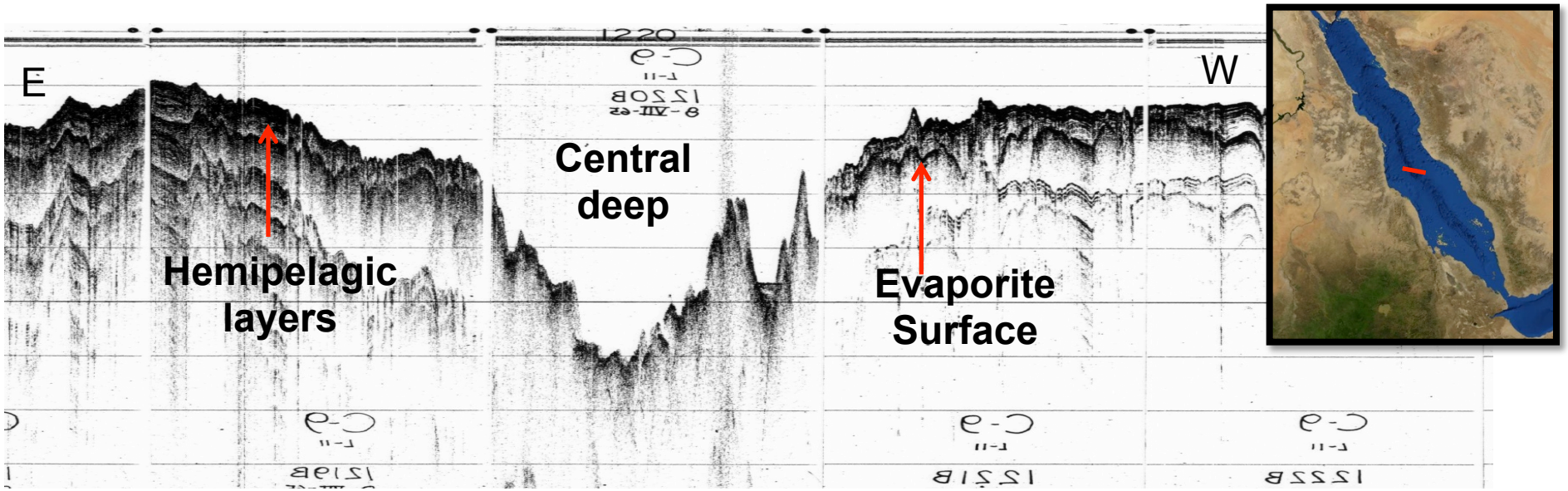



*Source: Bearman 1997, mod.*




1965, (Lamont-Doherty Earth Observatory, NOAA Archive)

# Offshore in the Red Sea

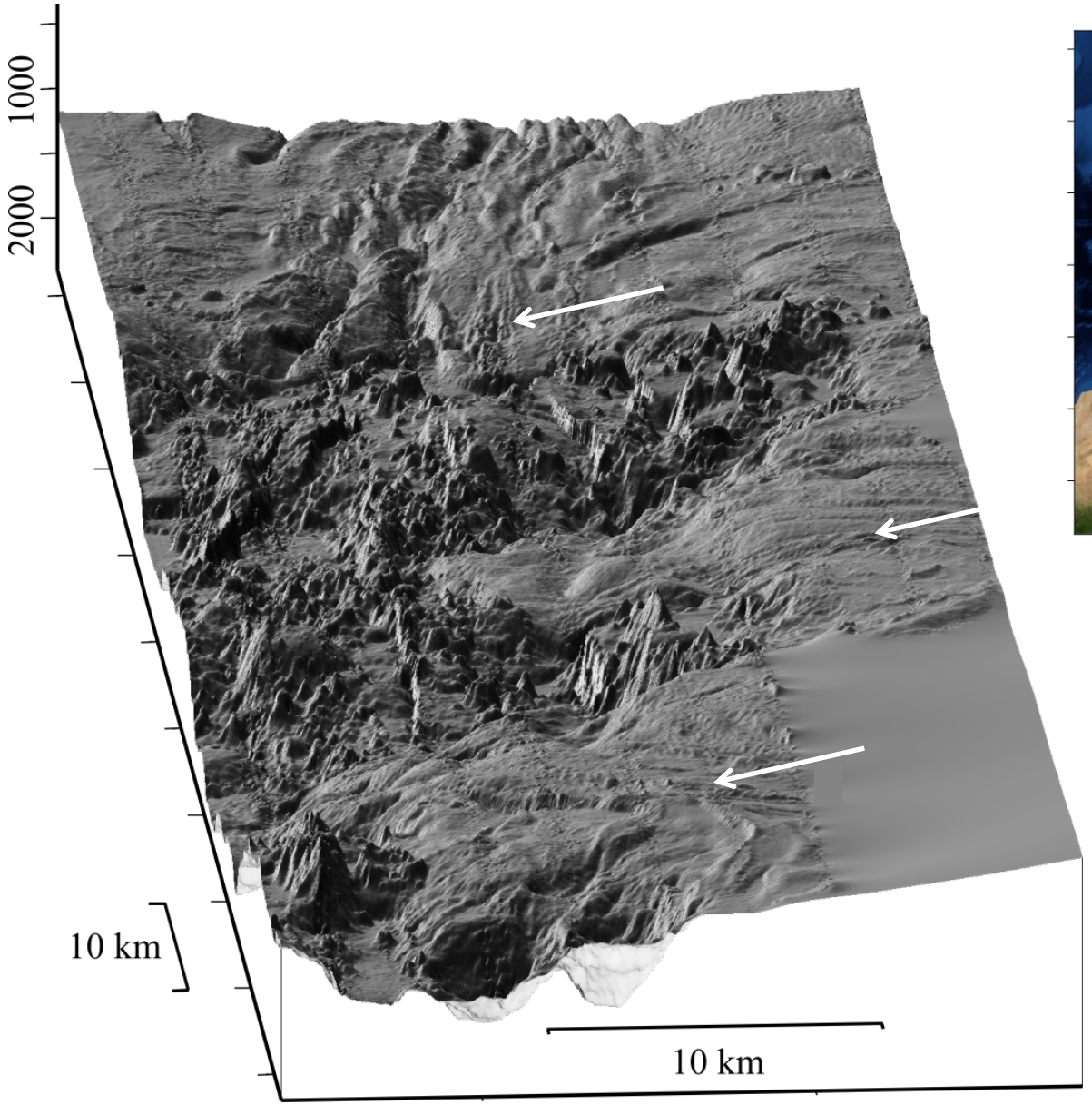



1965, (Lamont-Doherty Earth Observatory, NOAA Archive)

## Differences to namakiers

- Dry surface conditions not expected, but unknown hydraulic sealing
- Primary microstructure will be better preserved
- Thickness > 1km

# Salt glaciers in the Tethis Deep




Mitchell et al. 2010

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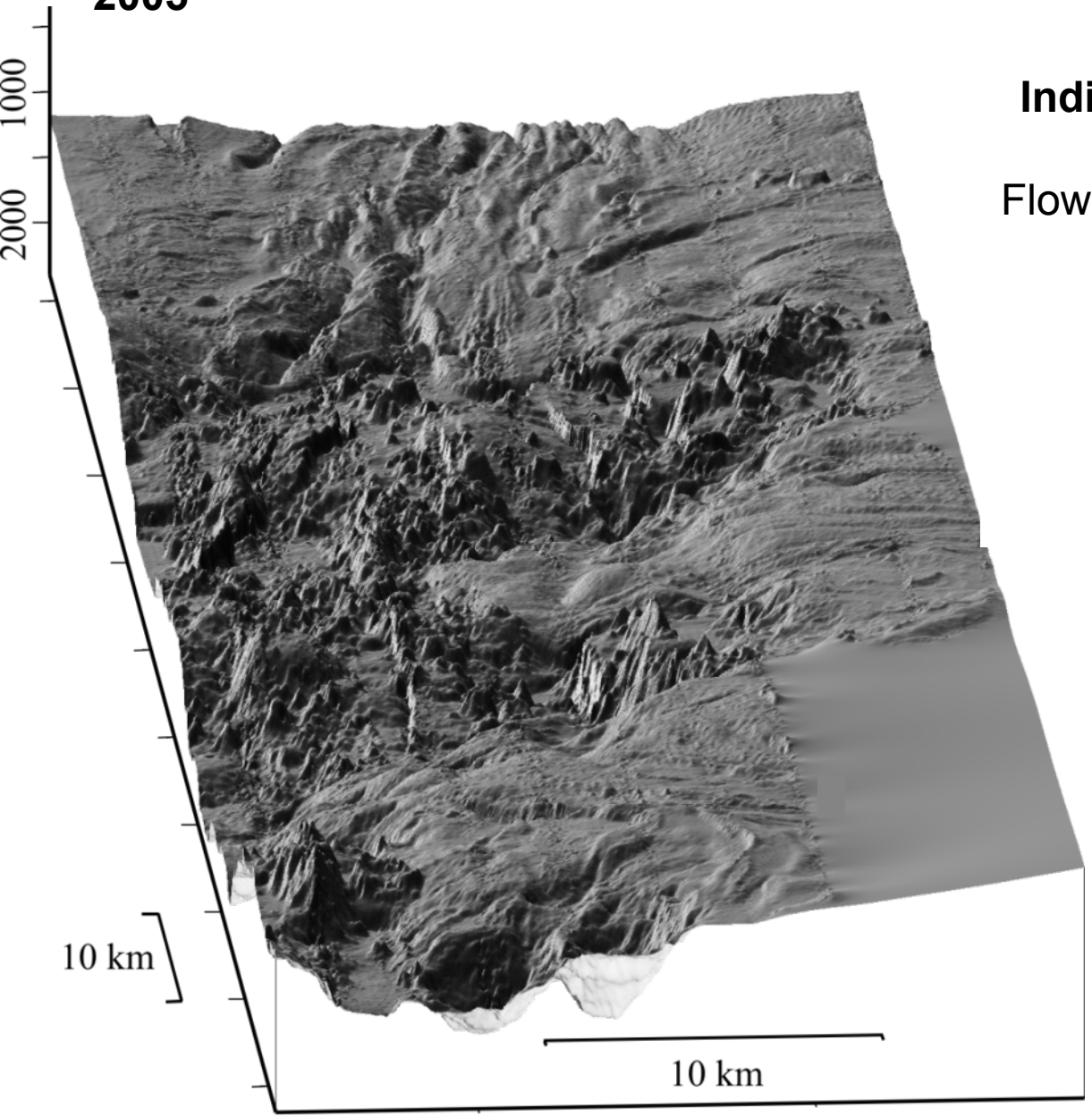


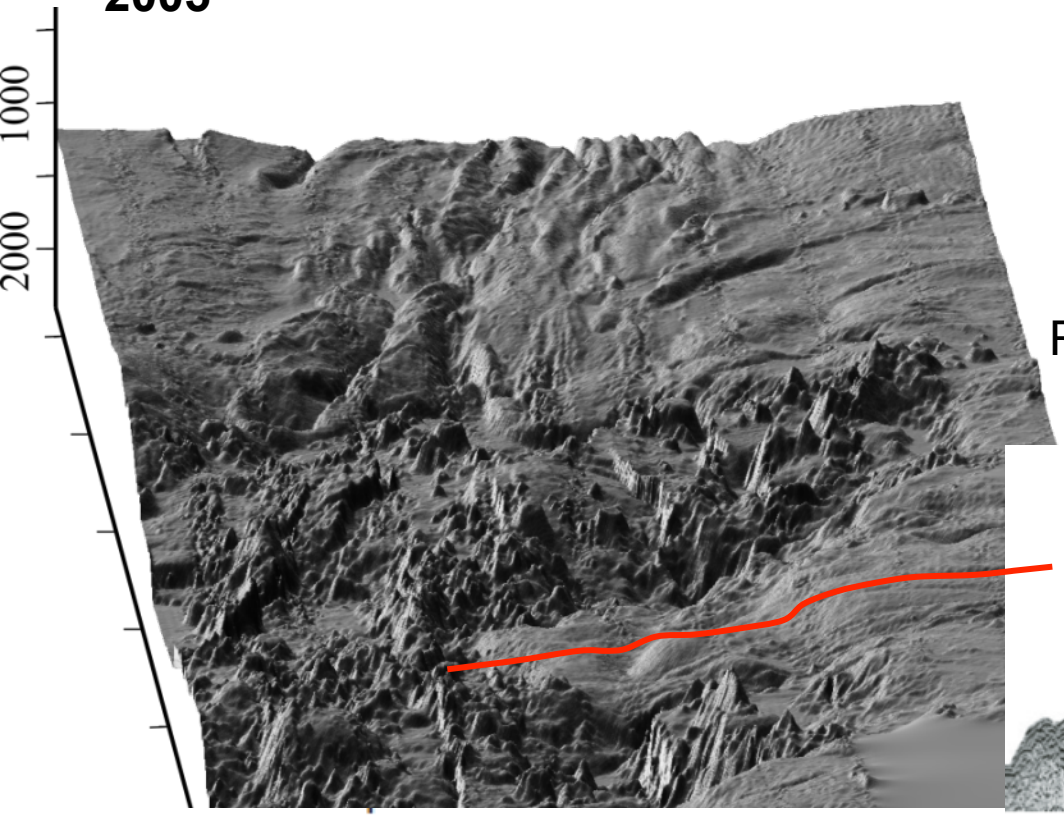

Mitchell et al. 2010

## Indications of salt movement

Flows are not volcanic (seismics)

# Indications of salt movement

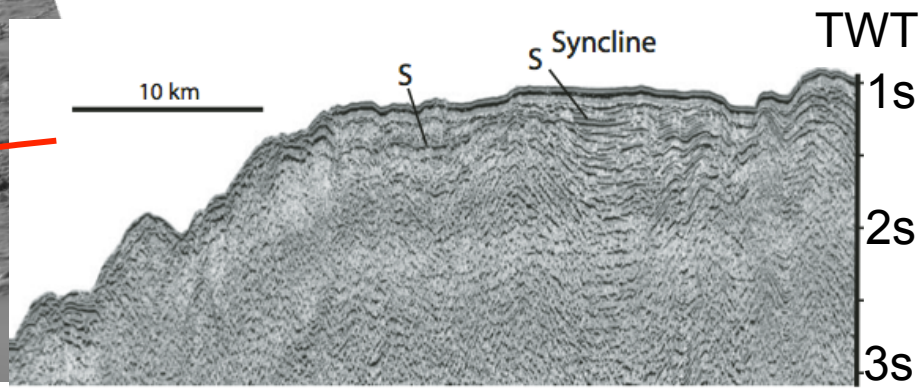
2005

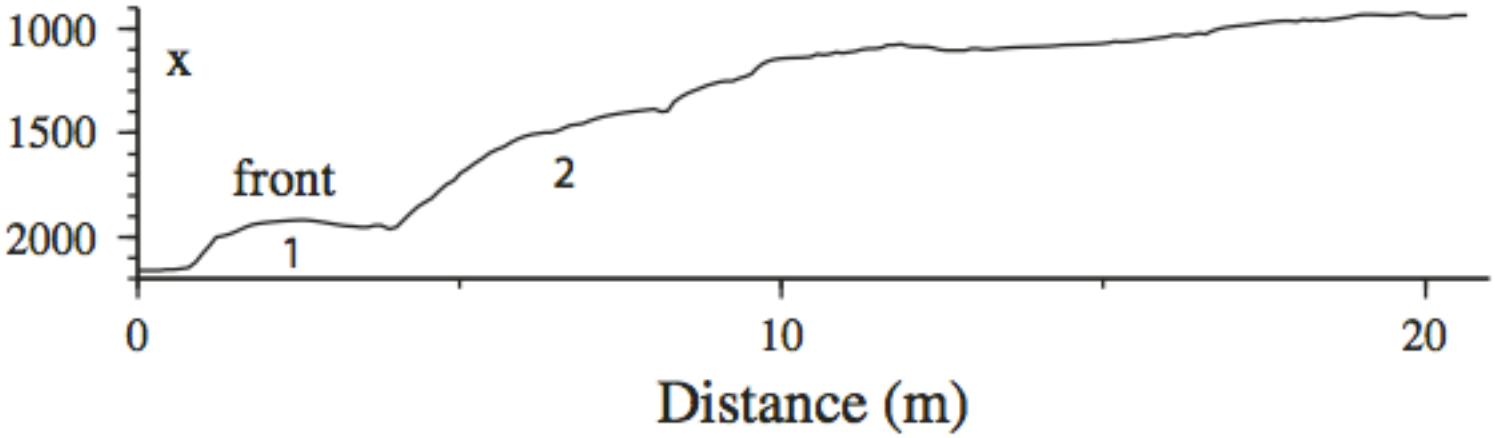



## Indications of salt movement

Flows are not volcanic (seismics)

Relief larger than hemipelagic thickness



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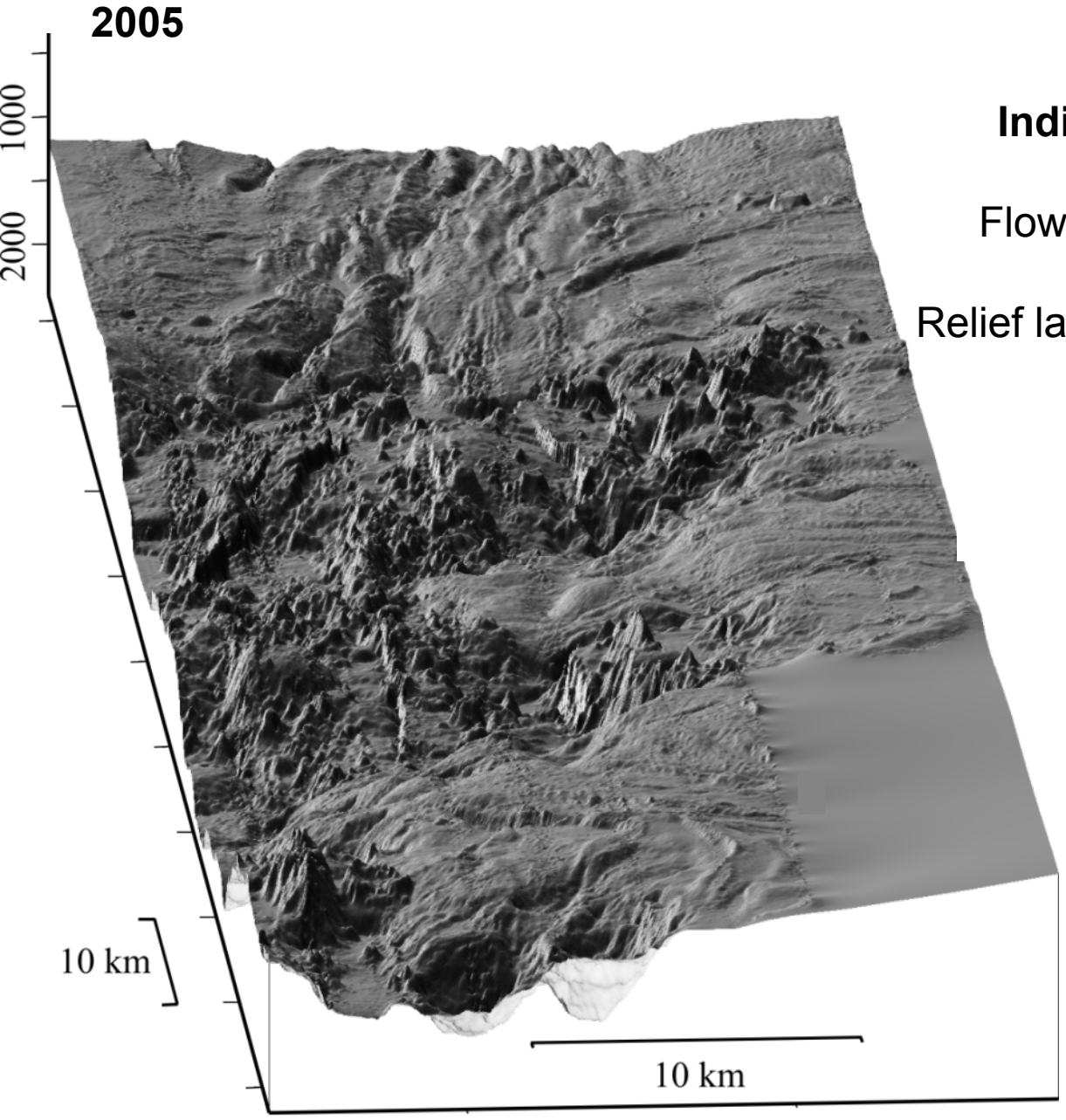



Mitchell et al. 2010

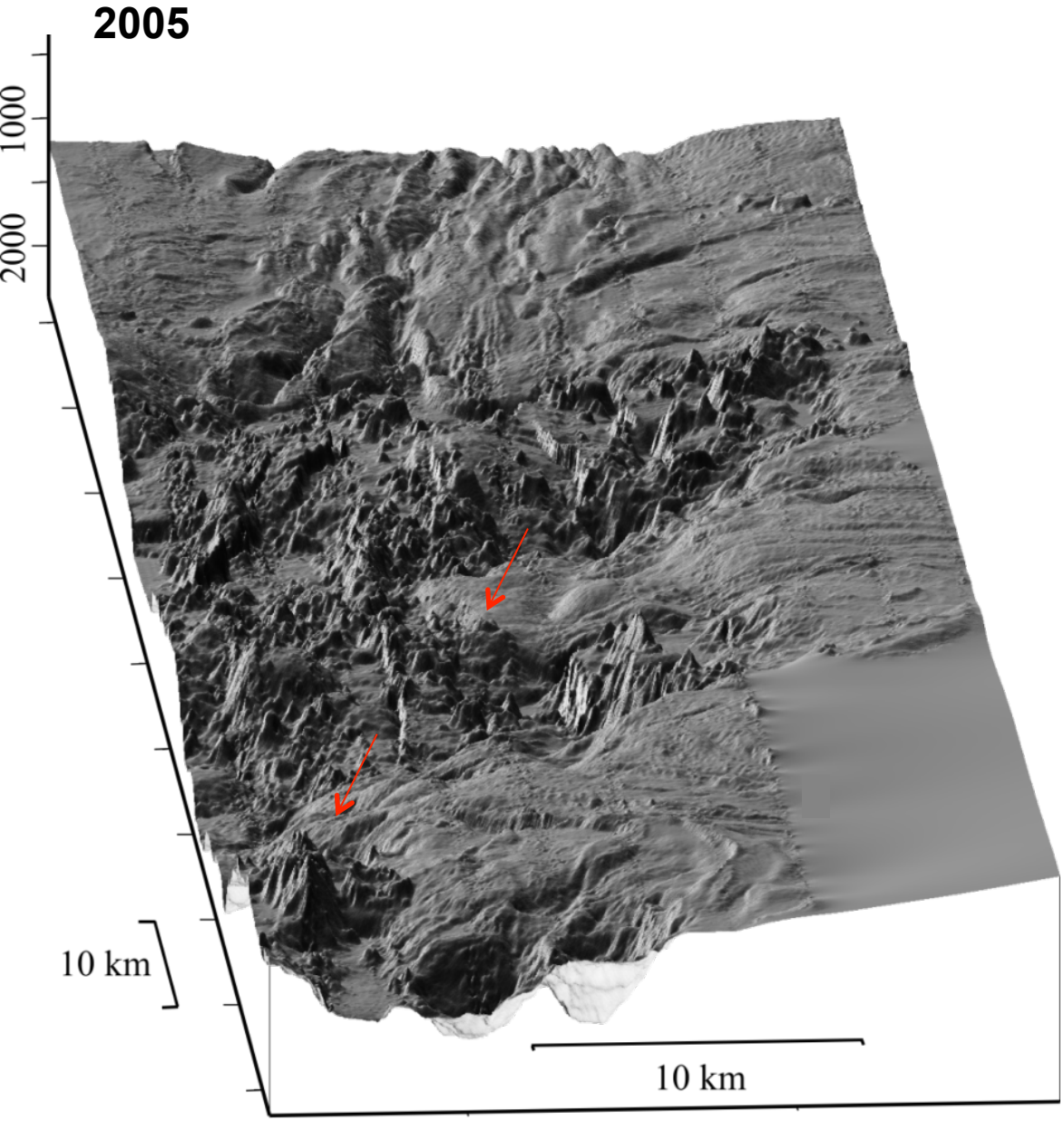
## Indications of salt movement

Flows are not volcanic (seismics)

Relief larger than hemipelagic thickness

No headwalls

# Indications of salt movement

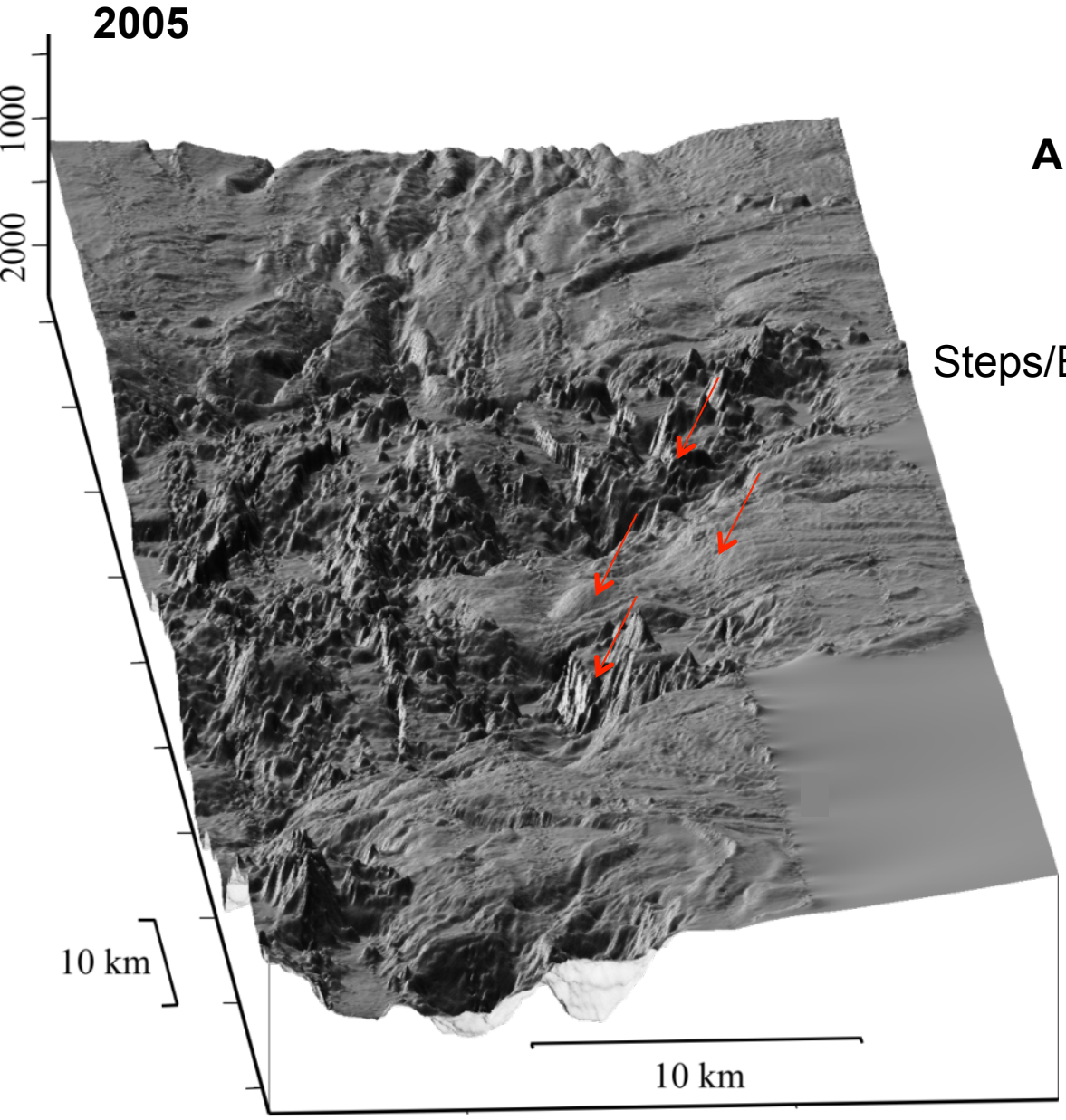



## A few morphological features

Rounded mounds

Mitchell et al. 2010

# Indications of salt movement




## A few morphological features

Rounded mounds

Steps/Escarpments: underlying basement

Mitchell et al. 2010

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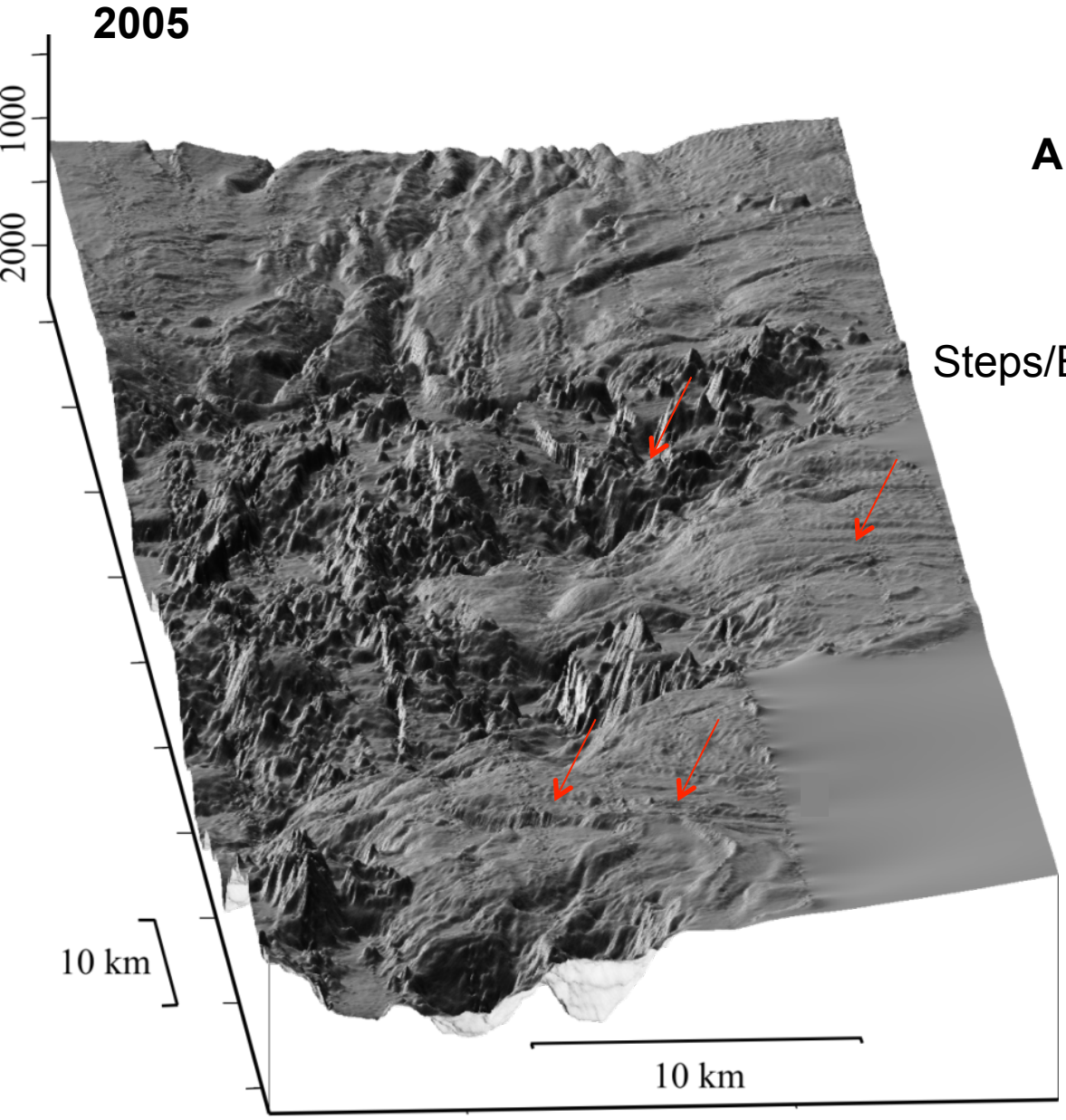


## A few morphological features

Rounded mounds

Steps/Escarpments: underlying basement

Downslope ridges:
Deformation? Strike slip?

Mitchell et al. 2010

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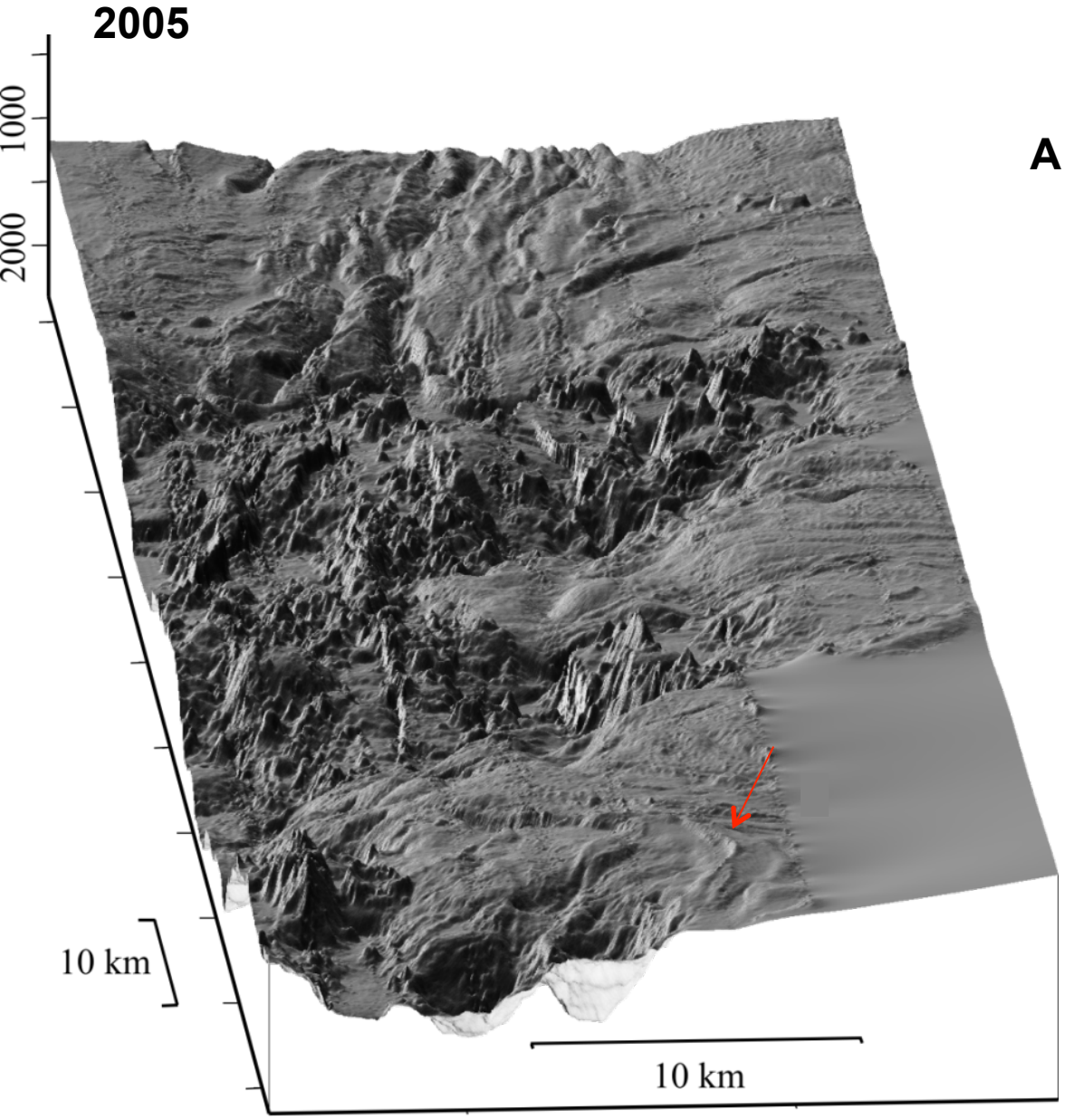


## A few morphological features

Rounded mounds

Steps/Escarpments:
underlying basement

Downslope ridges:
Deformation? Strike slip?

Curved ridges

Mitchell et al. 2010

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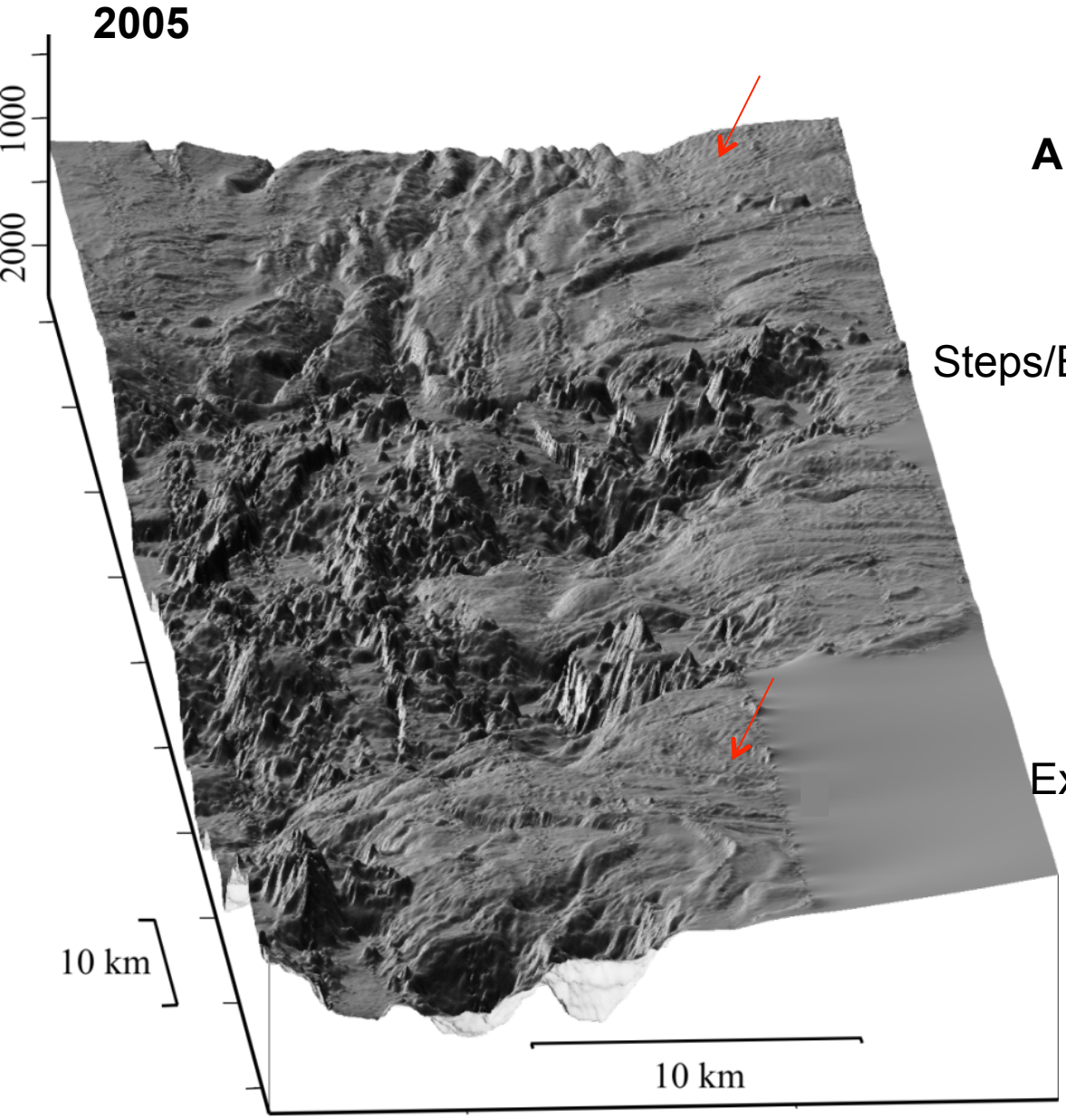



## A few morphological features

Rounded mounds

Steps/Escarpments: underlying basement

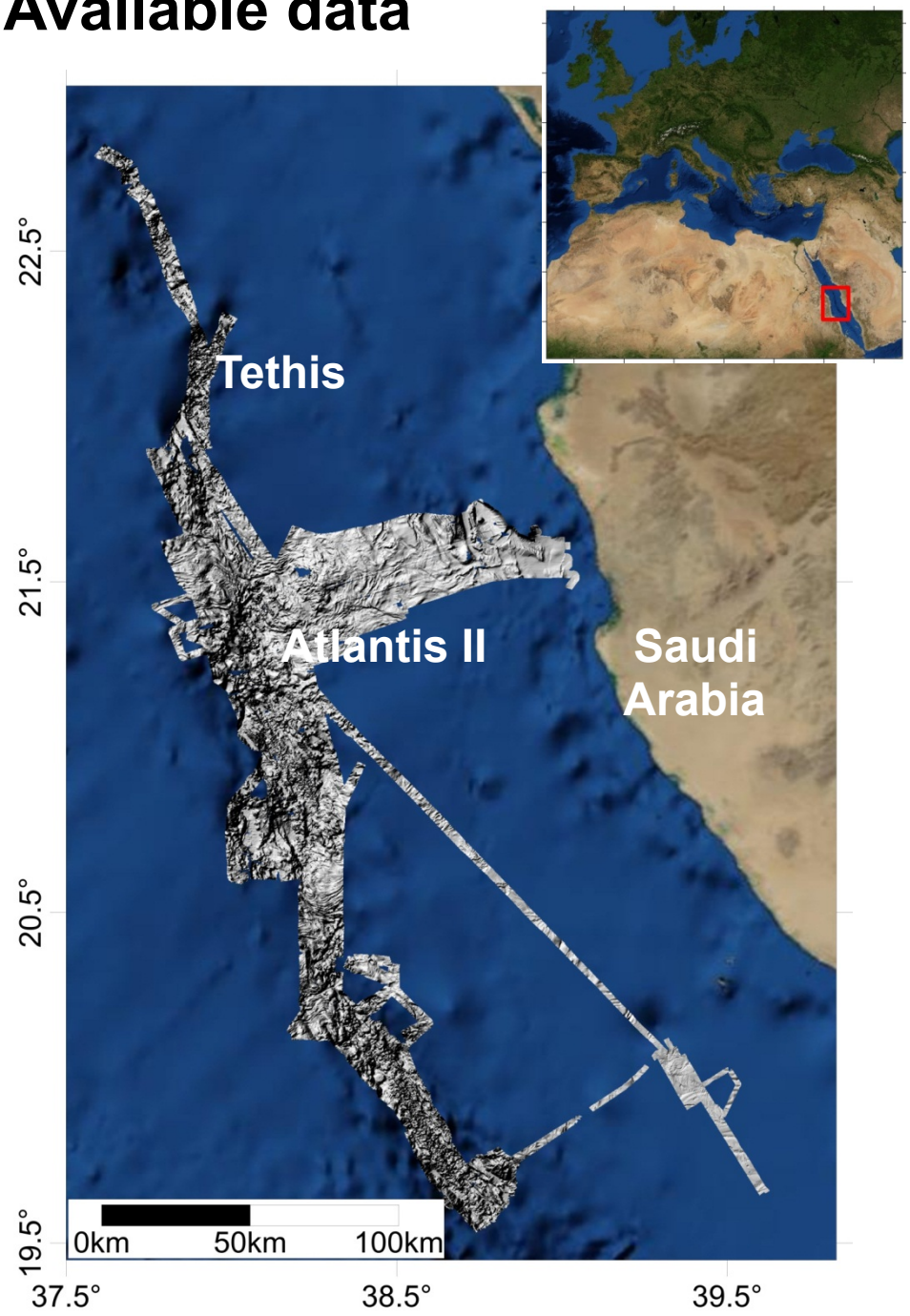
Downslope ridges:
Deformation? Strike slip?

Curved ridges

Along-Slope ridges:
Extension of hemipelagic layers

Mitchell et al. 2010

# Available data

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**15.000 km² multibeam data recorded during 2011 and 2012**

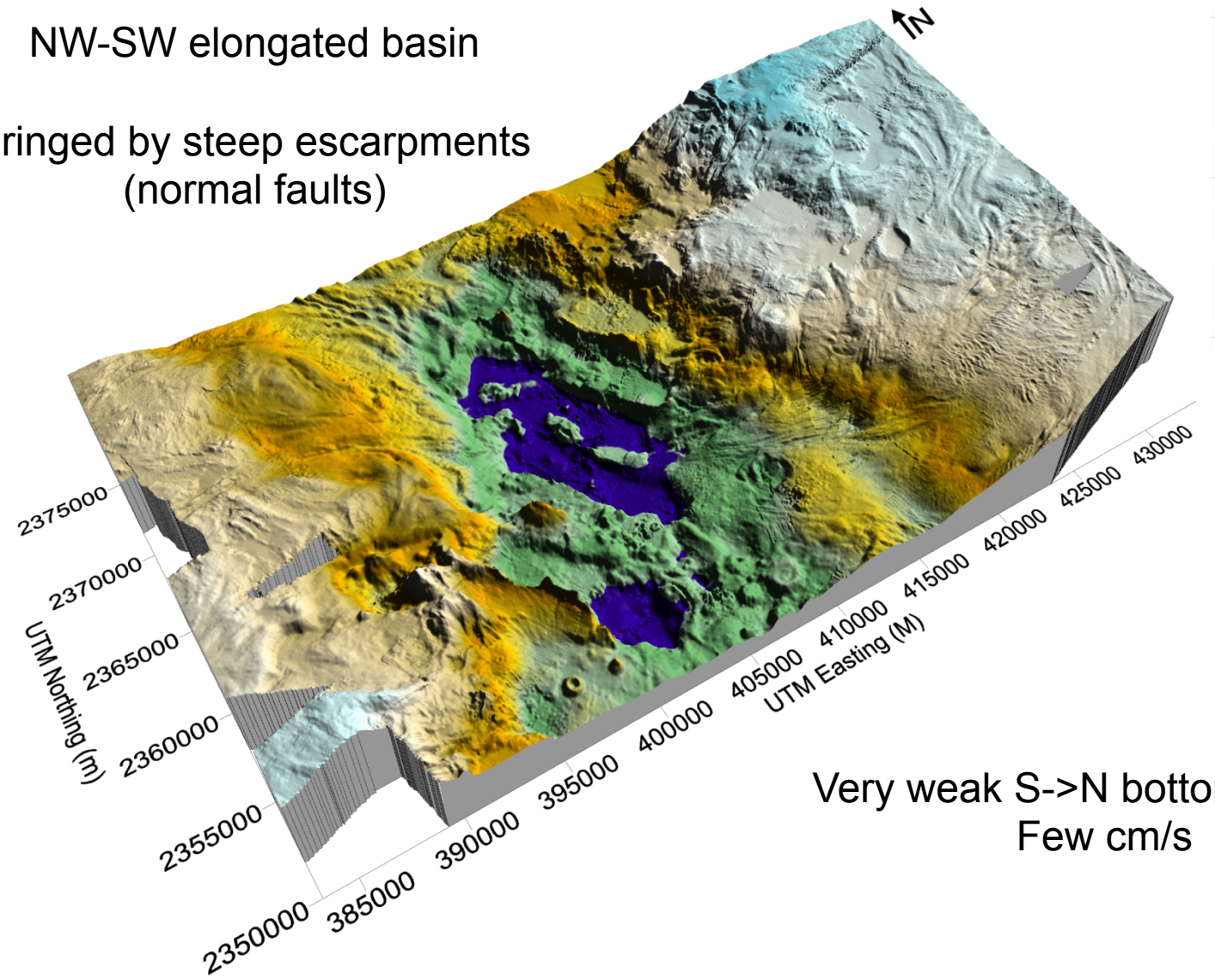
**500 km of sparker seismic**

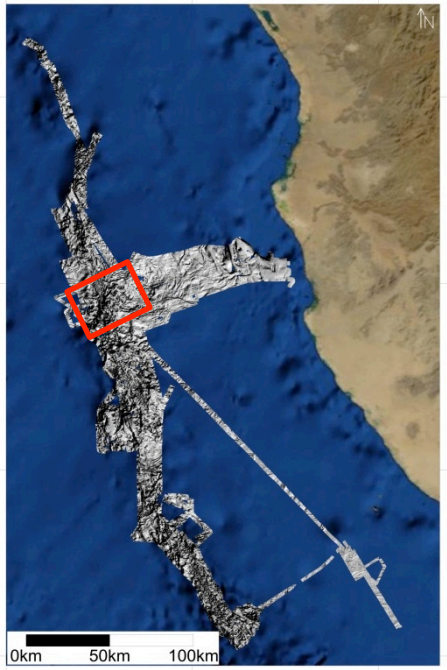
# Salt glaciers in the Atlantis II Deep?

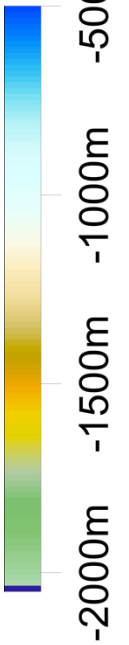
General structure:

NW-SW elongated basin

Fringed by steep escarpments (normal faults)

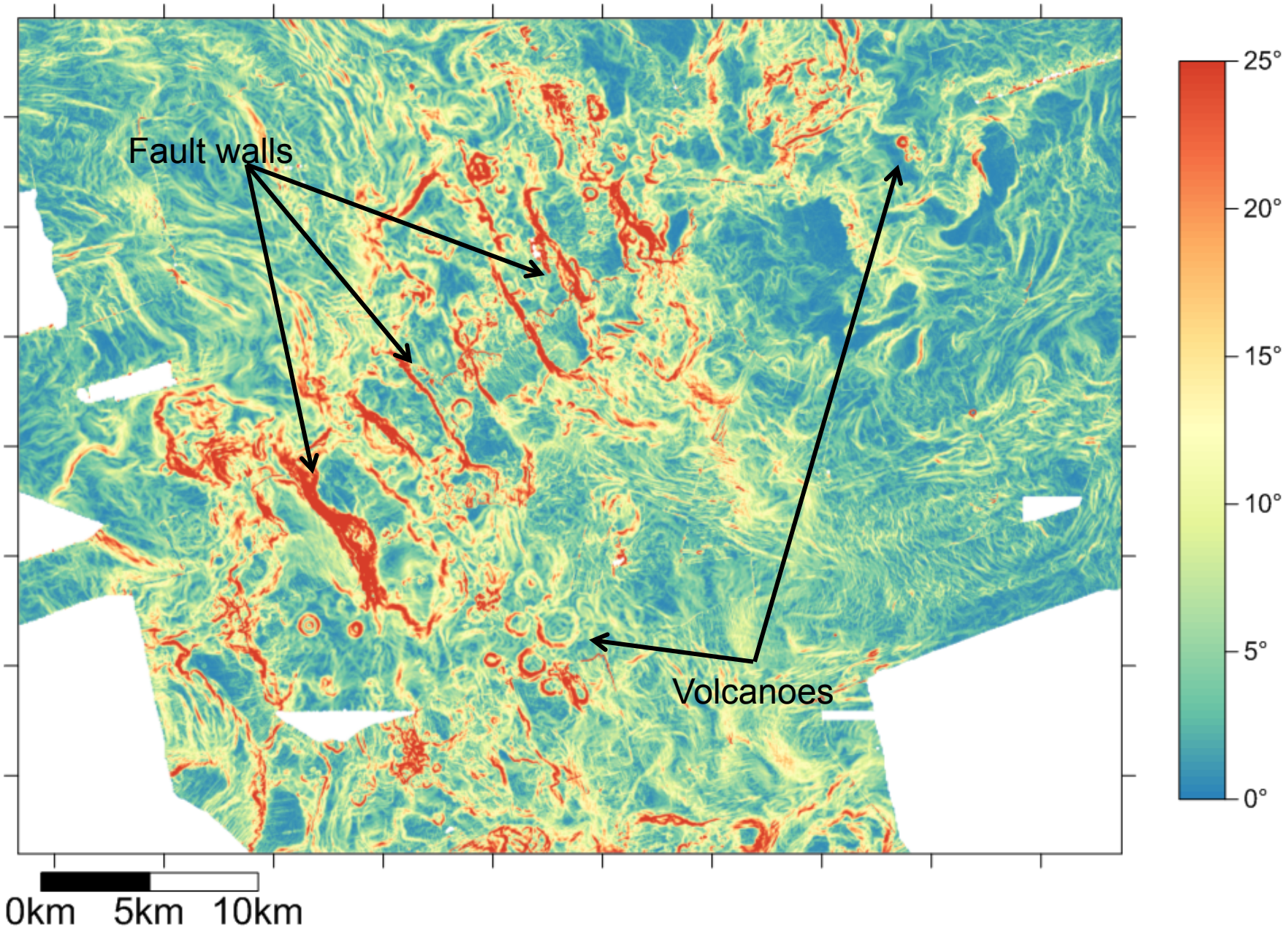



Very weak S->N bottom current:
Few cm/s

**Brine**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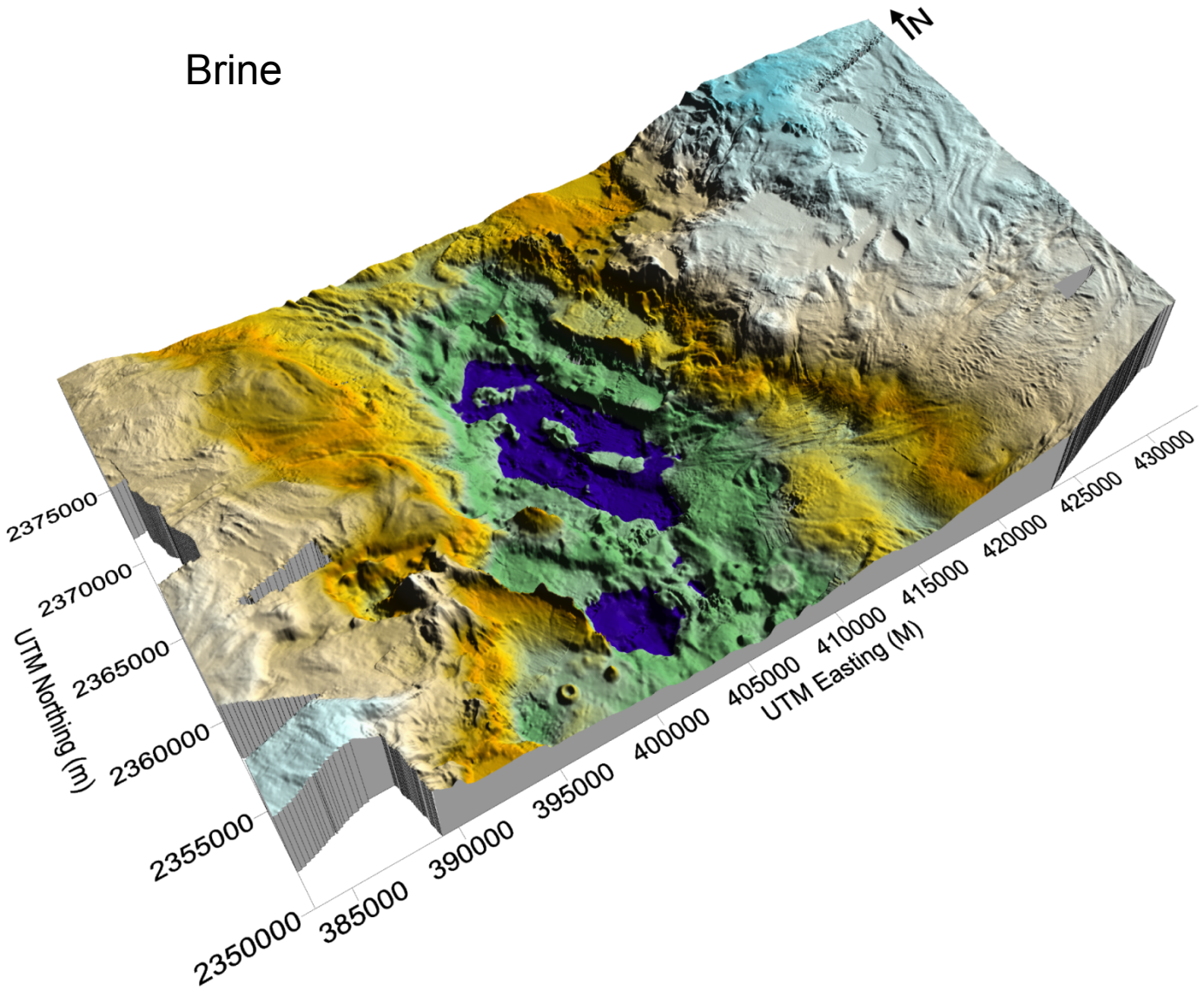
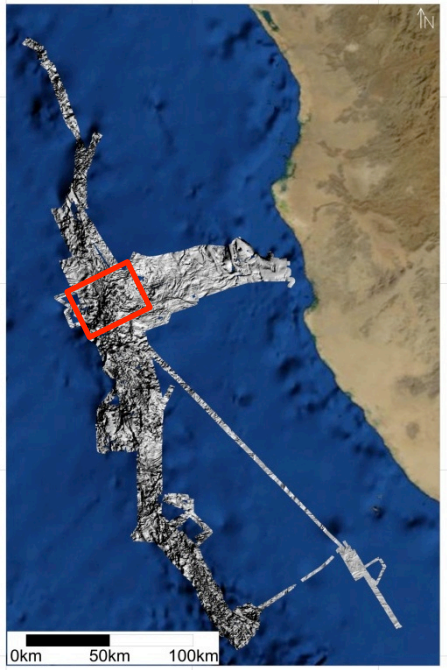
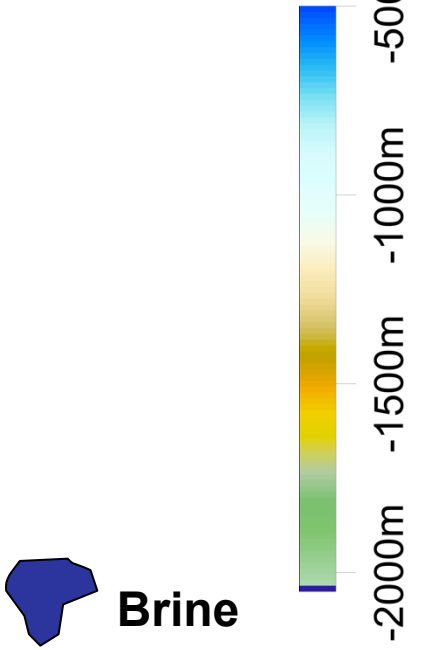
Fault walls
Volcanoes
25°
20°
15°
10°
5°
0°
0km
5km
10km

# Salt glaciers in the Atlantis II Deep?

**Different from Tethis Deep:**



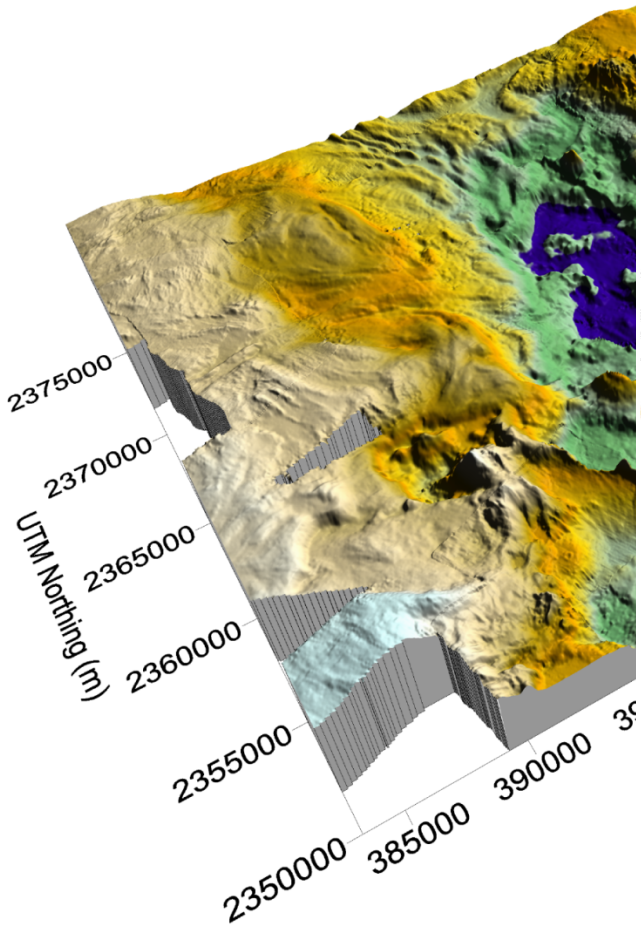


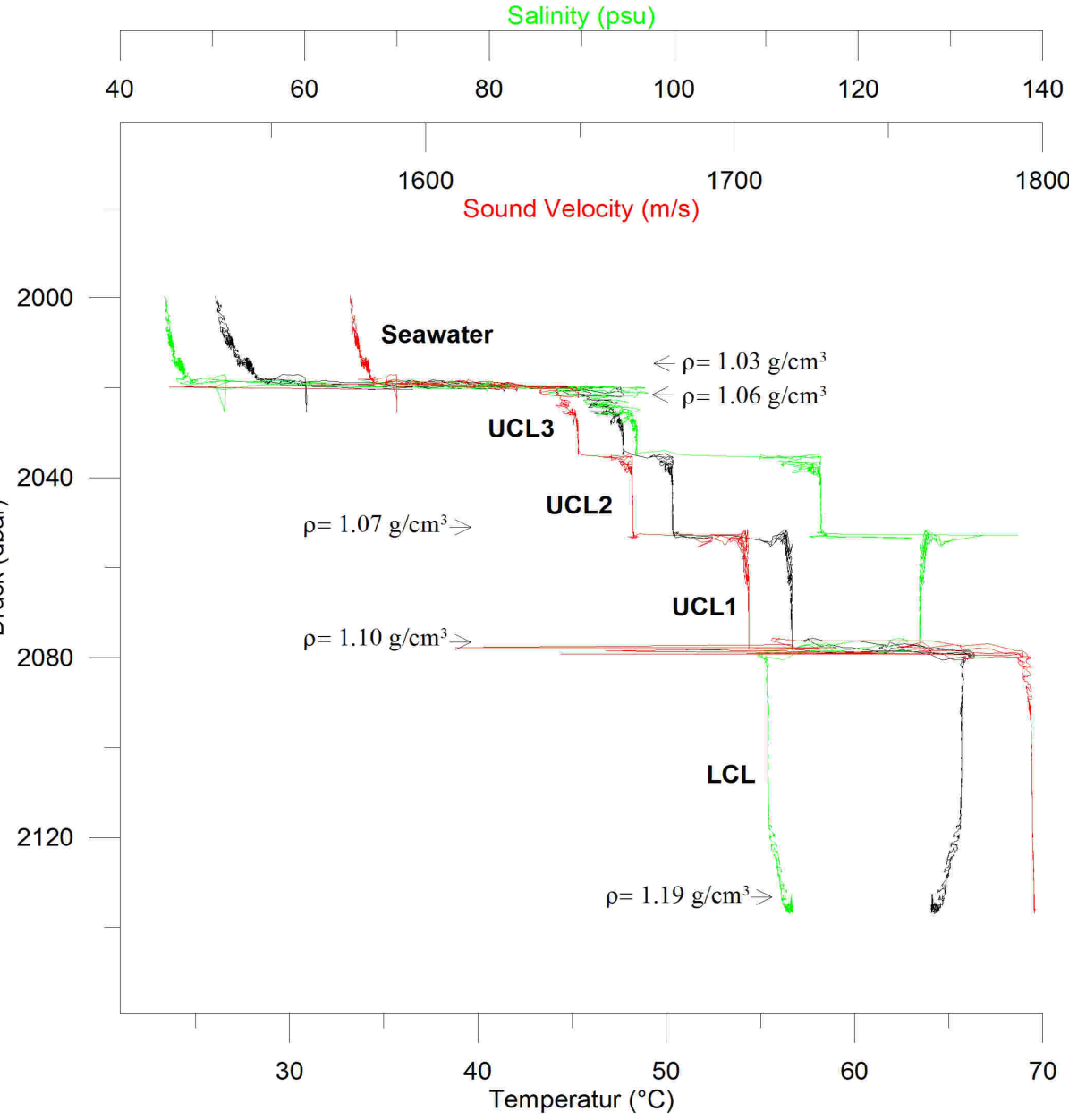

Brine

# Salt glaciers in the Atlantis II Deep?

Different from Tethis Deep:

Brine

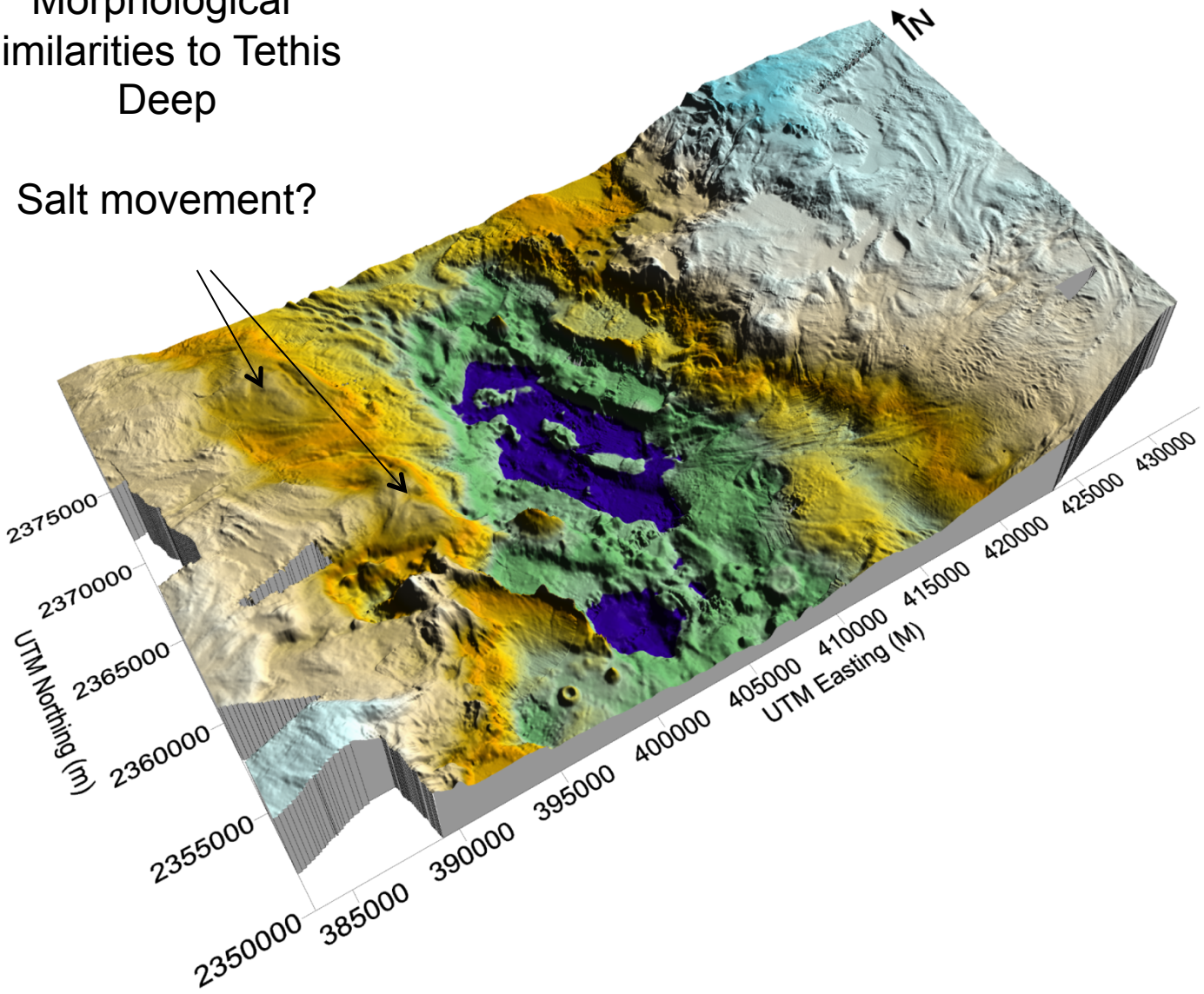


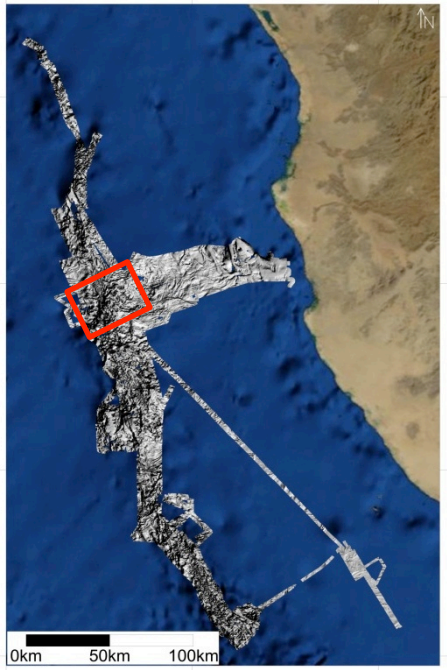



# Salt glaciers in the Atlantis II Deep?

Western wall: Morphological similarities to Tethis Deep

Salt movement?



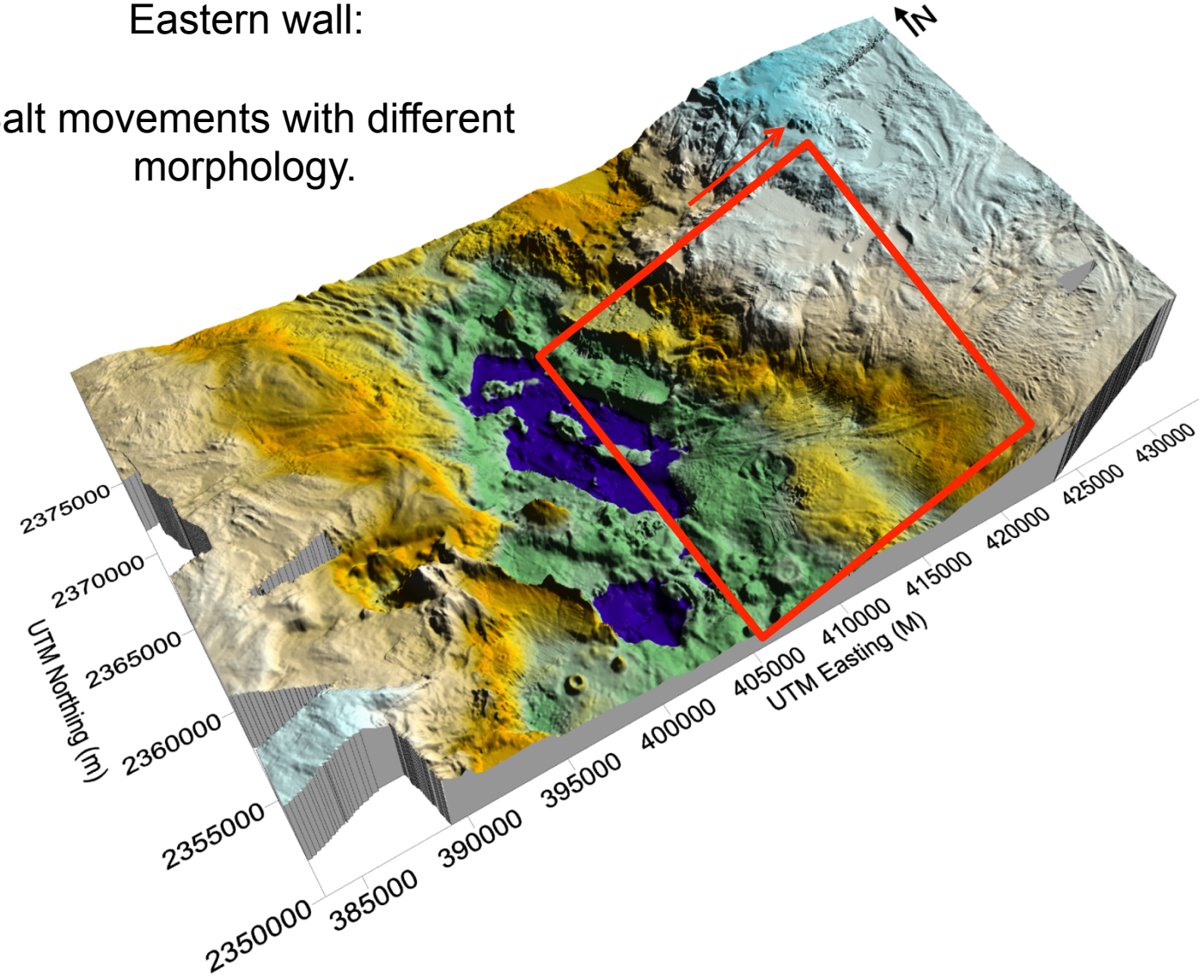

-500m
-1000m
-1500m
-2000m

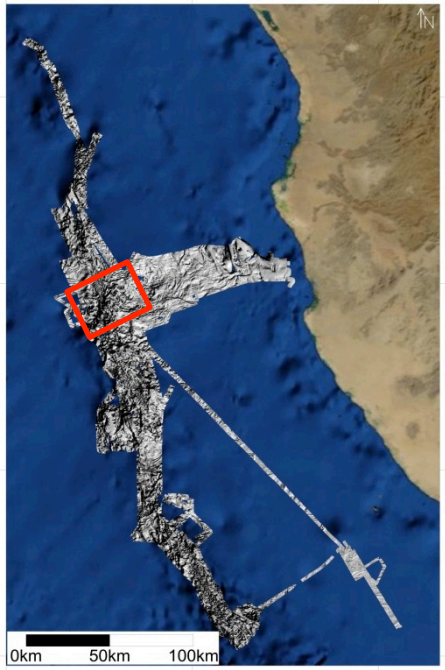
Brine

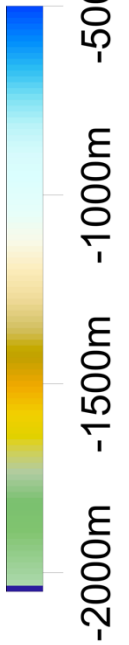
# Salt glaciers in the Atlantis II Deep?

Eastern wall:

Salt movements with different morphology.

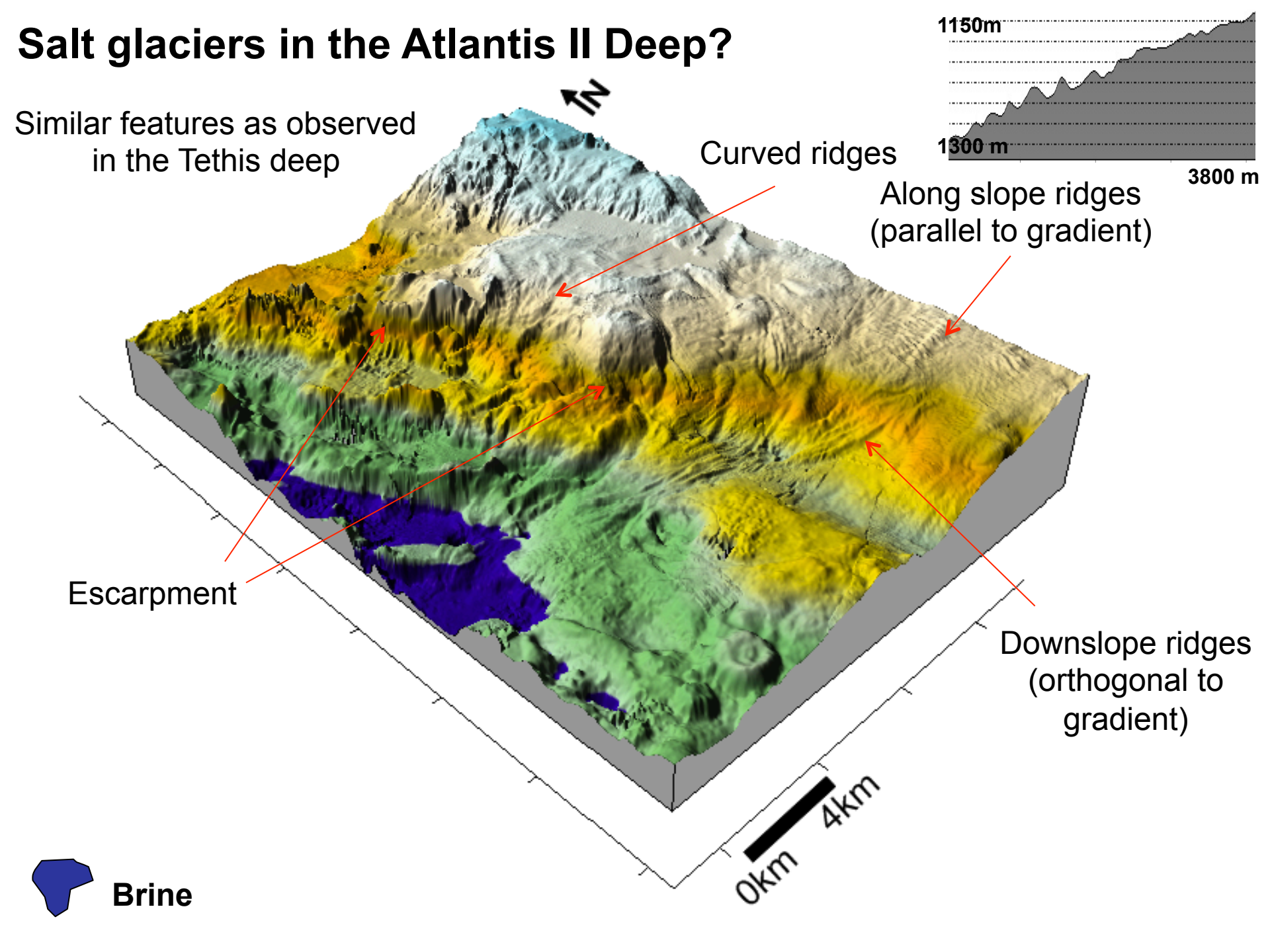


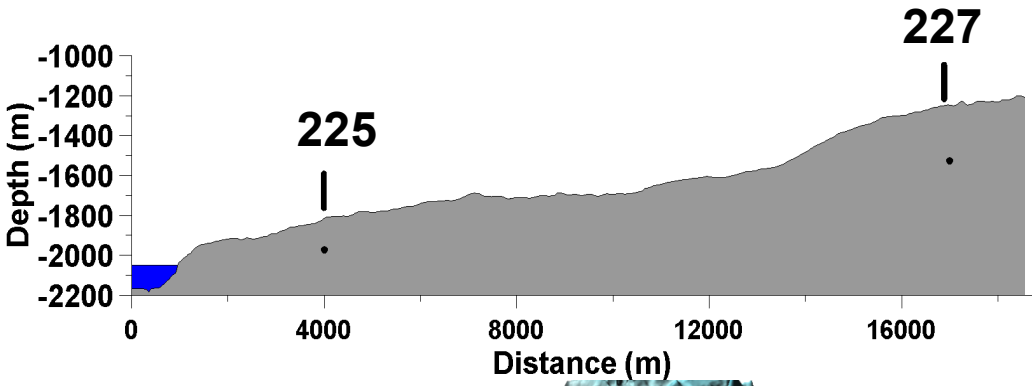




Brine

# Salt glaciers in the Atlantis II Deep?



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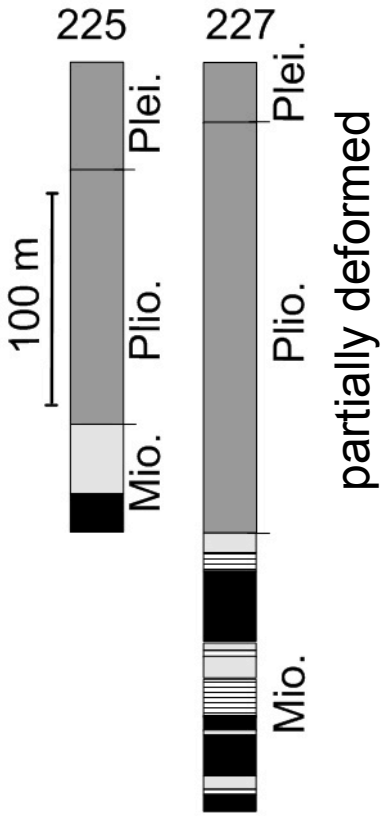
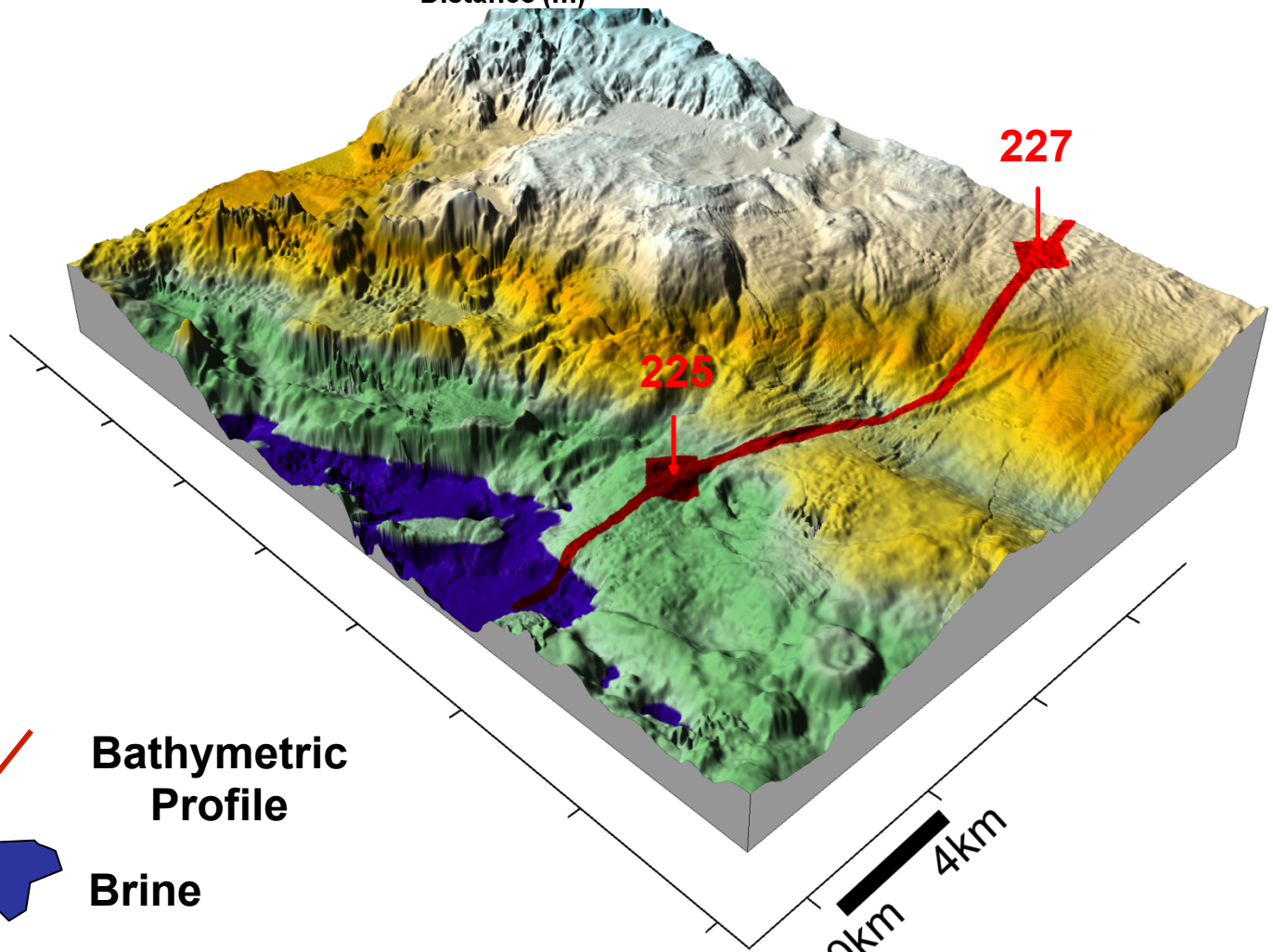
DSDP Cores



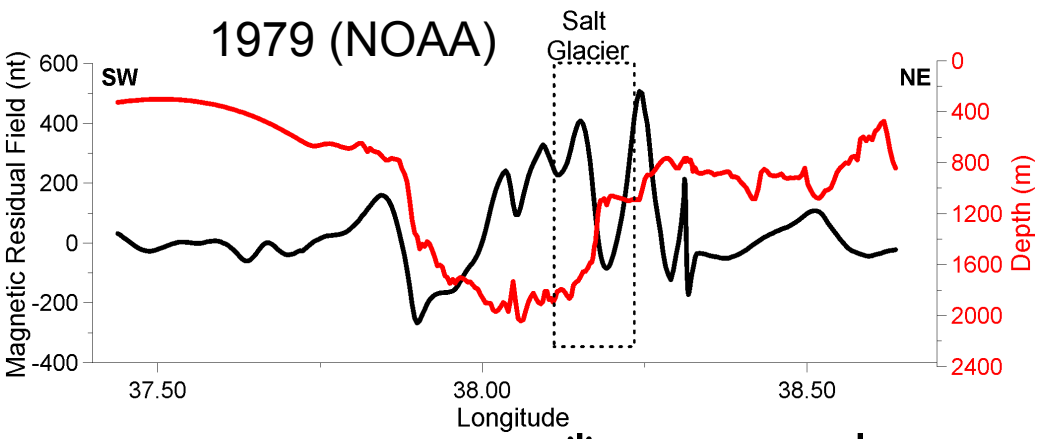




Bathymetric Profile

Brine

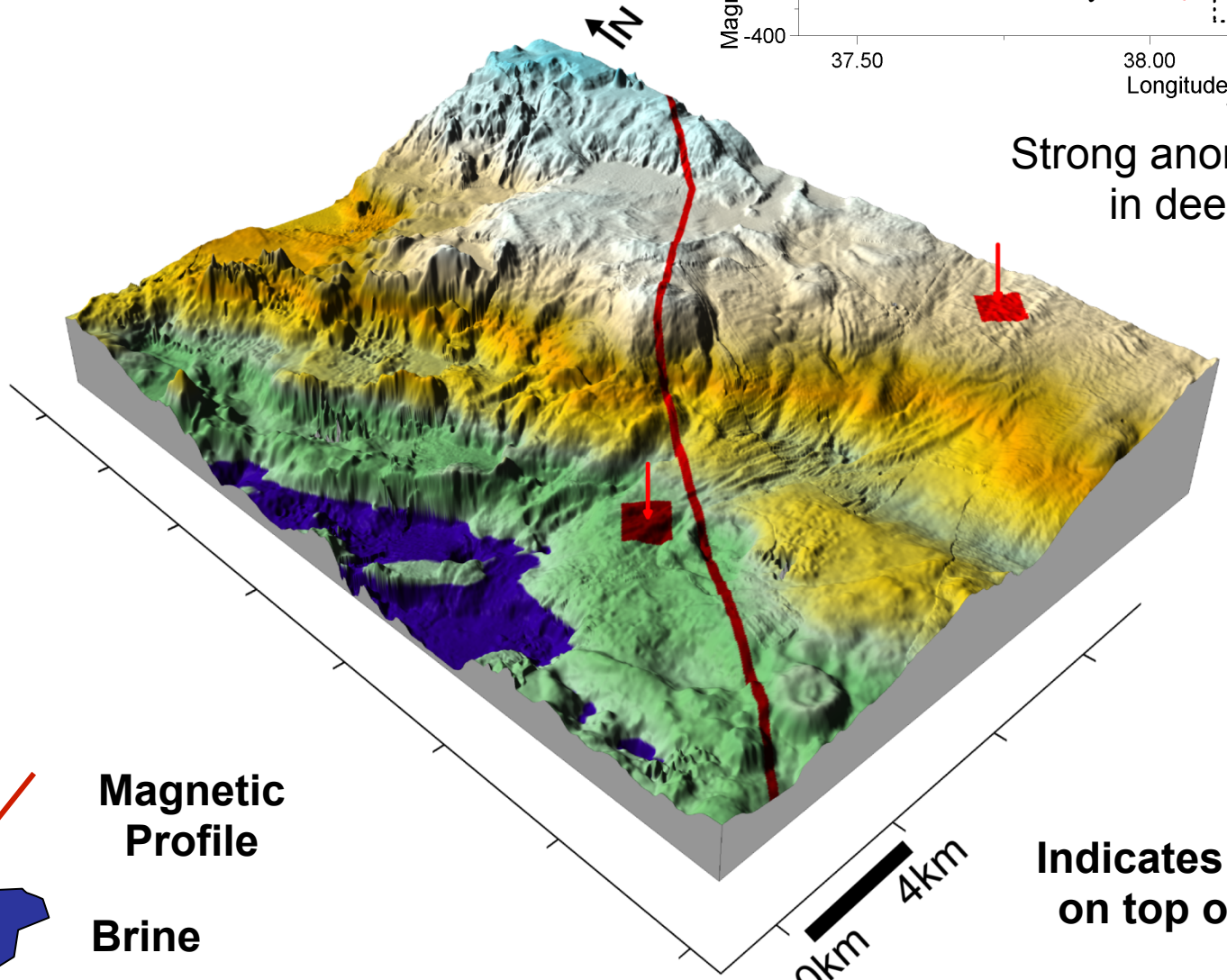
Shale
Anhydrite
Sediment
Halite

# Salt glaciers in the Atlantis II Deep?




Strong anomalies in deep

Weaker pattern away from ridge: thinned cont. crust




Magnetic Profile

Brine

**Indicates evaporites moved on top of basaltic material**

# Salt glaciers in the Atlantis II Deep?

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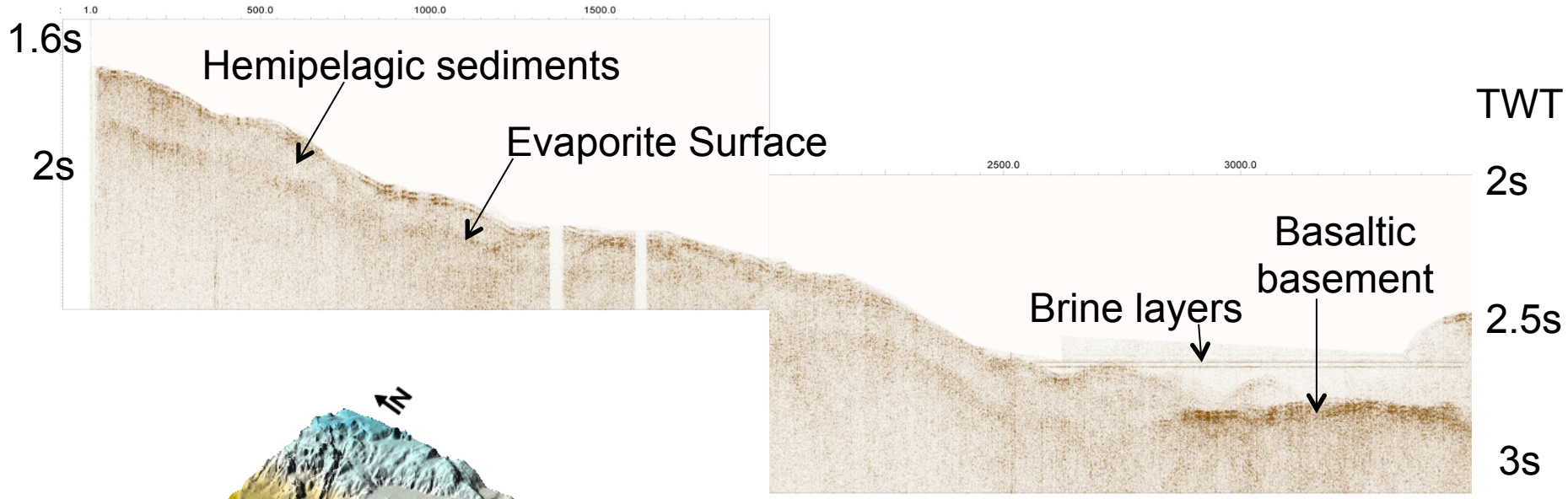


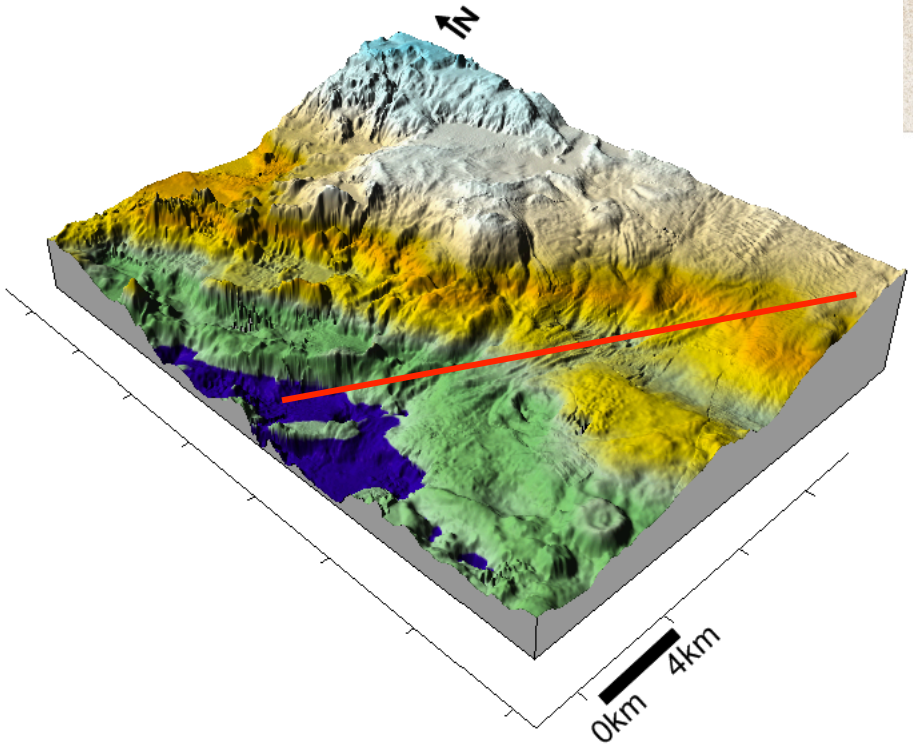


Brine

# Salt glaciers in the Atlantis II Deep?

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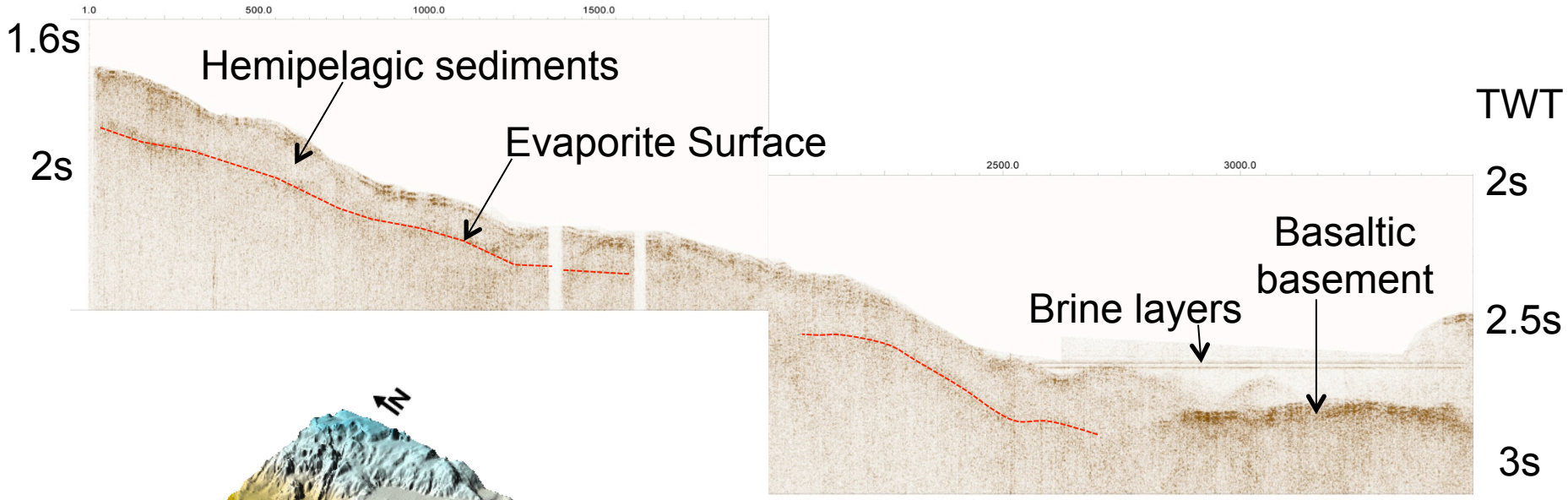
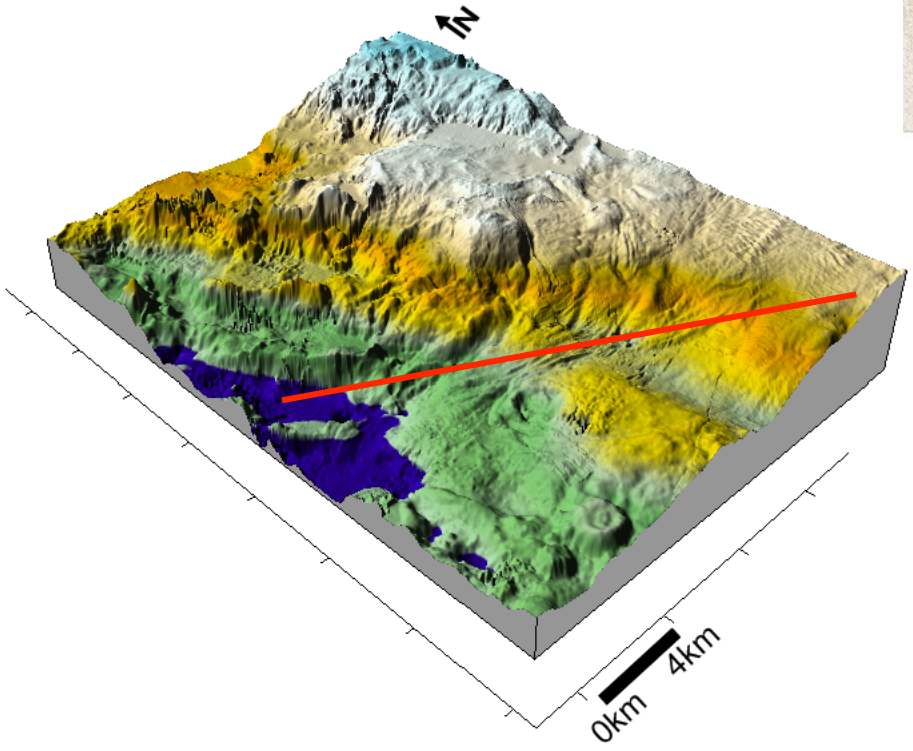


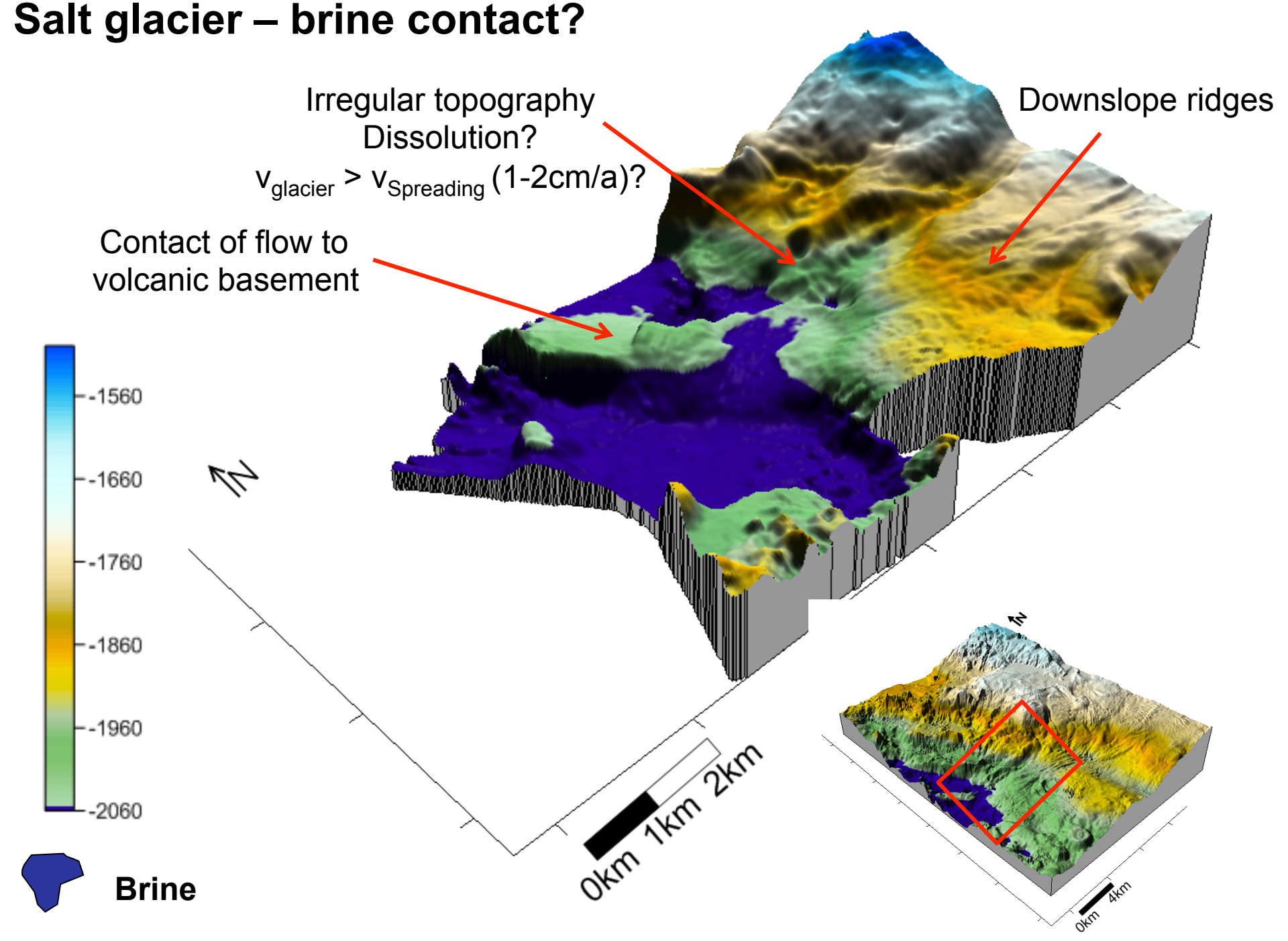




Based on core ground-truthing, evaporite surface can be traced below the brine level

Relation of basalt/evaporite contact is uncertain.

**Brine**

# Salt glacier – brine contact?



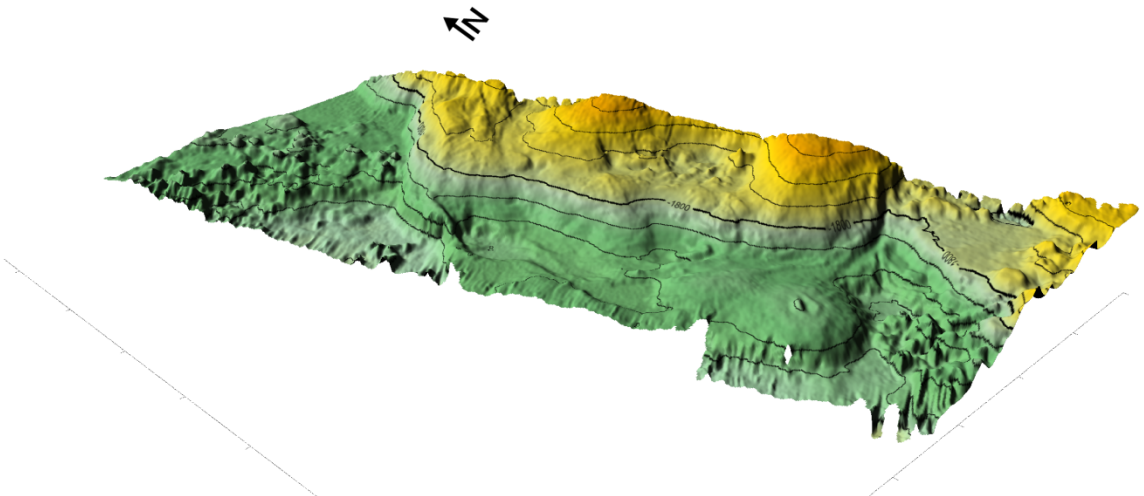
# Further work / Conclusion:

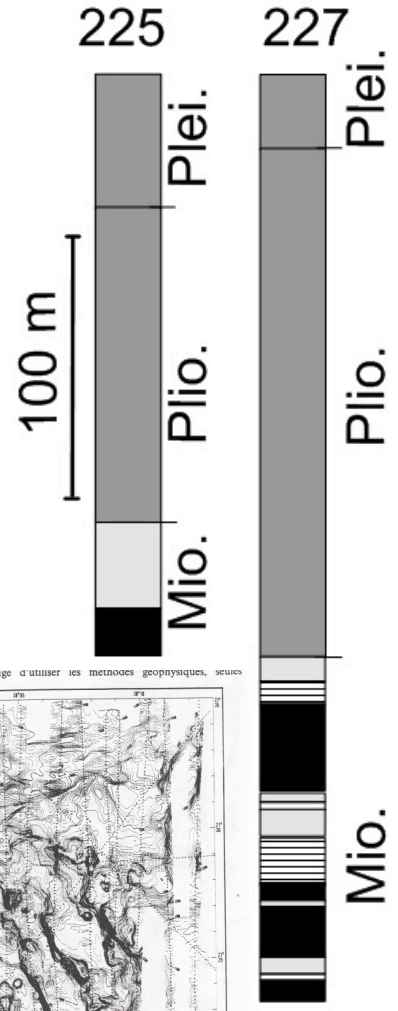
- We can be fairly certain salt glaciers exist along the Red Sea spreading axis

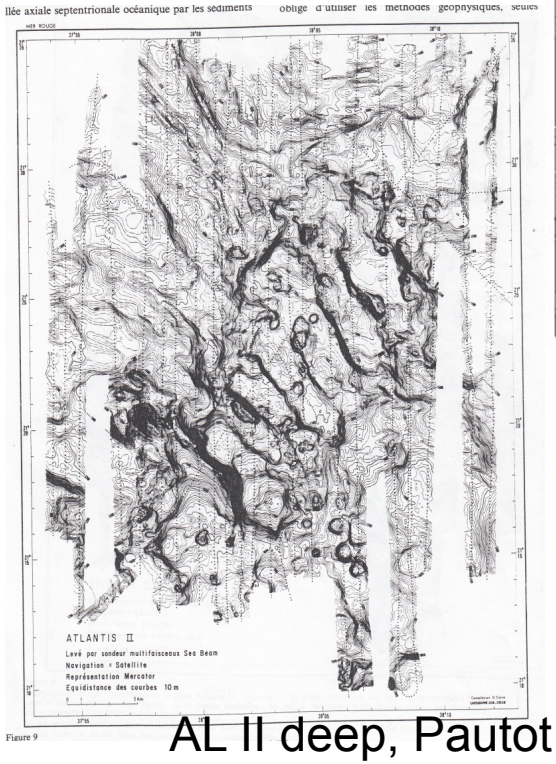
- Morphological criteria associated with evaporite flow need to be further established

- Constrain on salt glacier flow speed: Comparison of legacy multibeam data, magnetic data. Dissolution rate of evaporite? Connection to brines?

- Deformation mechanism & depth of deformation: Texture analysis. Shear zones related to shale?




AL II deep, Pautot 1983

EGU 2012

# Thanks!

**References:**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MITCHELL, N.C., LIGI, M., FERRANTE, V., BONATTI, E., RUTTER, E. 2010, Submarine salt flows in the central Red Sea. Geological Society of America Bulletin, 122(5-6), 701–713

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The Jeddah Transect

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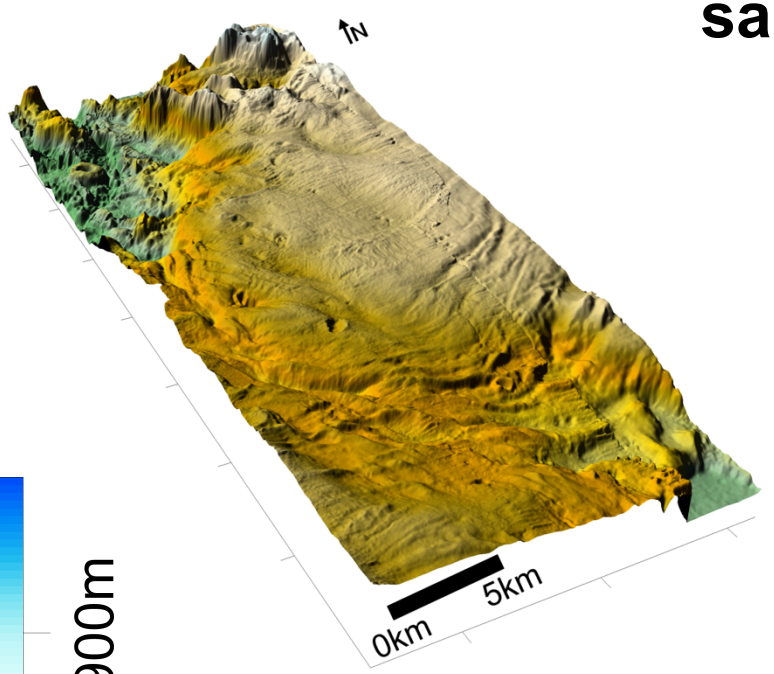
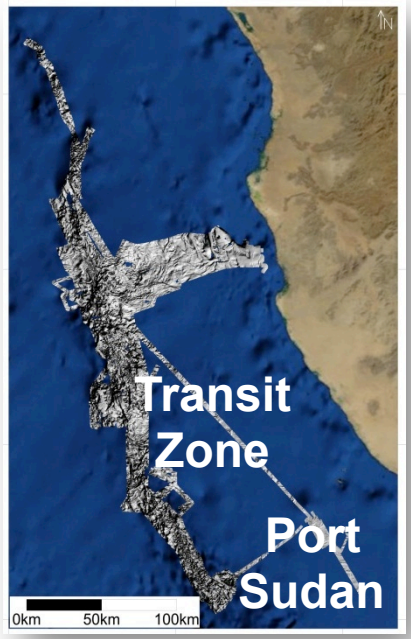
# Further potential salt flow sites

## Port Sudan




## Transit Zone