Transtensional basins in SE Crete and their importance as field analogues of deep-water basins in the Levantine region

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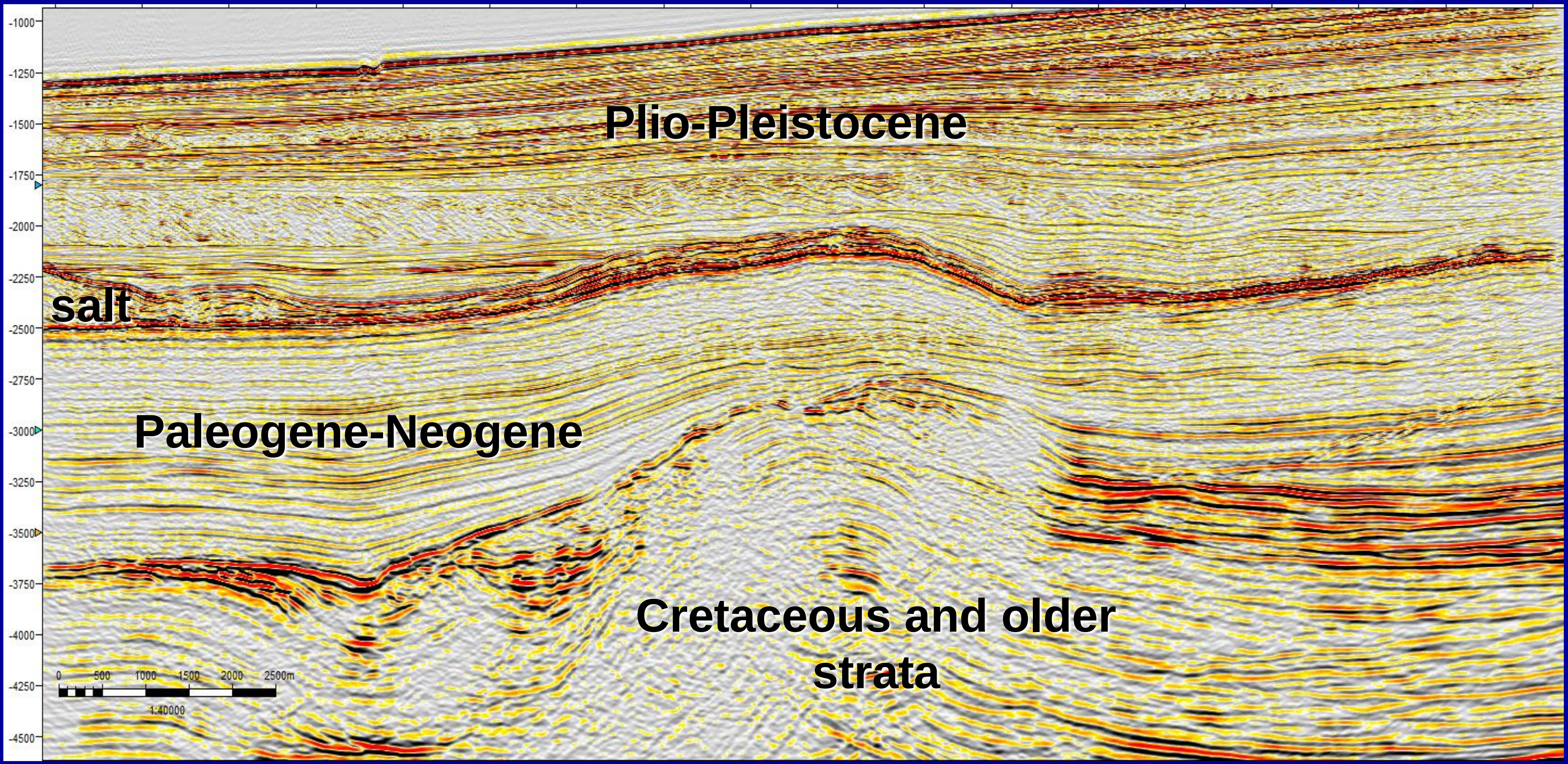
Why transtension: Levant A prospect (Israel)



Lugli et al (2013). J. Sed. Research
Seismic data cortesy of the BG Group

Summary

- Background: South Crete transtensional basins

- Depositional processes and areas

  a) Open slope turbidites

  b) MTDs and influence of basement

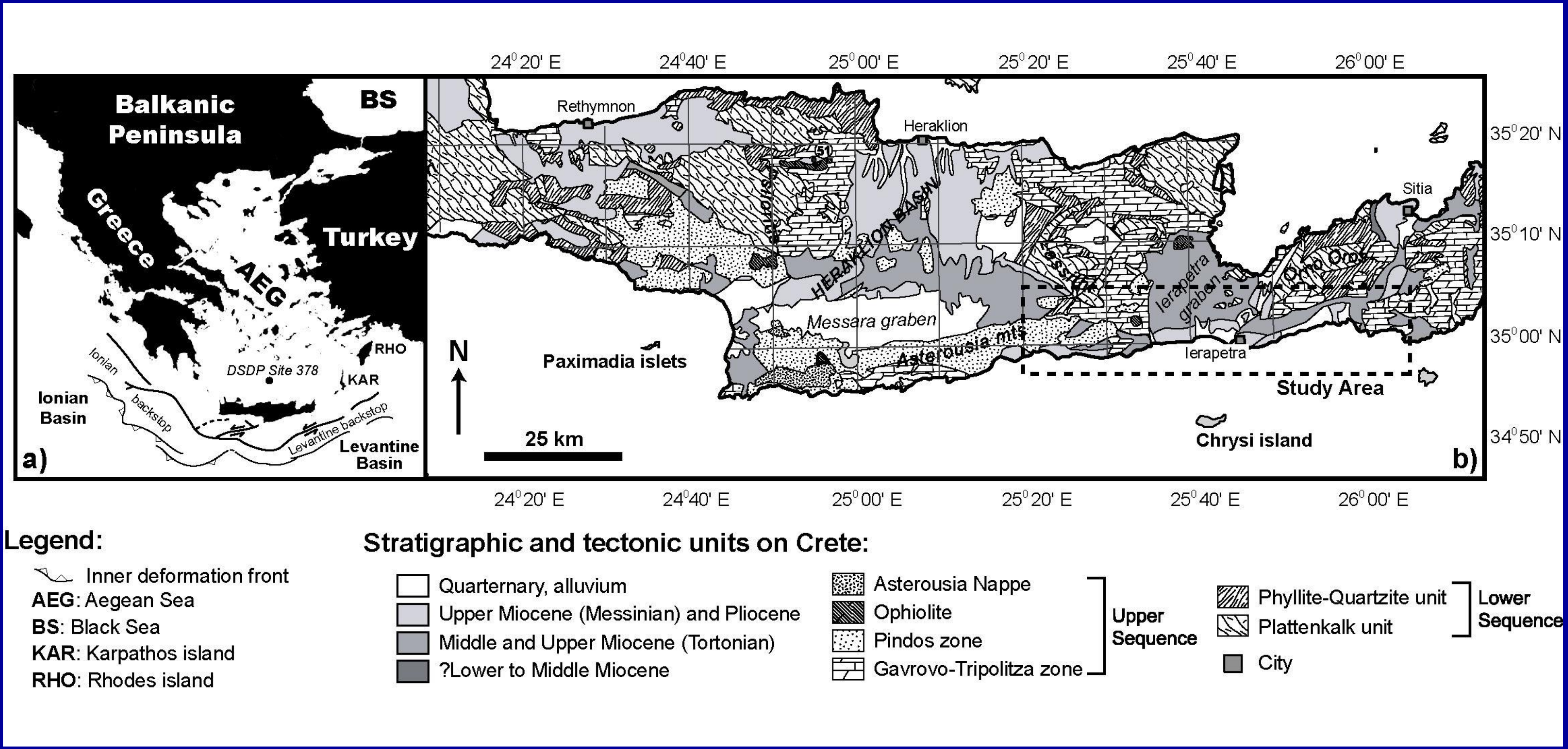
Some results: Modelling of fluid flow through MTDs, geological and facies maps.

RESERVOIR POTENTIAL

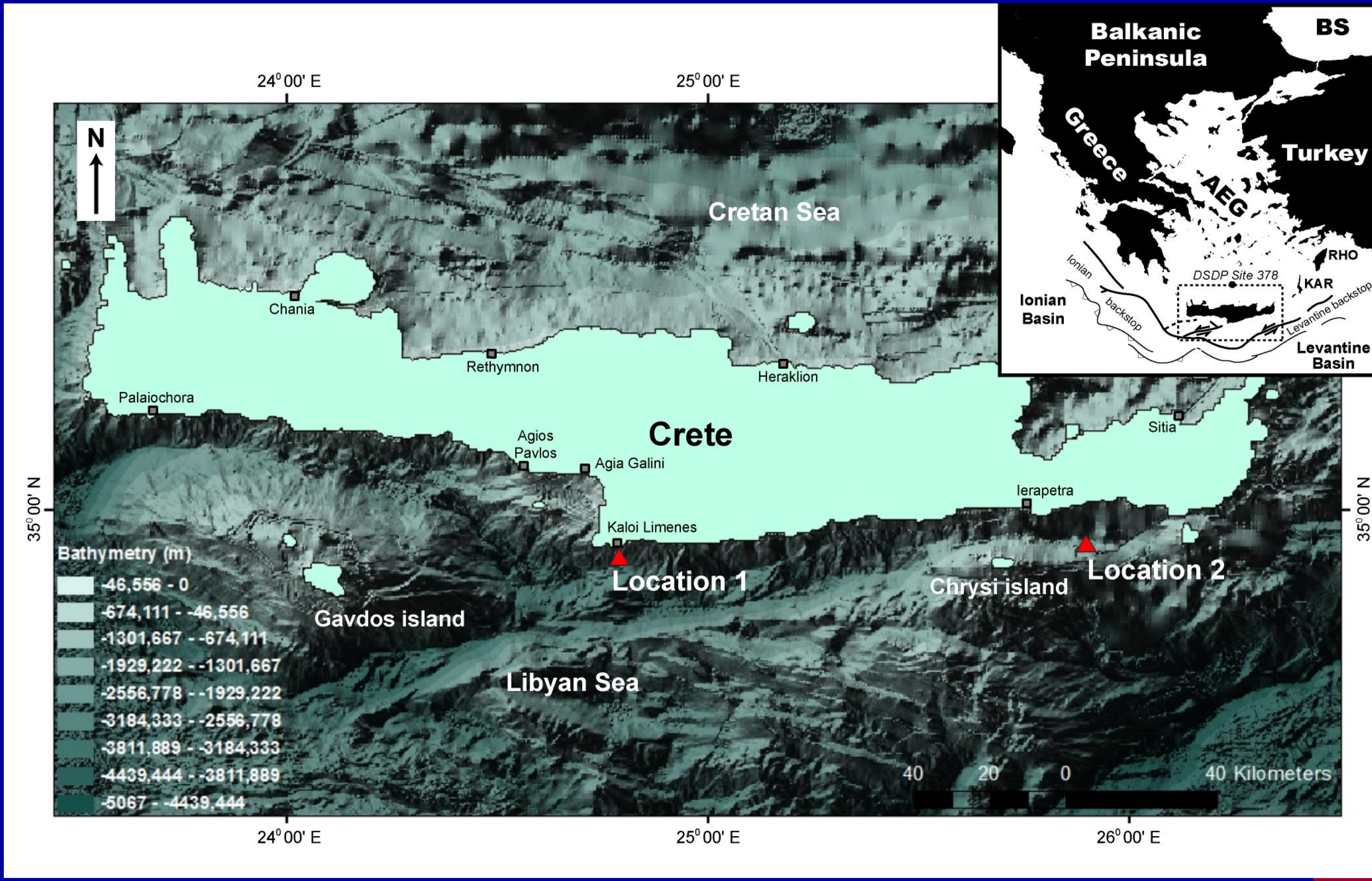
Part 1

Research Rationale
(SE Crete)

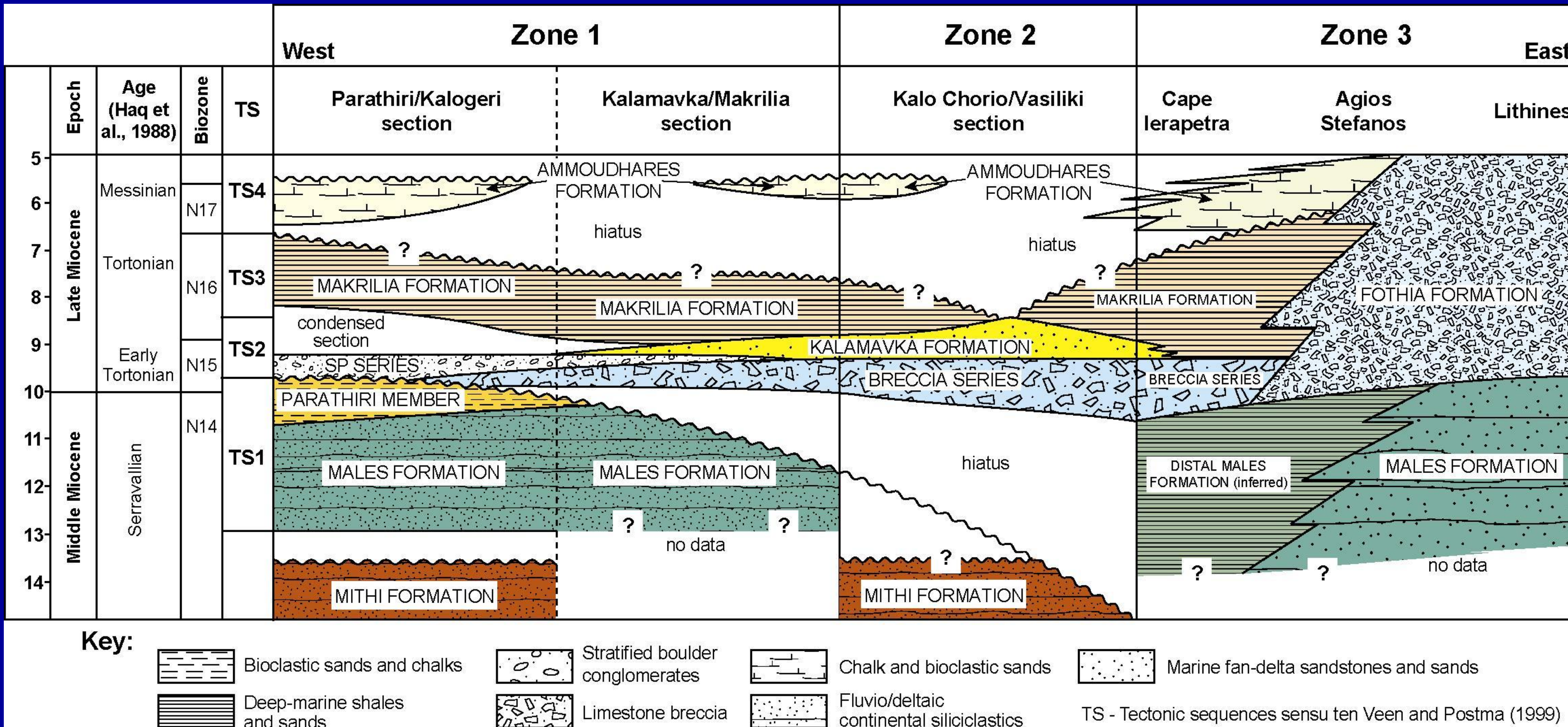
Study area


Balkanic Peninsula
BS
Greece
Turkey
AEG
RHO
KAR
DSDP Site 378
Ionian Basin
Ionian backstop
Levantine backstop
Levantine Basin
a)
24°20' E
24°40' E
25°00' E
25°20' E
25°40' E
26°00' E
35°20' N
35°10' N
35°00' N
34°50' N
Rethymnon
Heraklion
Sitia
Ierapetra
HERAKLION BASIN
Messara graben
Asterousia mts
Ierapetra graben
Paximadia islets
Study Area
Chrysi island
N
25 km
b)
Legend:
Inner deformation front
AEG: Aegean Sea
BS: Black Sea
KAR: Karpathos island
RHO: Rhodes island
Stratigraphic and tectonic units on Crete:
Quarternary, alluvium
Upper Miocene (Messinian) and Pliocene
Middle and Upper Miocene (Tortonian)
?Lower to Middle Miocene
Asterousia Nappe
Ophiolite
Pindos zone
Gavrovo-Tripolitza zone
Upper Sequence
Phyllite-Quartzite unit
Plattenkalk unit
Lower Sequence
City

Transtension in S Crete into Cyprus

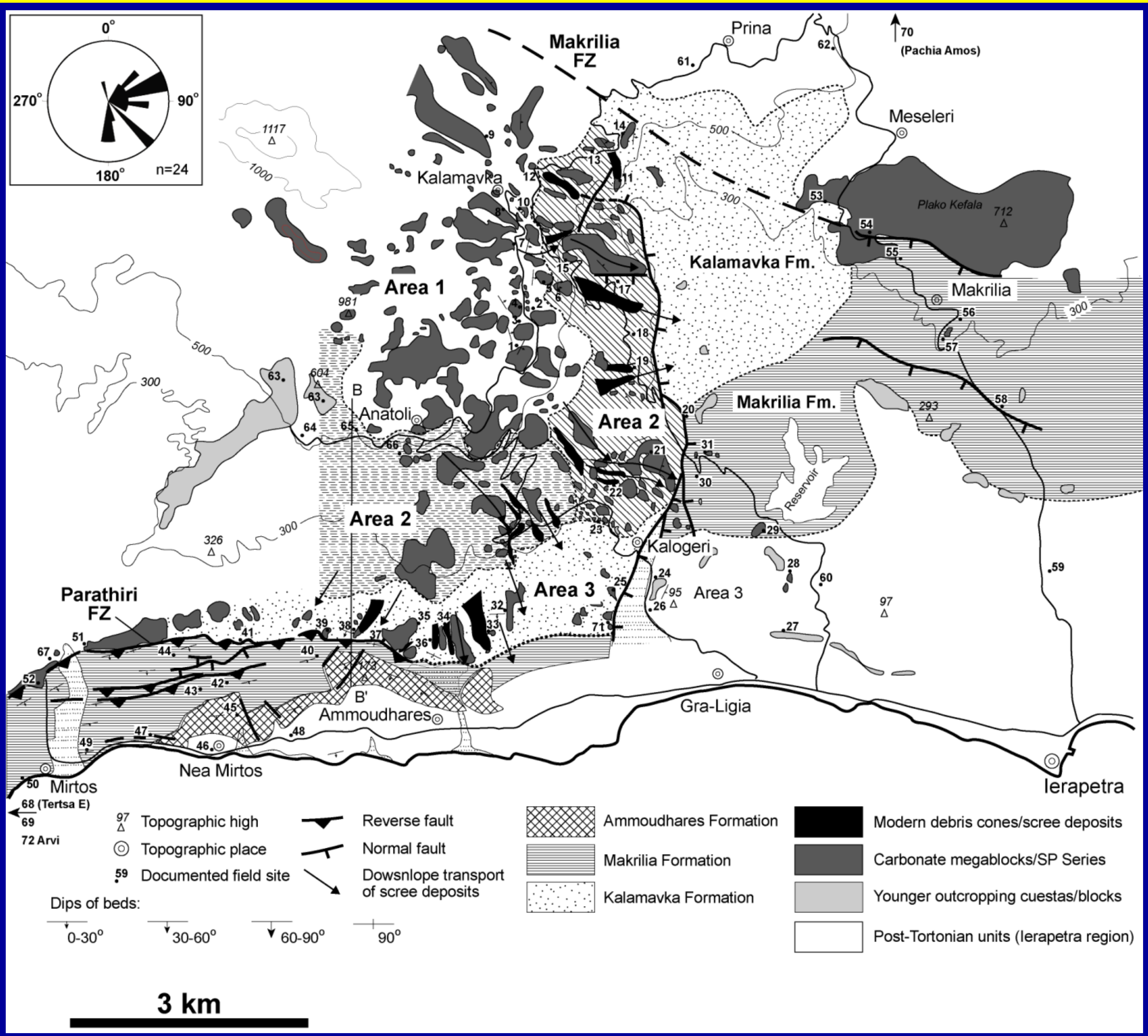


Stratigraphic units in SE Crete



Alves and Cupkovic (2017). Sedimentology. In preparation

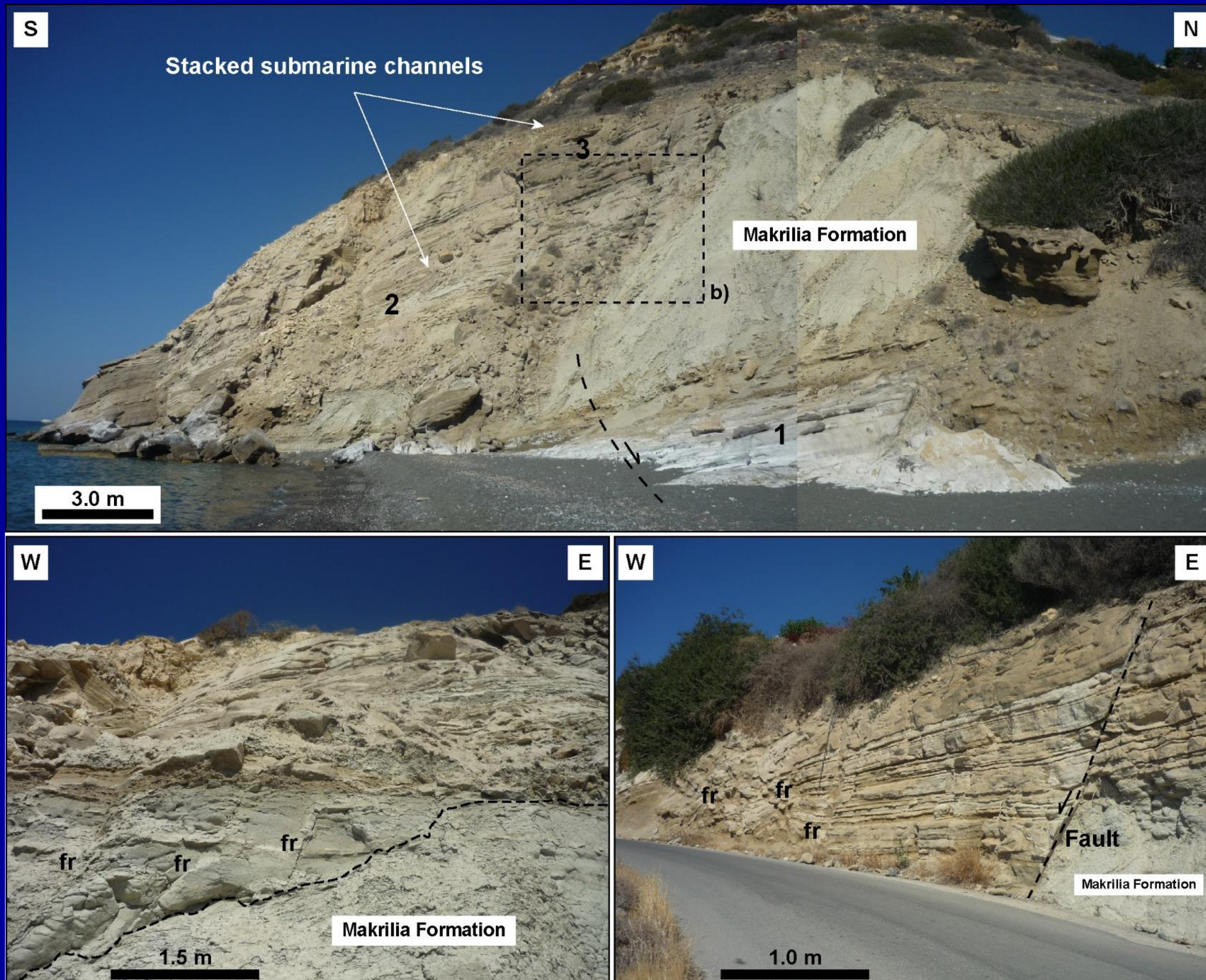
Slope complexes in SE Crete



Part 2: Outcrop Data

What is the reservoir potential of fault degradation complexes?

Field data - Crete: Channel-fill deposits



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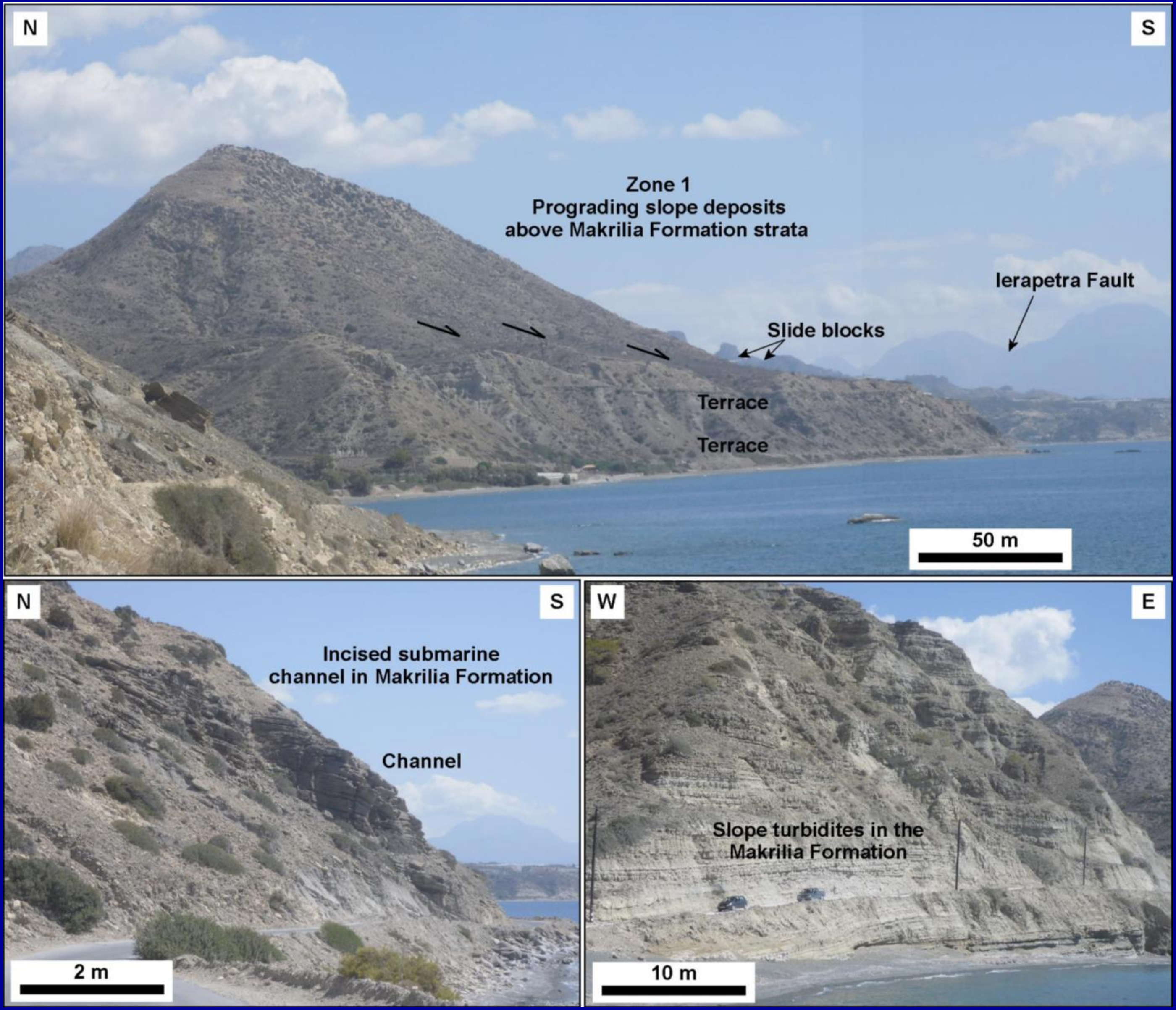
Field data - Crete: Overbank turbidites



Alves and Cupkovic (2017). Sedimentology. In preparation

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Field data - Crete: Degradation products

Alves and Cupkovic (2017). Sedimentology. In preparation

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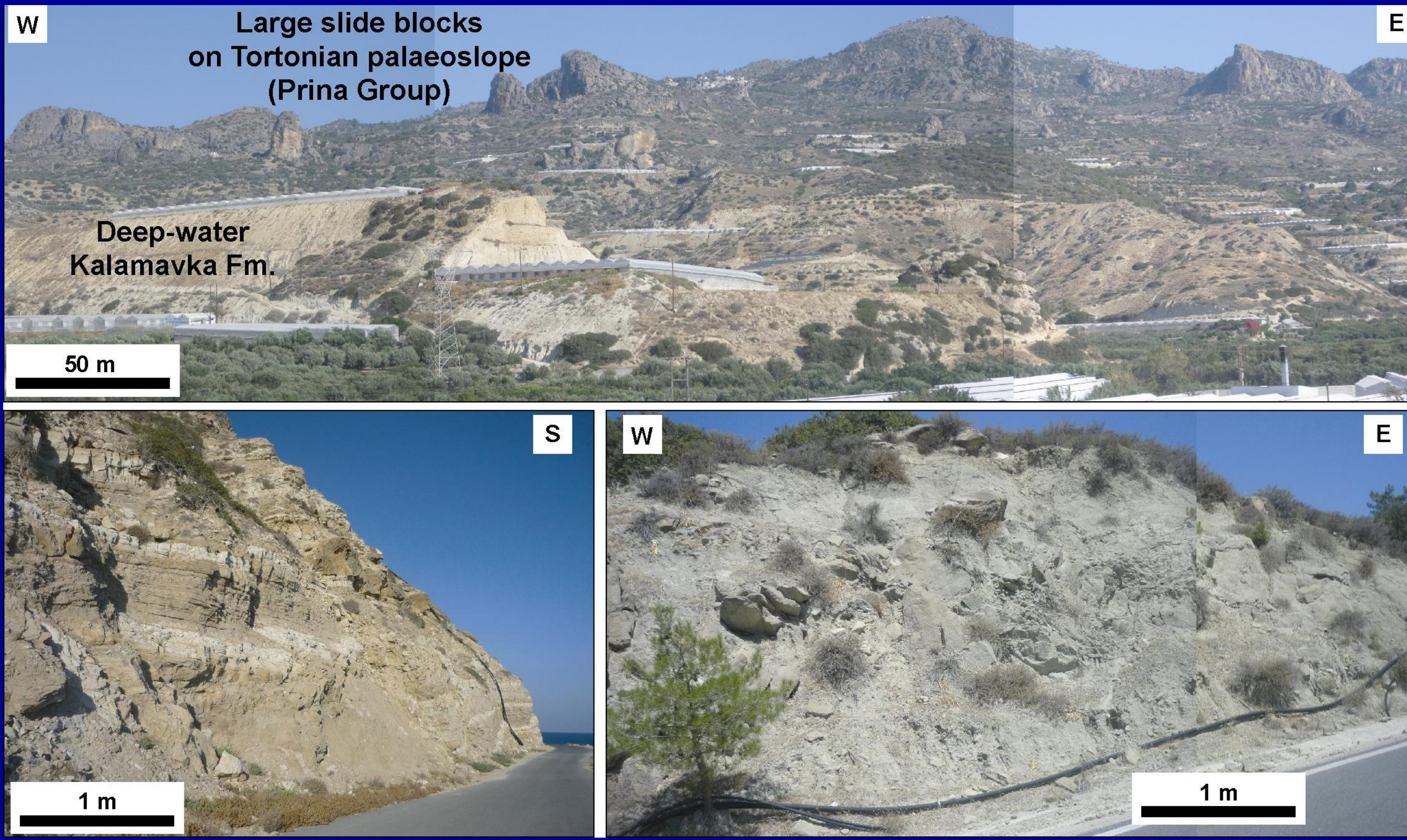
PART 3: Blocky MTDs

Relationship to degradation complexes

Turbidites and degradation complexes



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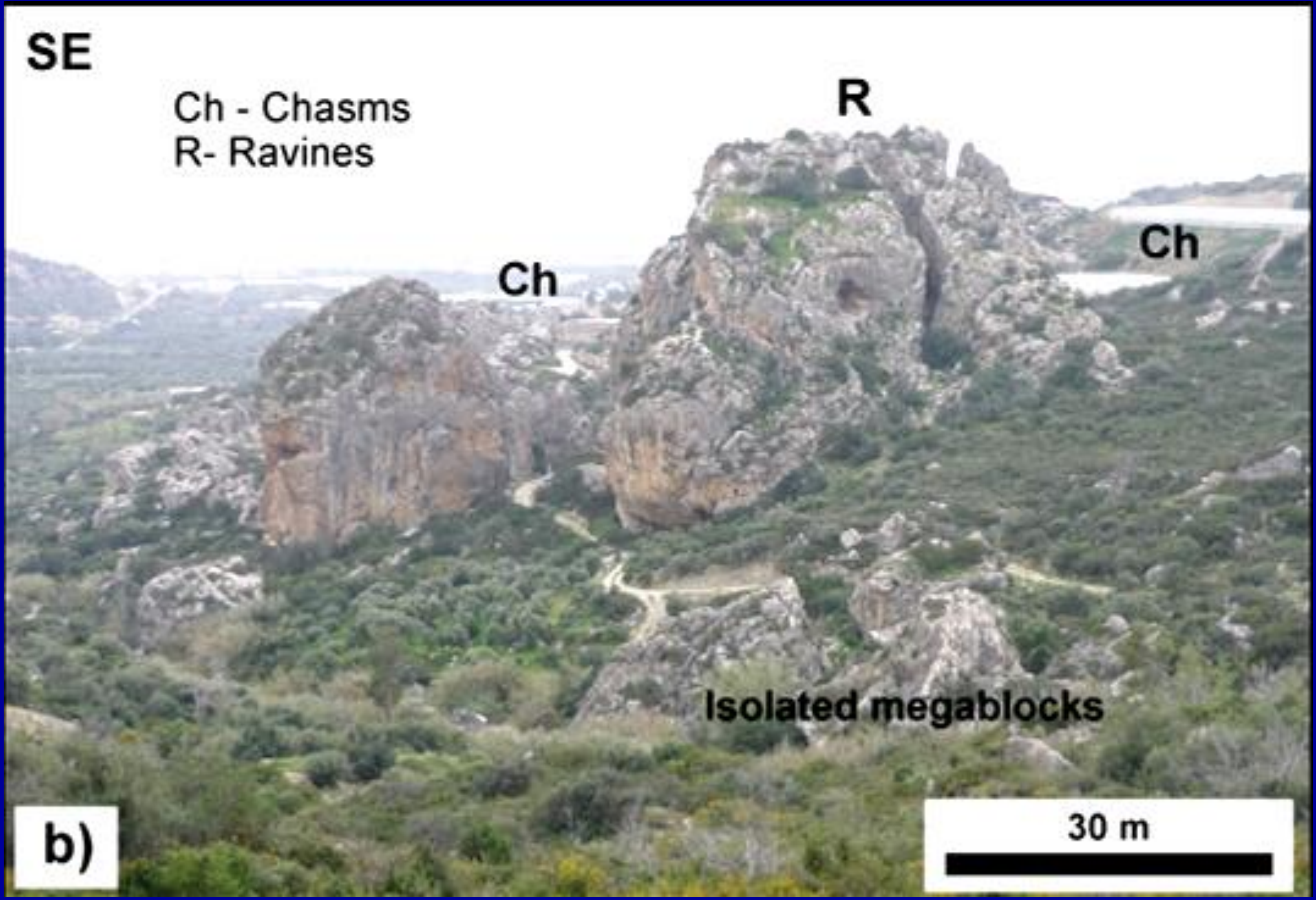
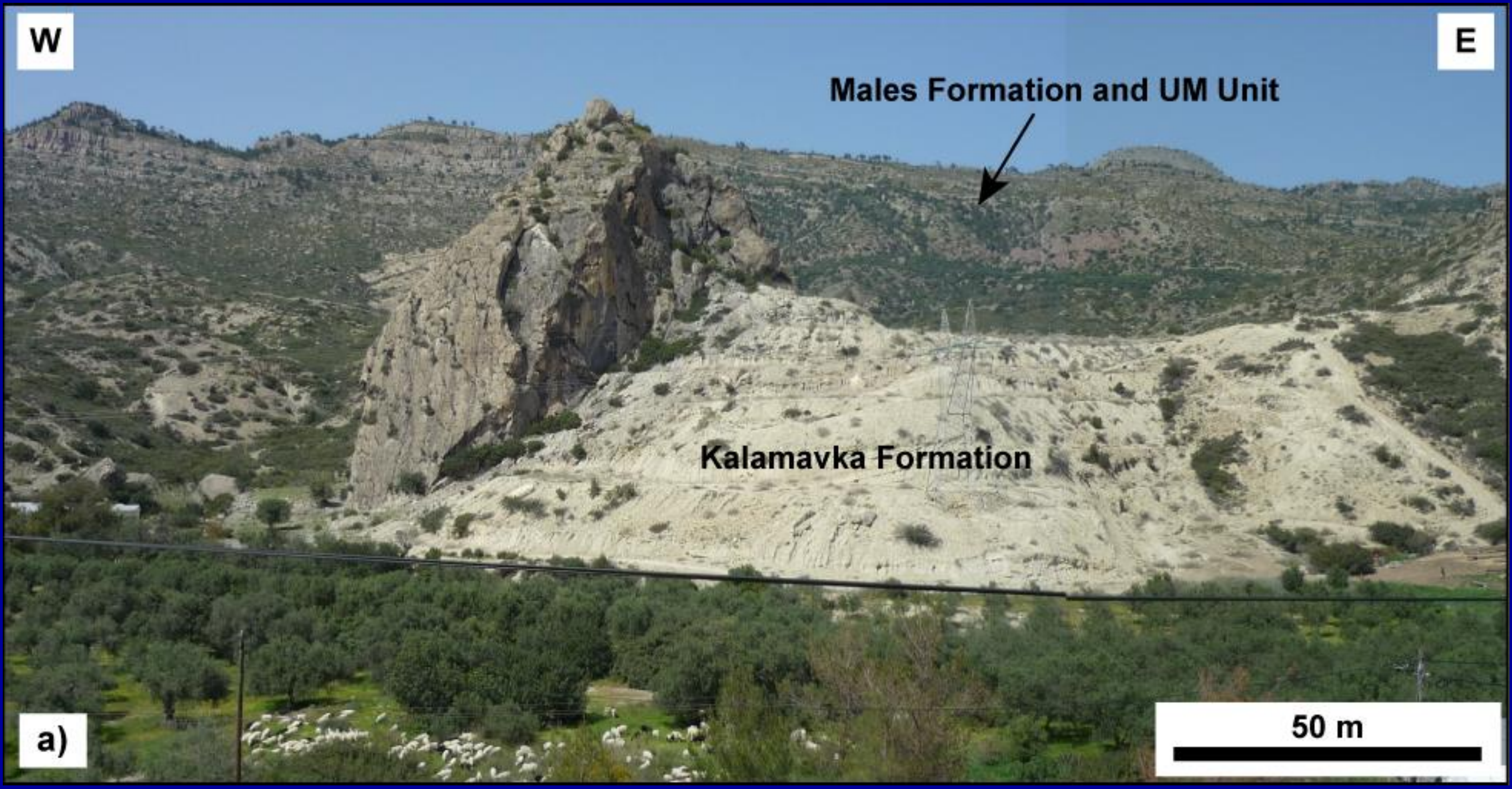
Field data - Crete: Ravines and chasms

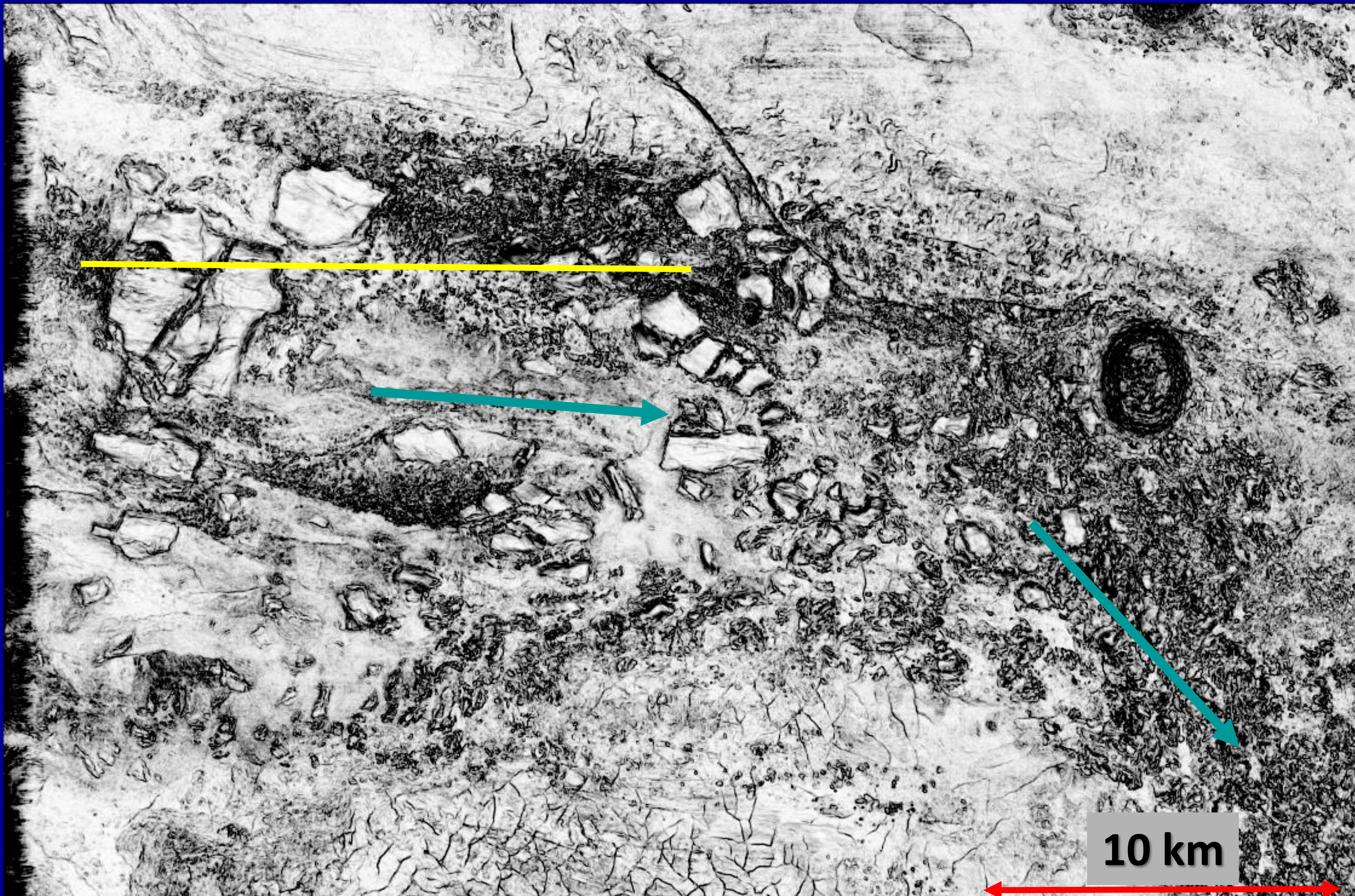


Alves and Lourenço (2010). Geomorphology

Isolated rafted strata (140 metre block)

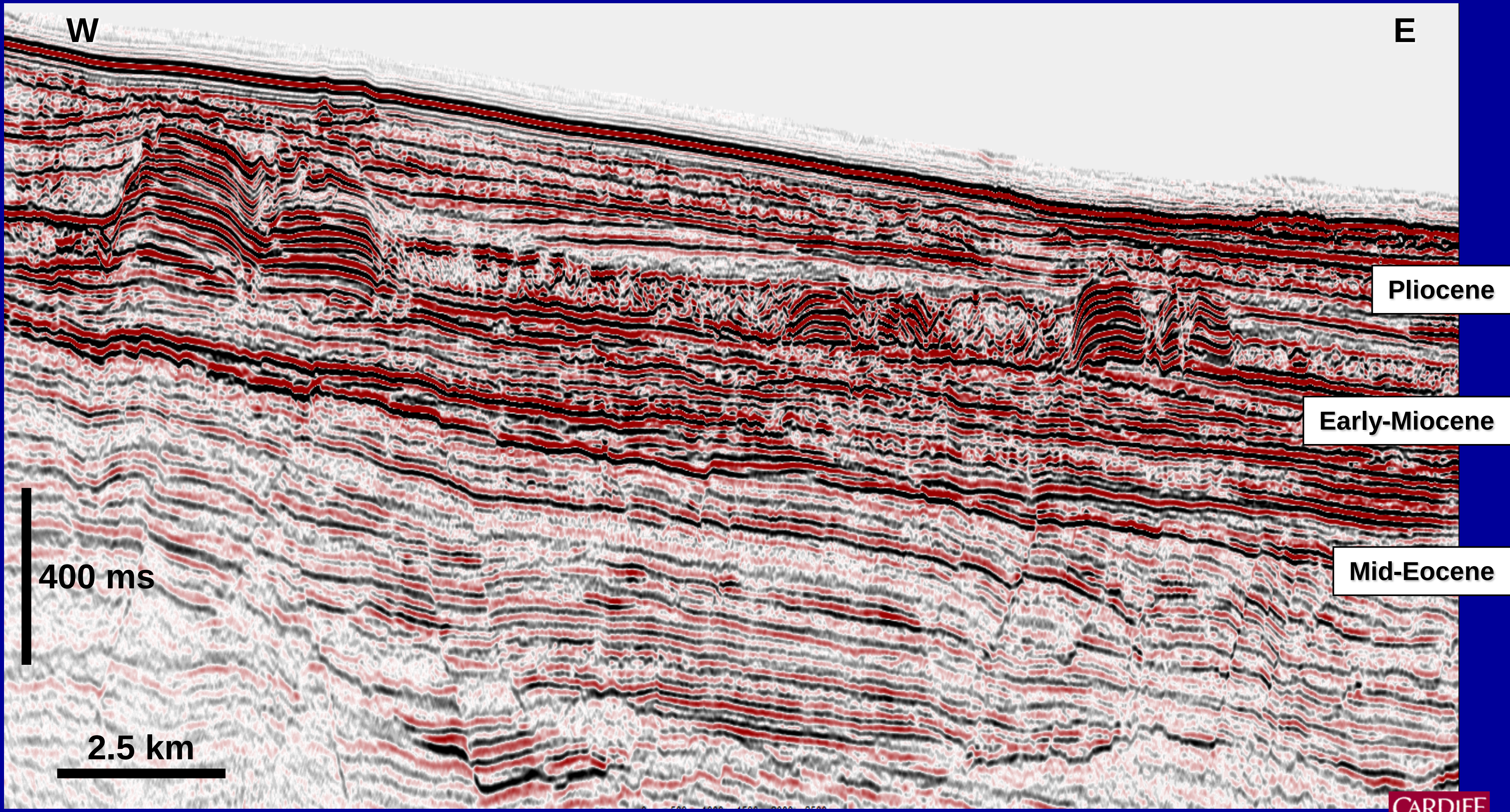


Blocky Mass-Transport Deposits (MTD)



Alves and Cartwright (2009). Earth and Planetary Science Letters

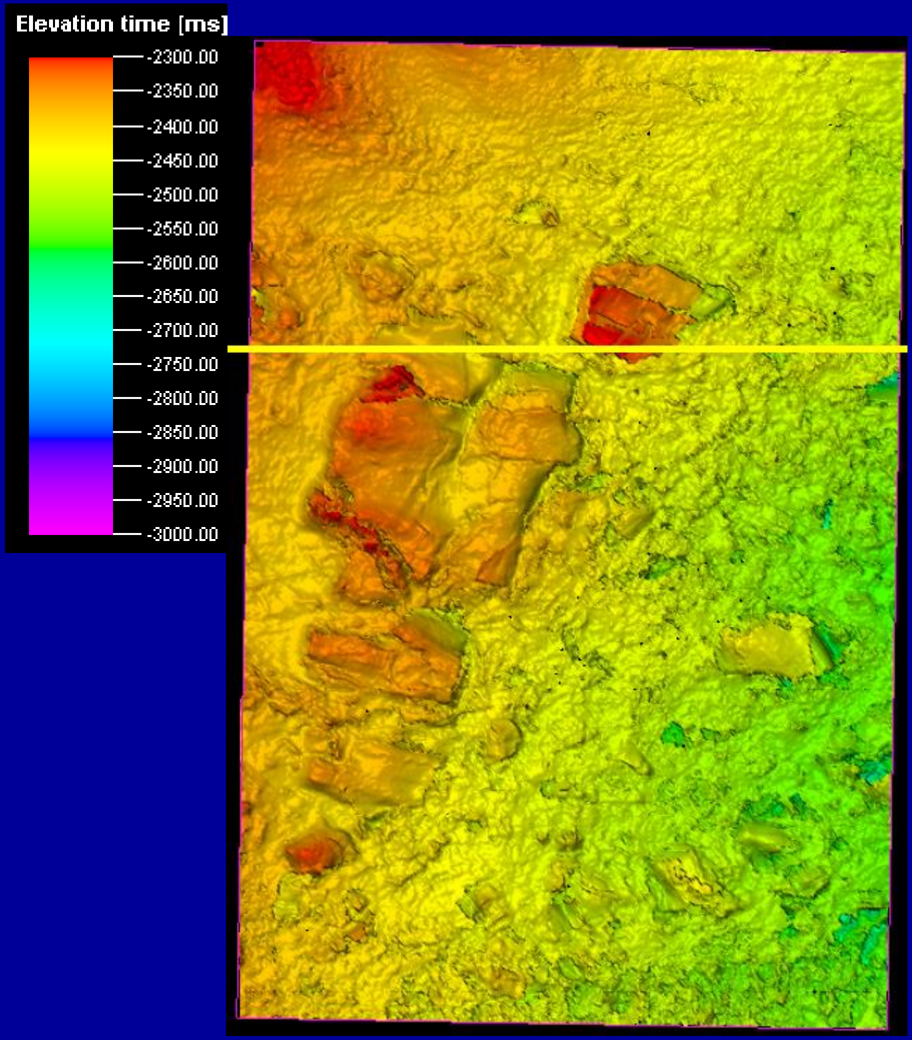
Heterogeneities in a Late Miocene MTD

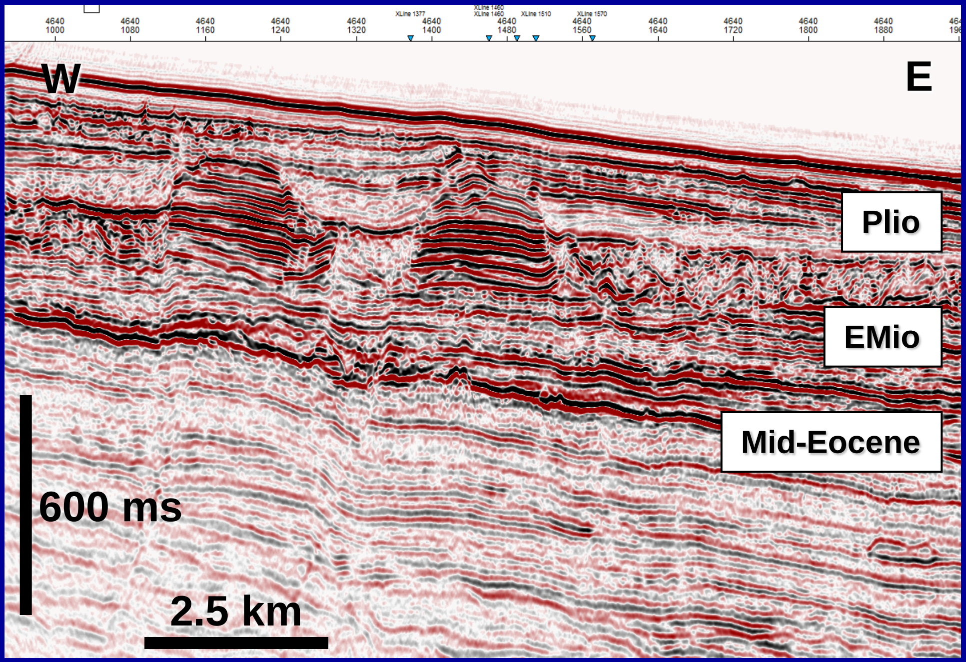


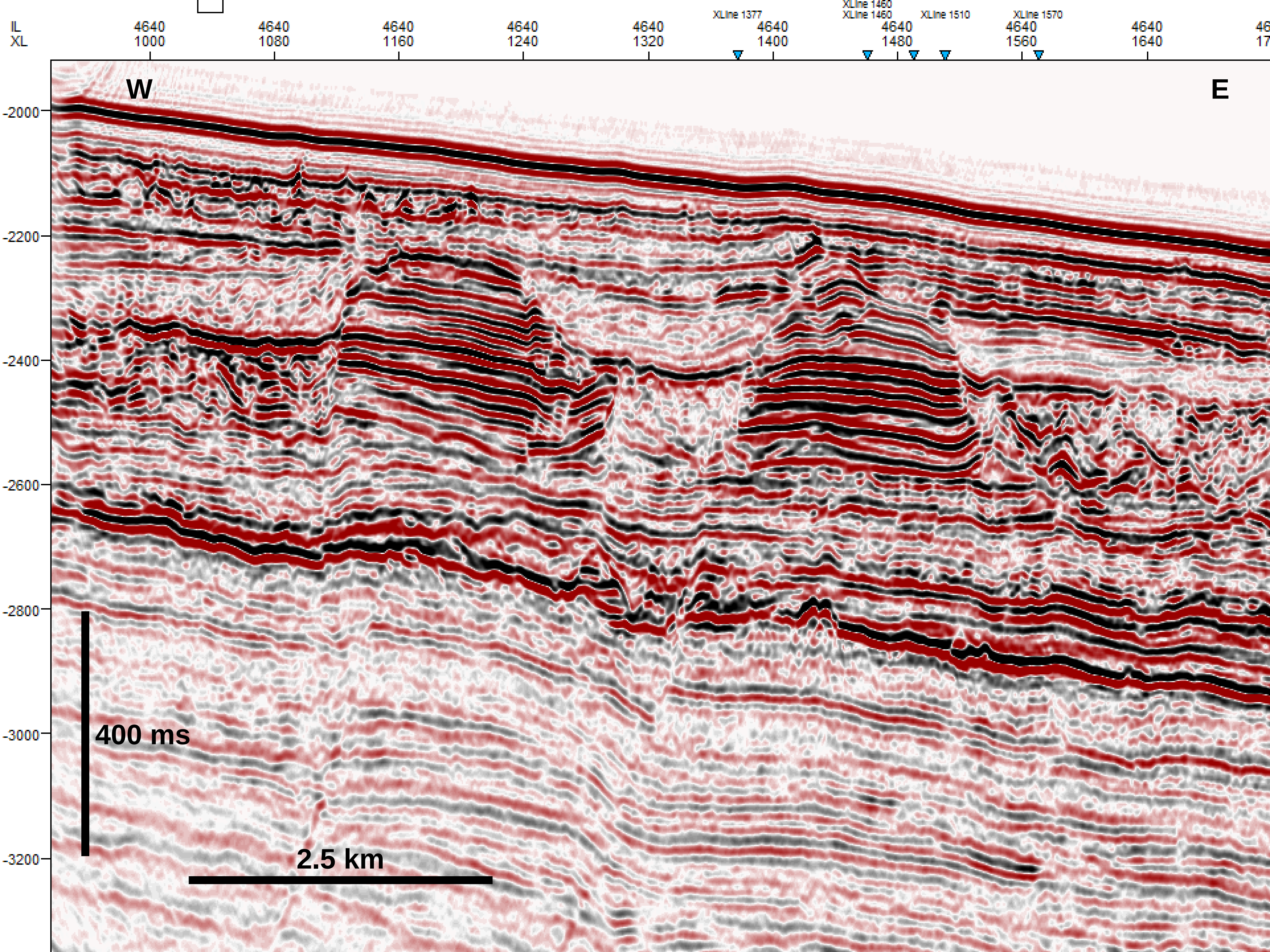
(Open) Question

Impact of slope failure and remnant/rafted blocks on fluid flow?

Modelling a 28 x 10 km area







IL
XL
4640
1000
4640
1080
4640
1160
4640
1240
4640
1320
XLine 1377
4640
1400
XLine 1460
XLine 1460
4640
1480
XLine 1510
4640
1560
XLine 1570
4640
1640
W
E
-2000
-2200
-2400
-2600
-2800
-3000
-3200
400 ms
2.5 km

Leakage factor (Morris et al., 1996)

Dilation Tendency

Dilation tendency is the likelihood for a fault or extension fracture to dilate based on the 3D stress conditions and is computed as:

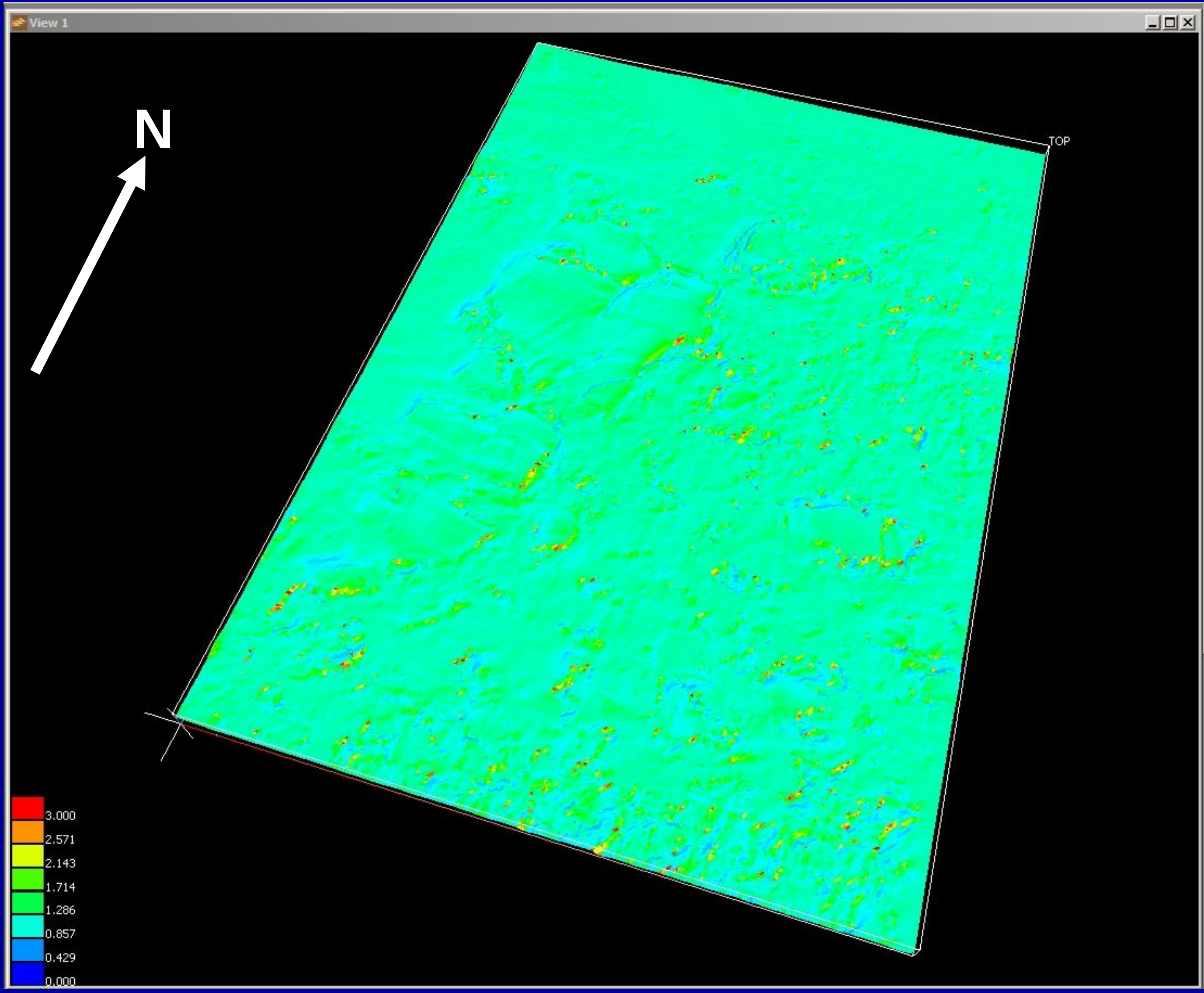
$$\text{Dilation tendency} = (\sigma_n - \sigma_1)/(\sigma_1 - \sigma_3)$$

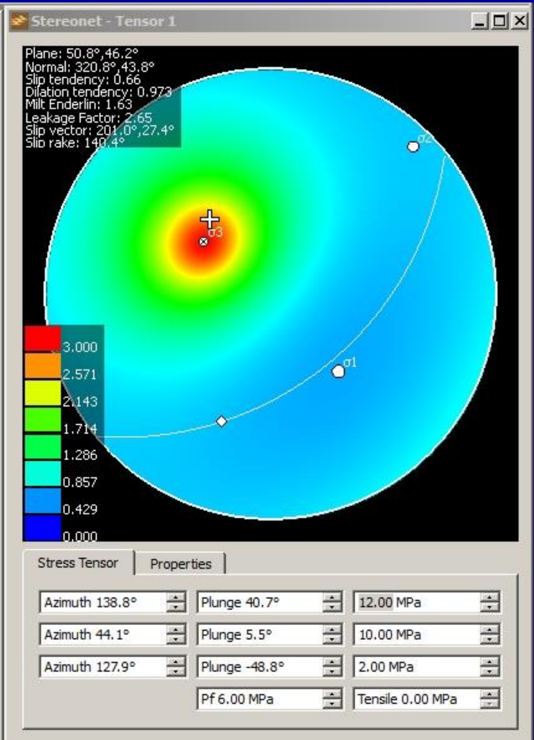
Leakage Factor

Leakage factor is similar to dilation tendency, but it takes into account detailed information on fluid pressure and tensile strength of fault-zone or fracture-filling material such as:

$$\text{Leakage Factor} = [(\sigma_n - p_f - t_{strength}) - \sigma_1]/\sigma_1 - \sigma_3$$

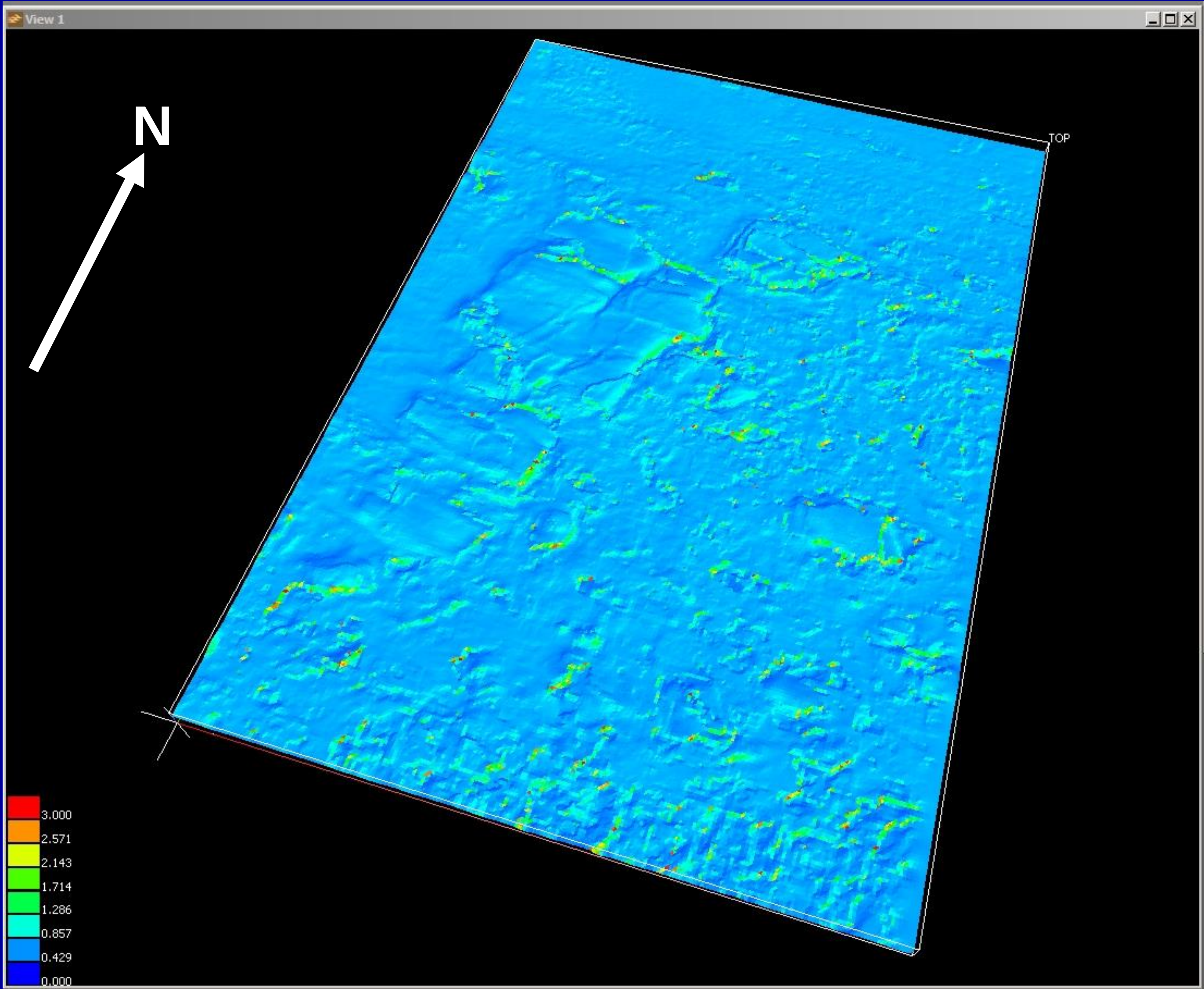
Leakage factor @ seafloor failure

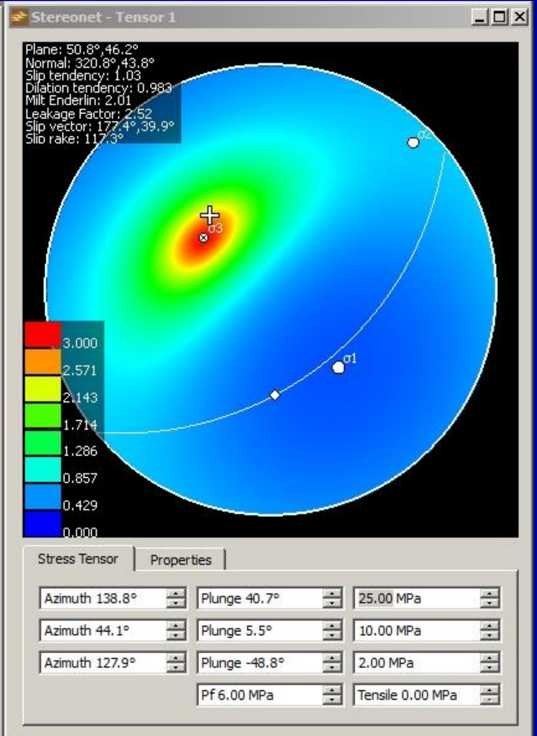




P_f = 6 MPa
(60 bar, 900 psi)

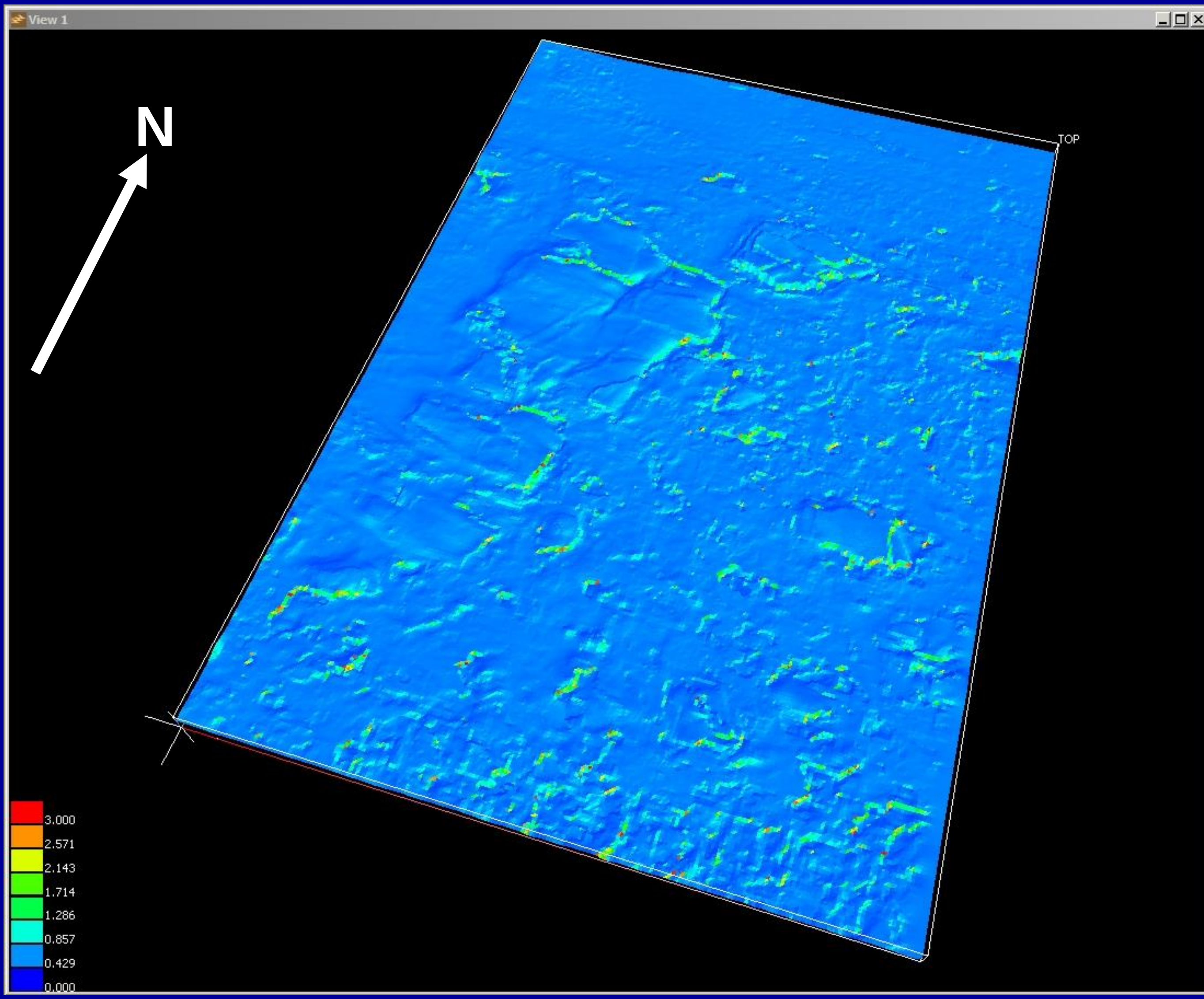
σ_1 = 25 Mpa (1000 m below seafloor)

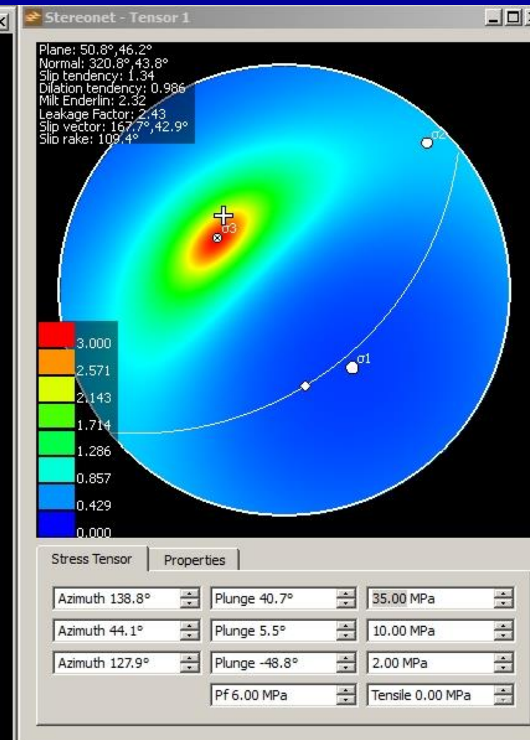




P_f = 6 MPa
(60 bar, 900 psi)

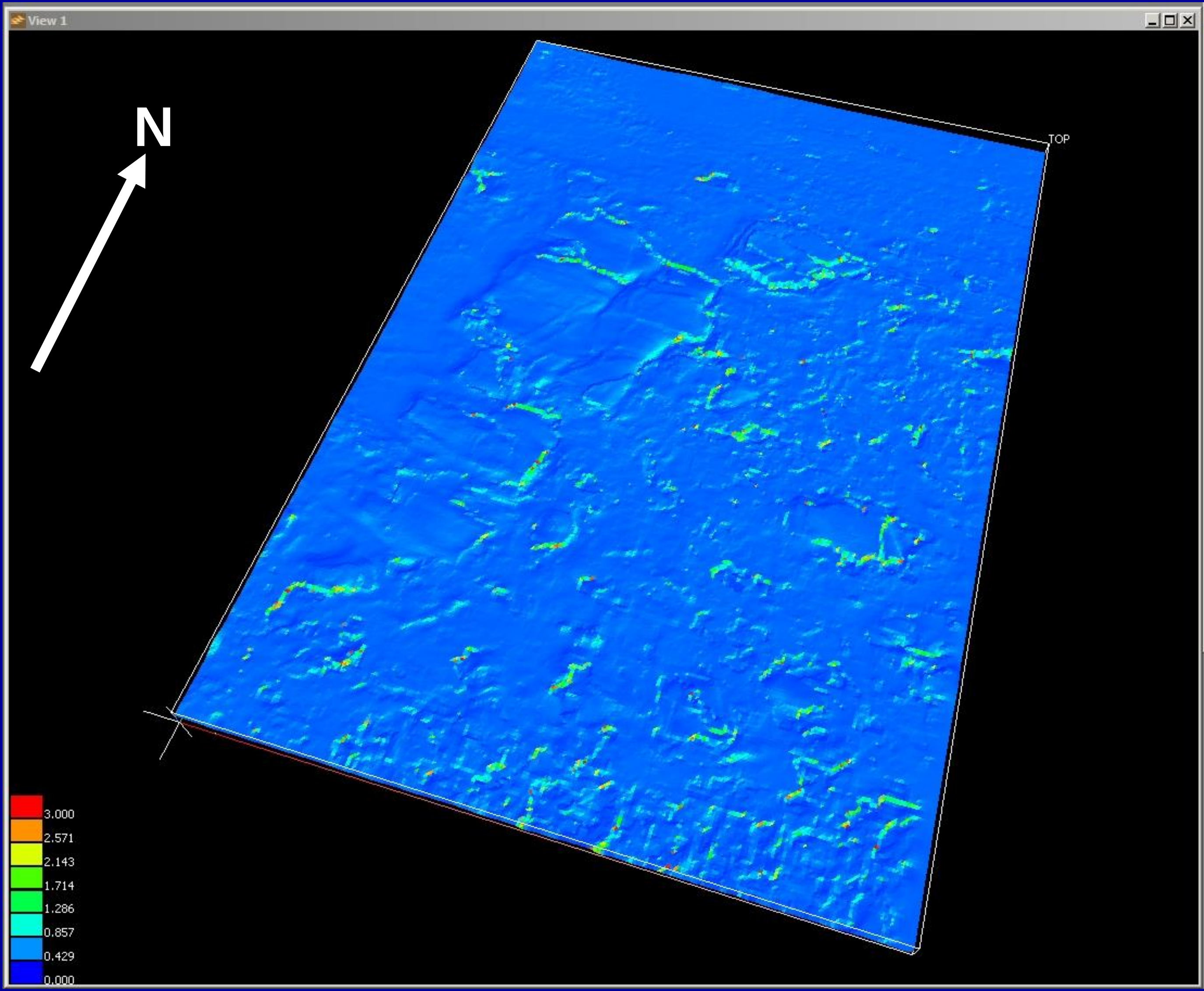
σ_1 = 35 Mpa (1400 m below seafloor)

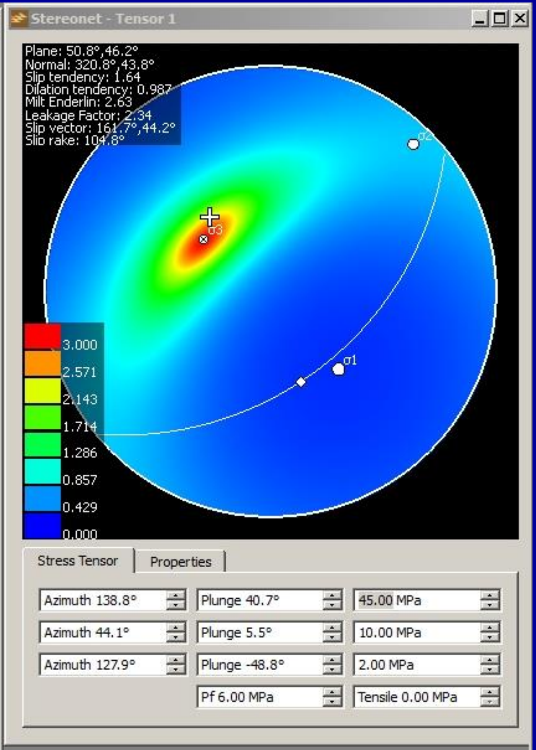




P_f = 6 MPa
(60 bar, 900 psi)

σ_1 = 45 Mpa (1800 m below seafloor)

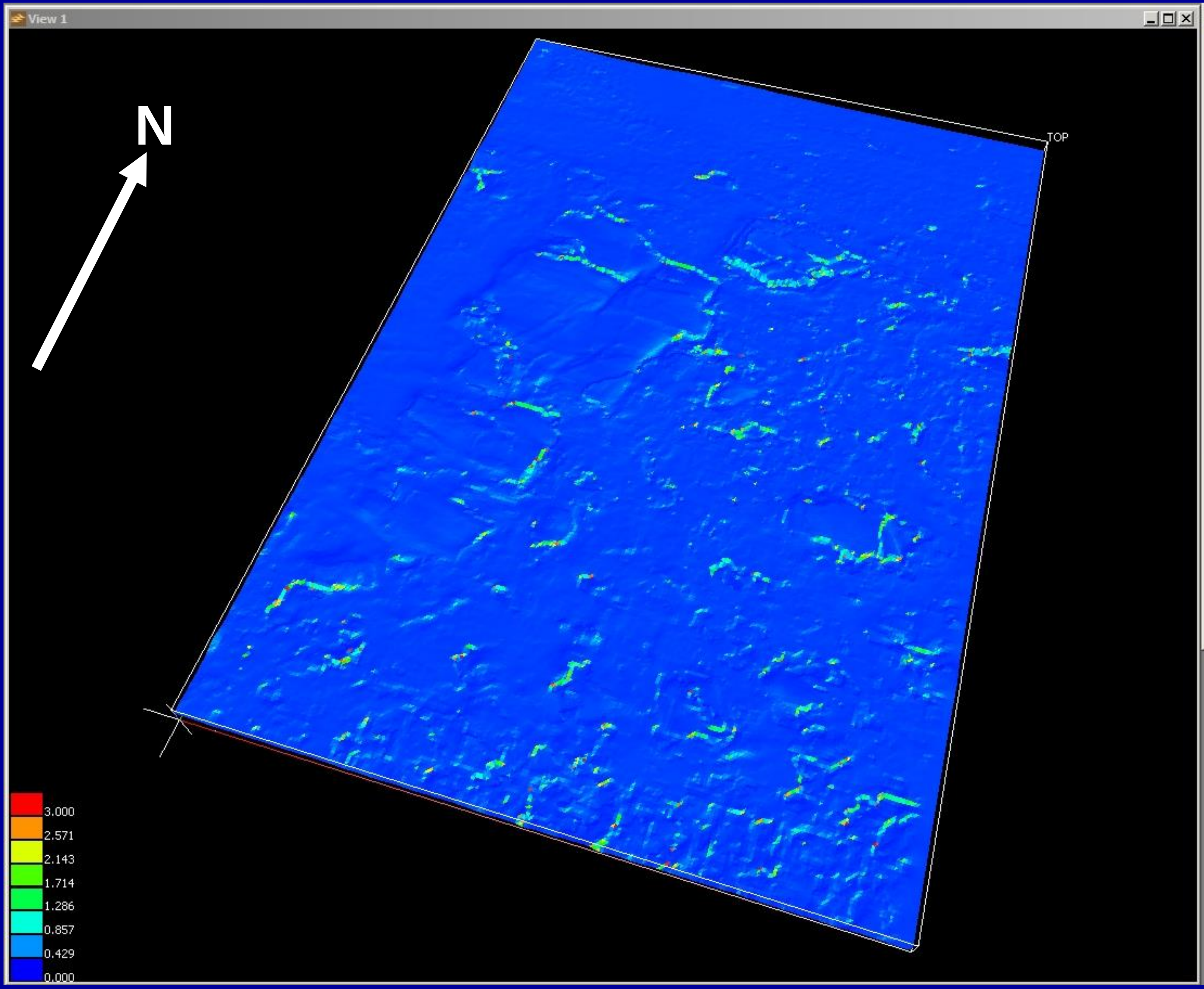


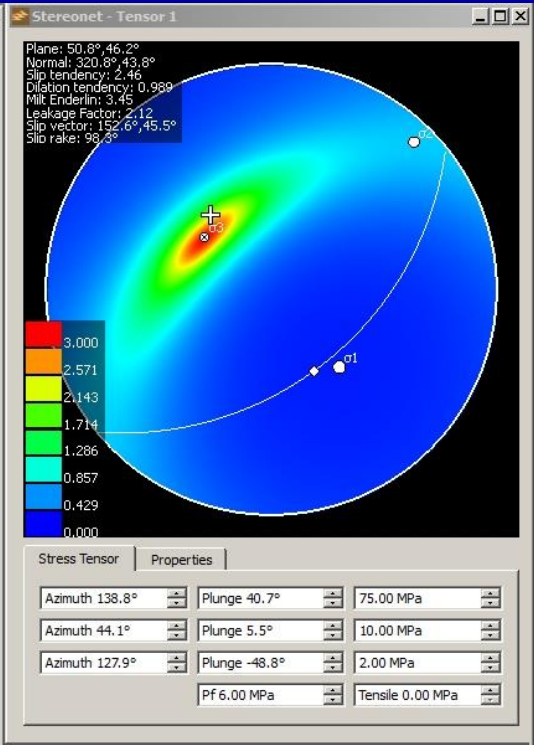


P_f = 6 MPa

(60 bar, 900 psi)

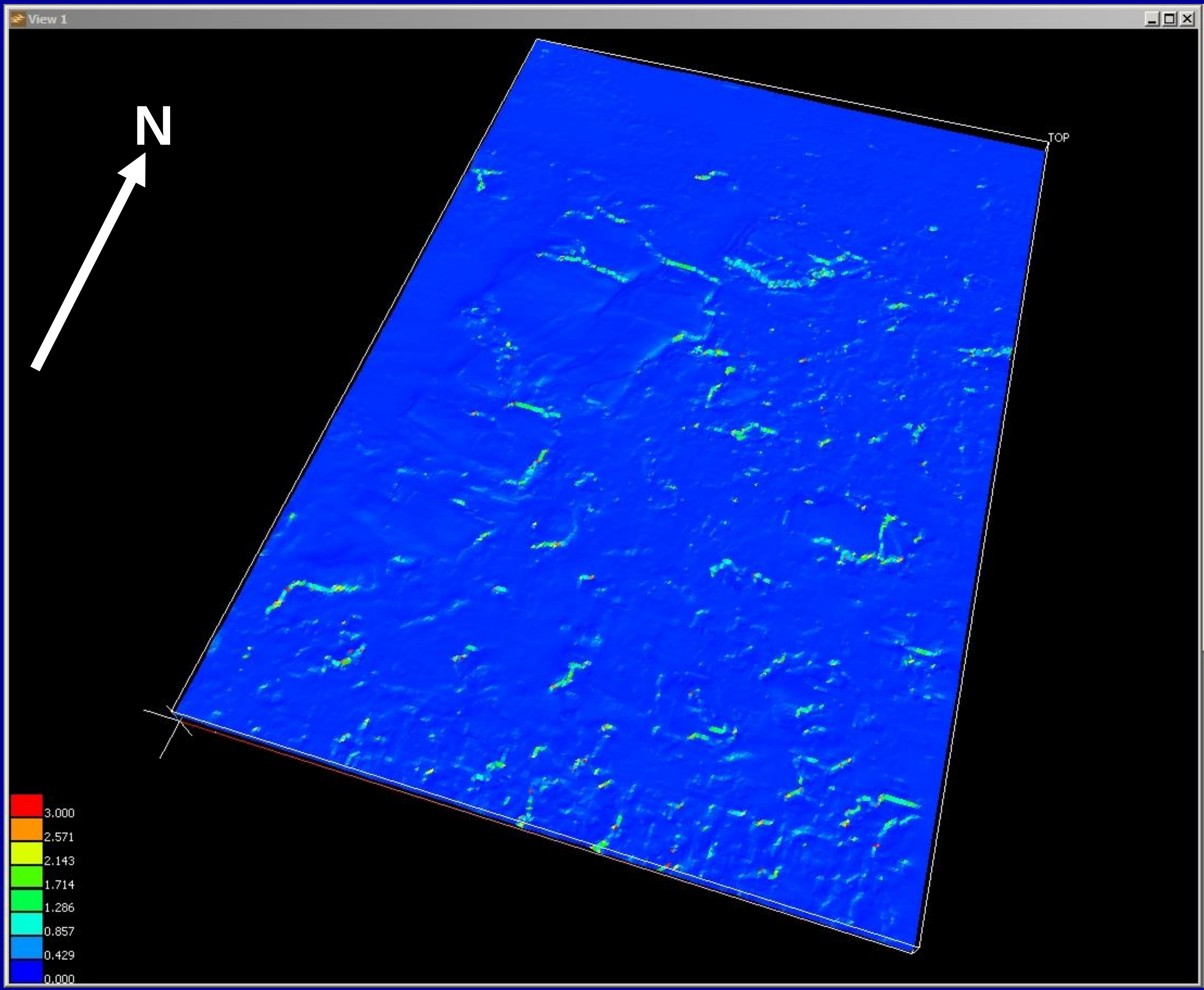
σ_1 = 75 Mpa (3000 m below seafloor)

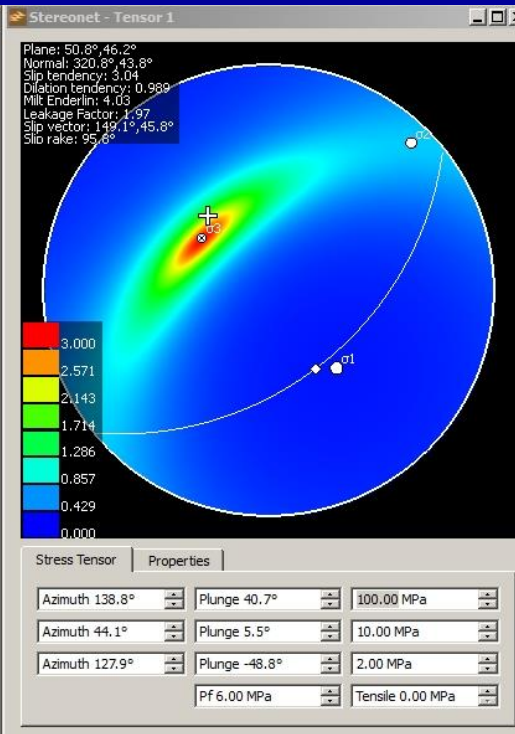




P_f = 6 MPa
(60 bar, 900 psi)

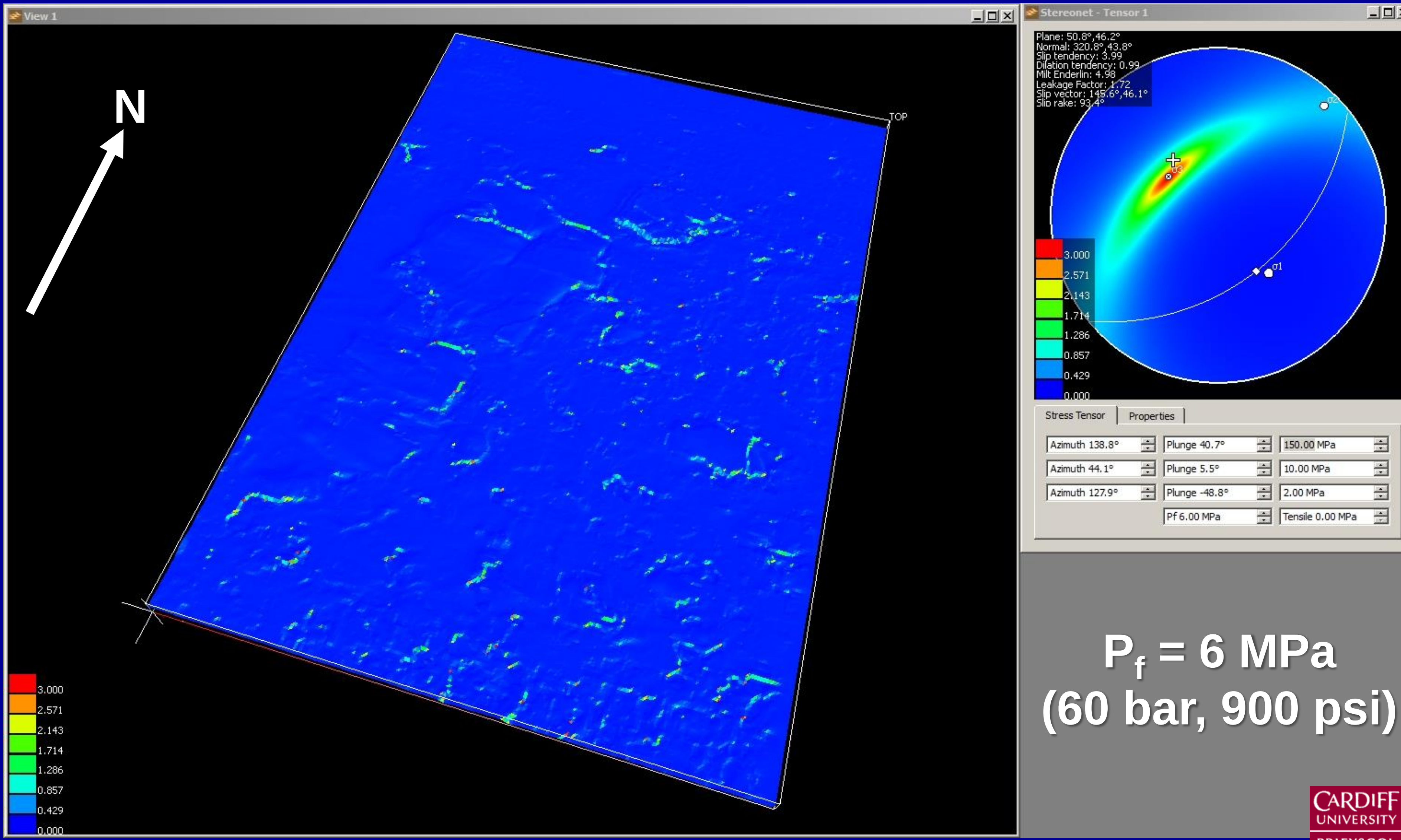
σ_1 = 100 Mpa (4000 m below seafloor)





P_f = 6 MPa
(60 bar, 900 psi)

σ_1 = 150 Mpa (6000 m below seafloor)



P_f = 6 MPa
(60 bar, 900 psi)

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Conclusions

1. **Immature MTDs in SE CRETE**: Can represent large slope instability events, with 100s m of strata failed in one discrete event. Seismic evidence shows blocks of similar scales on several continental margins.

2. **Degree of disaggregation**: Blocks tend to disaggregate quickly, with rafted strata being embedded in debrites and highly deformed. RESERVOIR POTENTIAL IS IMPORTANT.

3. **Impact on HC plays**: Blocks' margins, ravines and chasms form leakage points during burial. These leakage points are maintained at depth: RESERVOIR vs. SEAL COMPETENCE FOR THE LEVANT REGIONS.