36° Convegno Nazionale, Trieste 14-16 Novembre 2017

Subsurface data, analogue and numerical models: an integrated approach to reconstruct and constrain active fault systems (Sciacca Fault, Italy)

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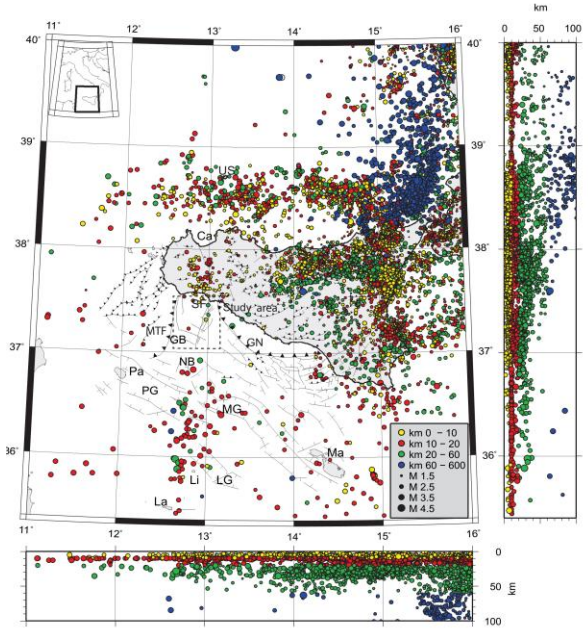
3) OGS-Trieste
4) University of Trieste

Outline

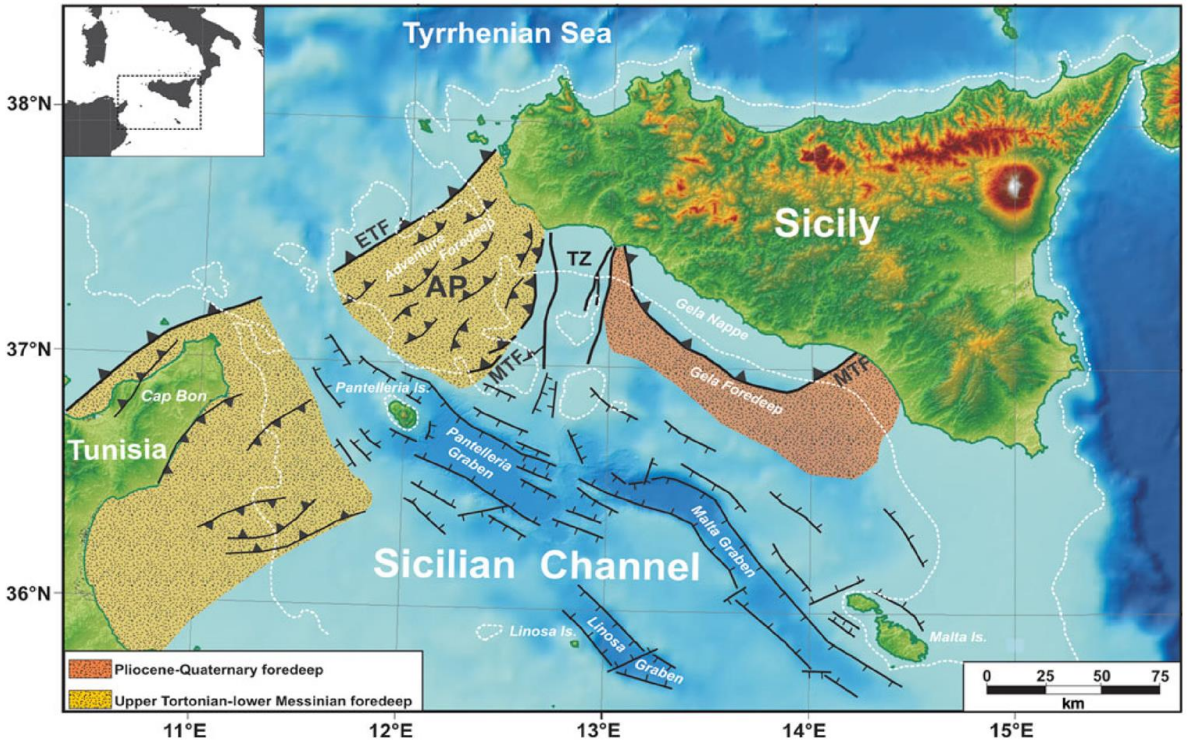
- Introduction
  - Study area
  - Dataset/Goal of the research
- Methodes
  - Seismic interpretation
  - Analogue modelling
- Proposed geological model
- Active tectonics
- Numerical modelling
- Conclusion

Introduction – study area

- Complex geological/geodynamic setting
- Good coverage of seismic dataset+previous work
- Active tectonics



Calo & Parisi et al., 2014



Civile et al., 2015

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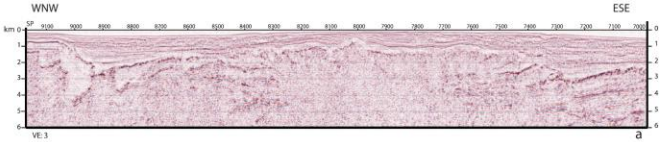
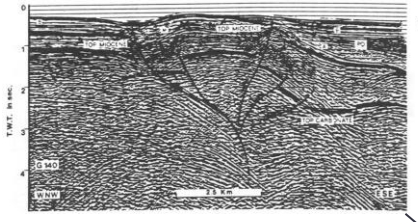
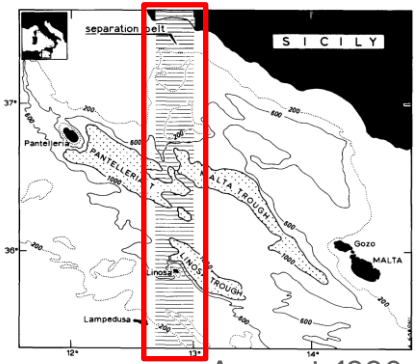


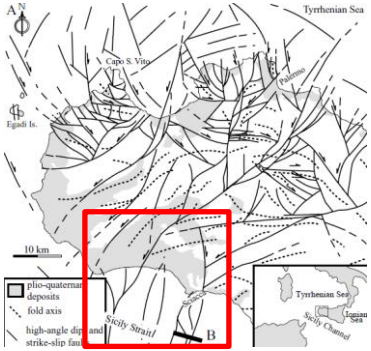
Ghisetti et al., 2009



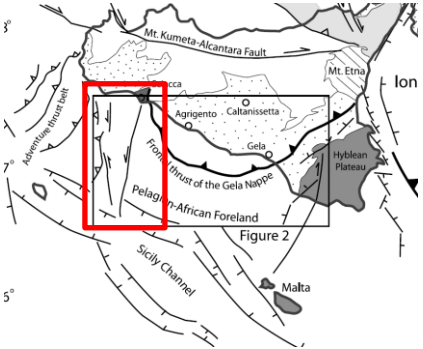
Argnani, 1990



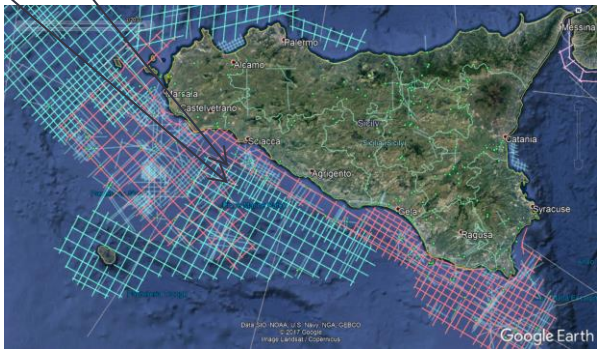
Argnani, 1990



Nigro & Renda, 2002



Ghisetti et al., 2009



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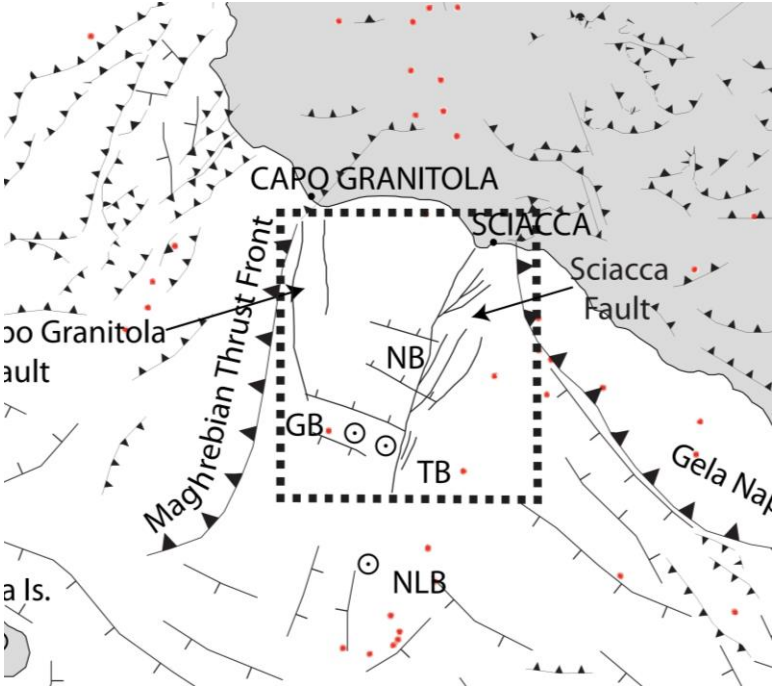
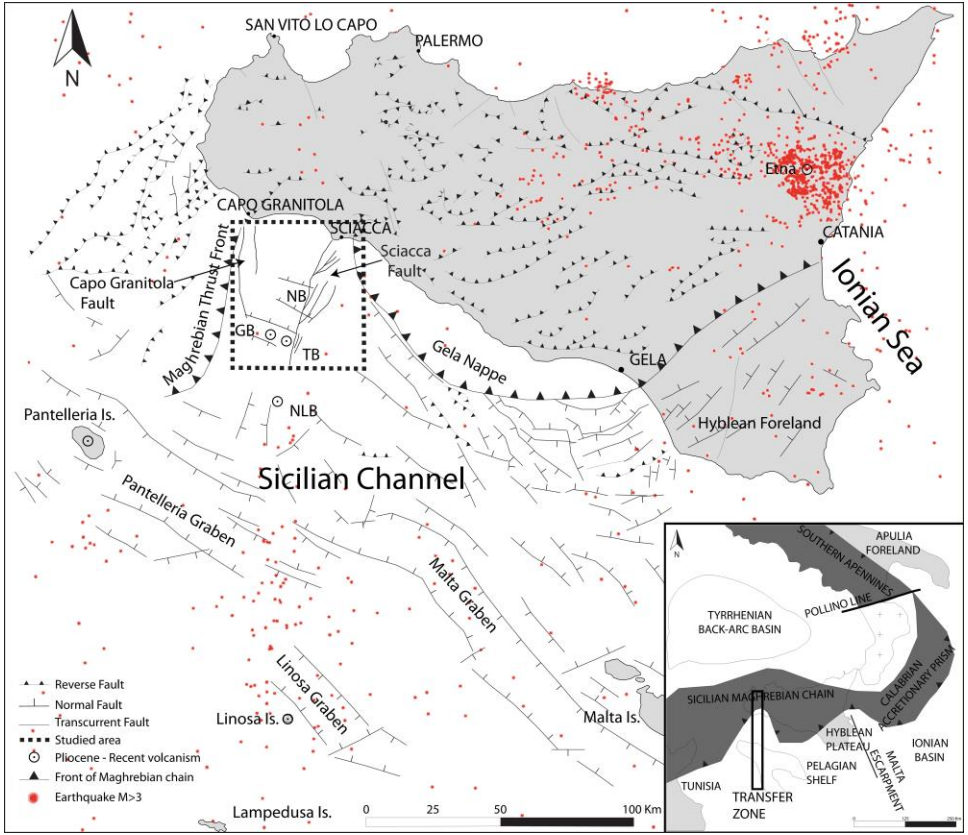
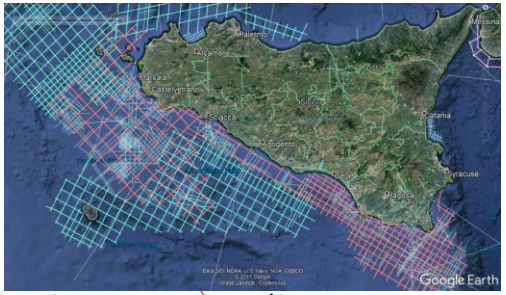


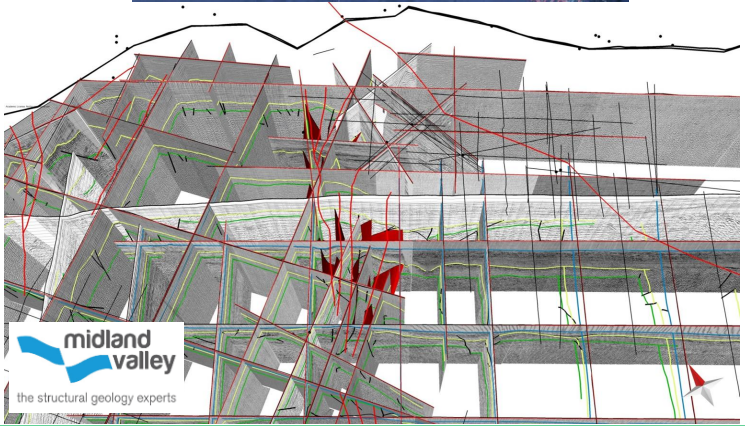


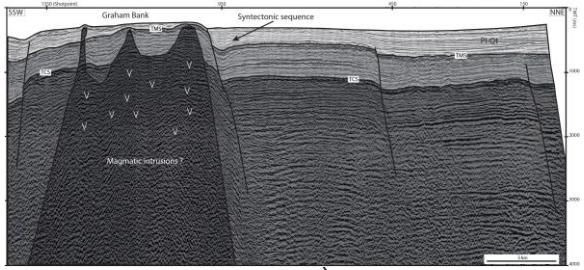
Fedorik et al., in press

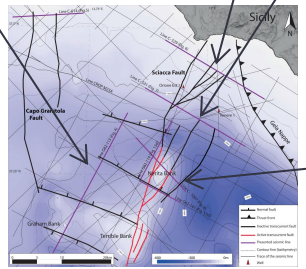
Methodes – Seismic interpretation

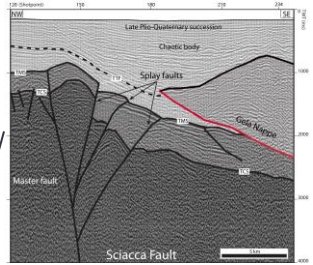
- ViDEPI project - Italian Commercial Zones “G” and “C”
- Convert the raster files to SEG-Y format files and georeferenced
- Uploaded and interpreted using the MOVE® software

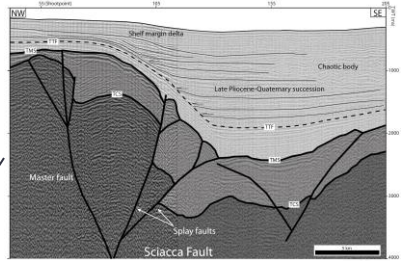


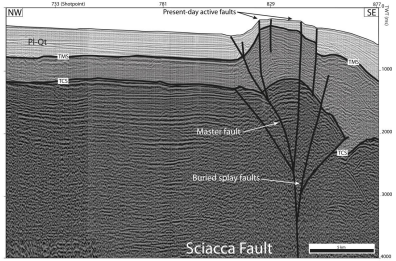












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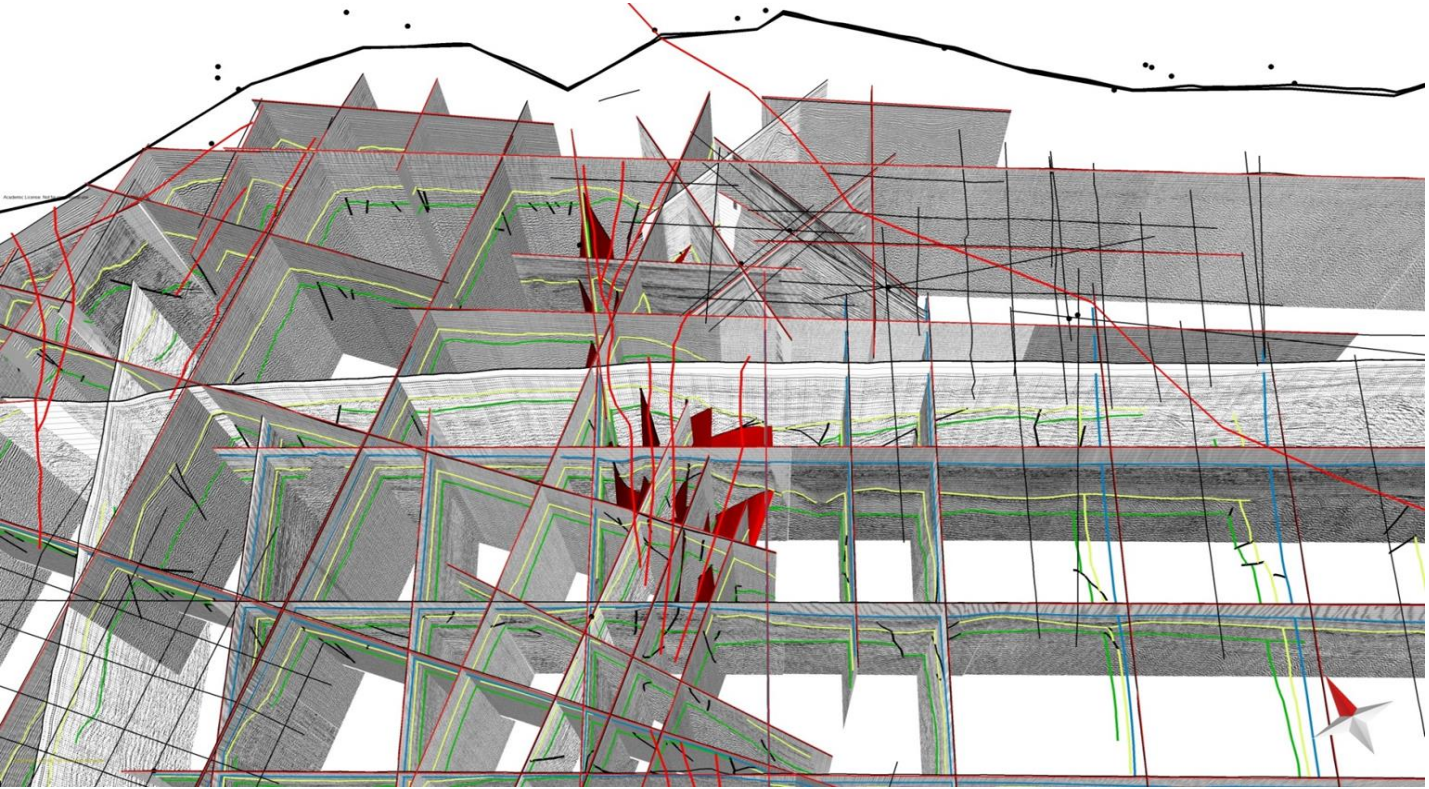
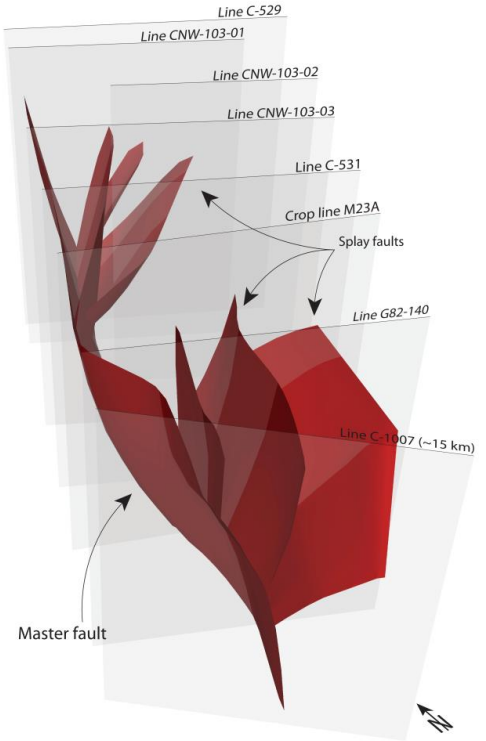
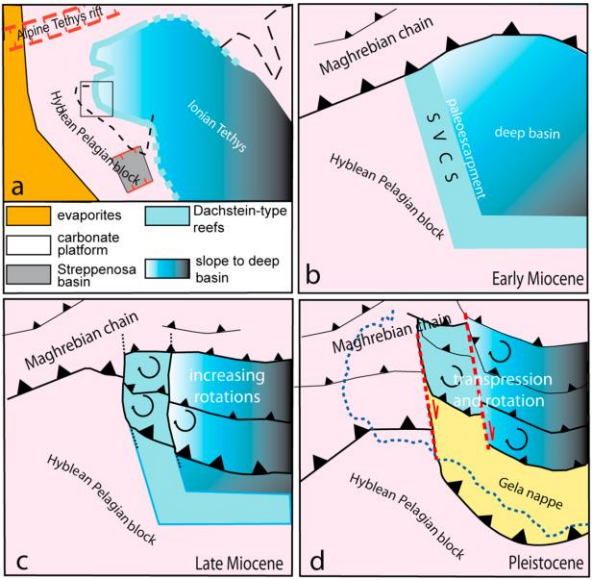


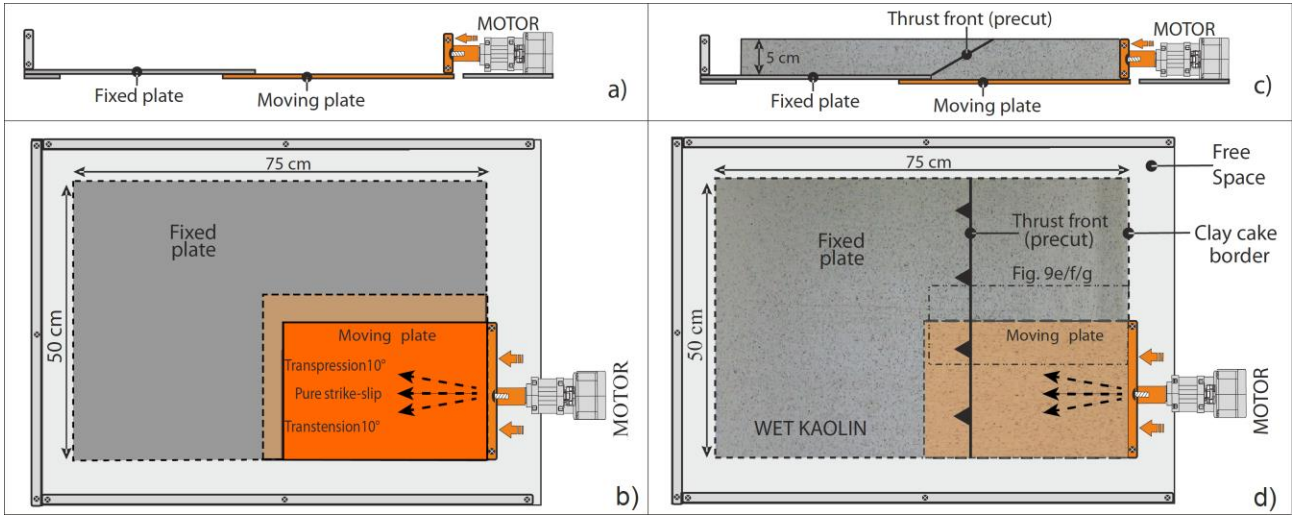


Methodes – Analogue modelling

- Analogue material (kaolin) has been impregnated with 60% of water content by mass, so reaching a density of 1.65 g/cm3. Cohesion: 60-140 Pa (Eisenstadt and Sims, 2005)
- 1 cm corresponds to about 0.1-1.0 km in nature
- Speed of deformation - 0.02 mm/s

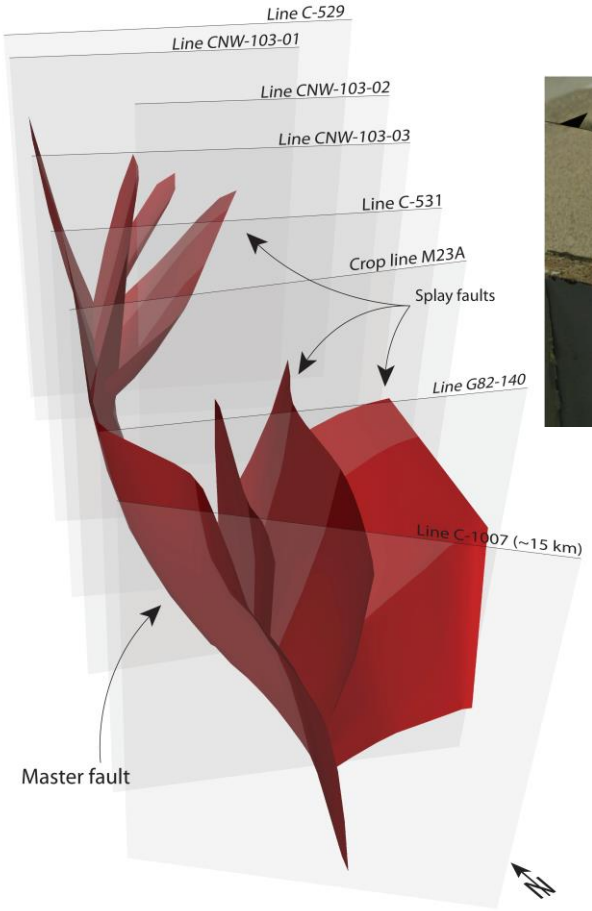


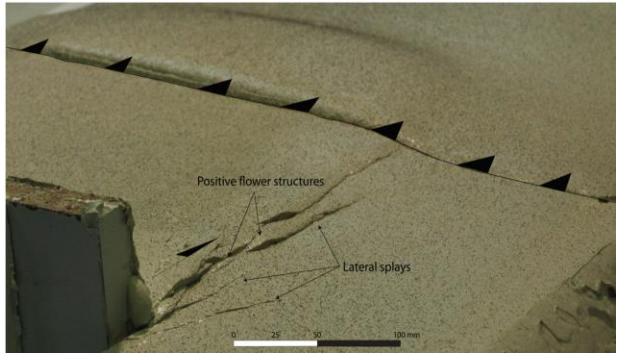
Di Stefano et al., 2015

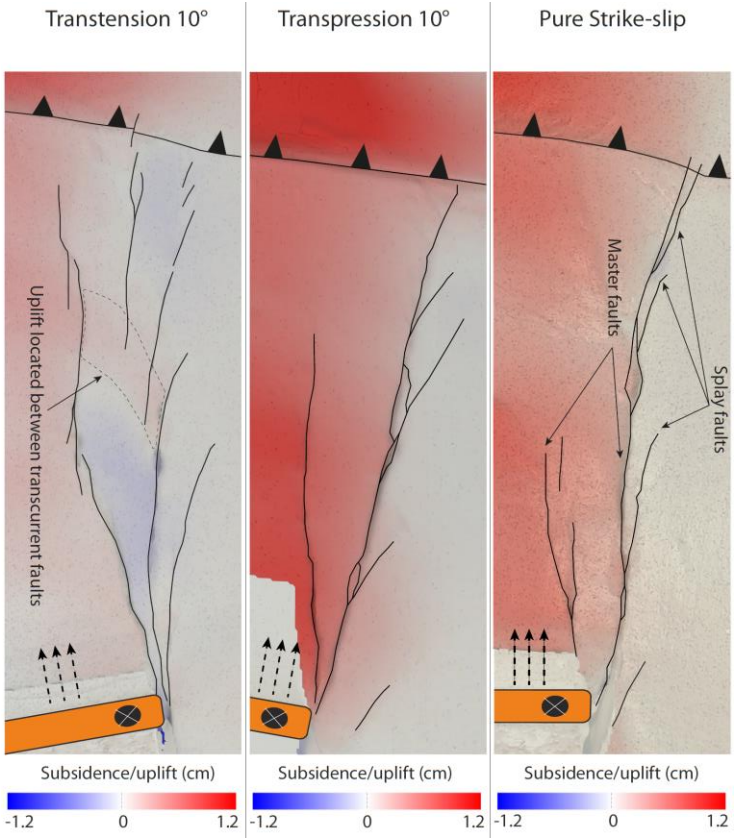


Fedorik et al., in press

Results: 3D vs. analogue modelling



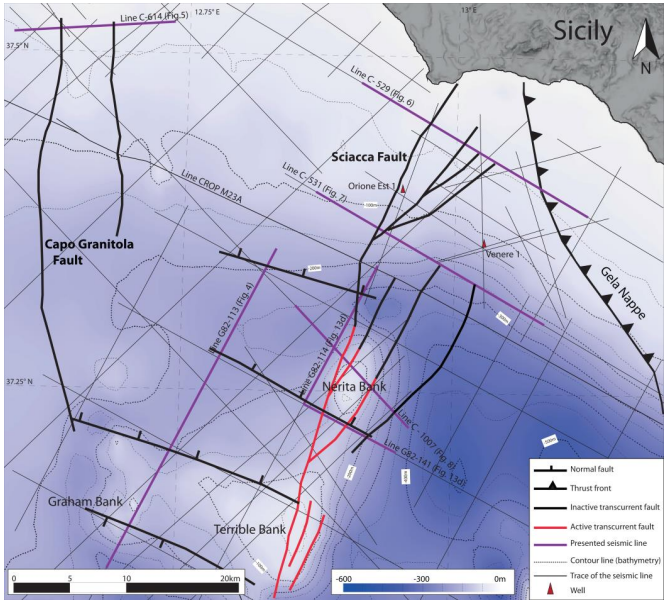


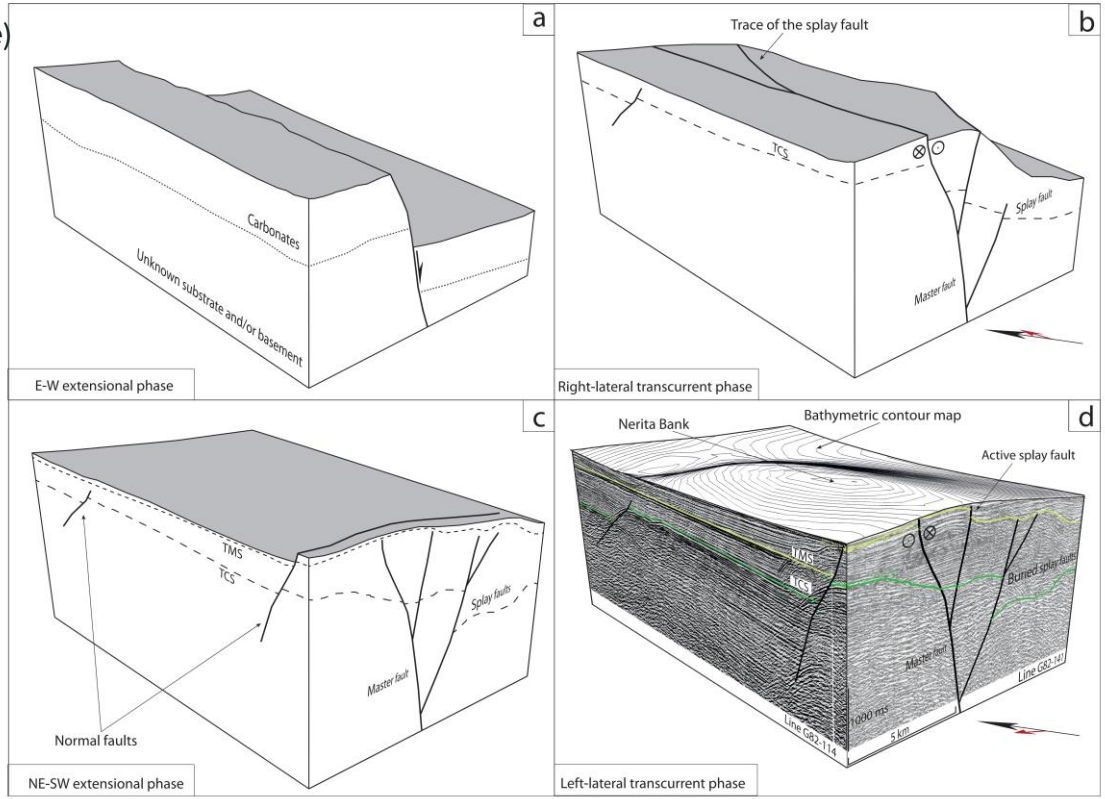


Fedorik et al., in press

Proposed geological model

- Probably active up to Miocene as a high angle normal
- Right-lateral transcurrent fault (Early Pliocene)
- NW-SE-oriented normal faults
- Left-lateral partial reactivation

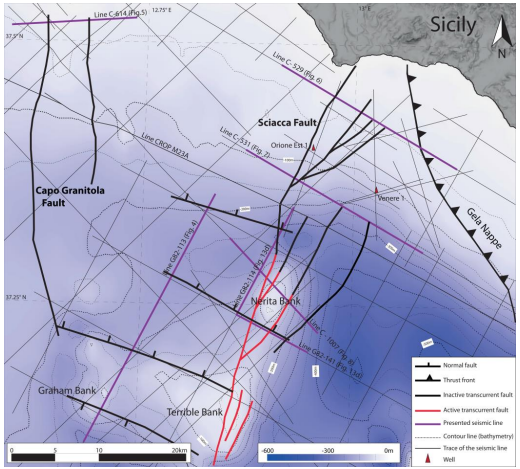


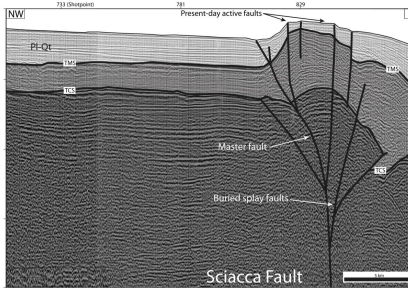


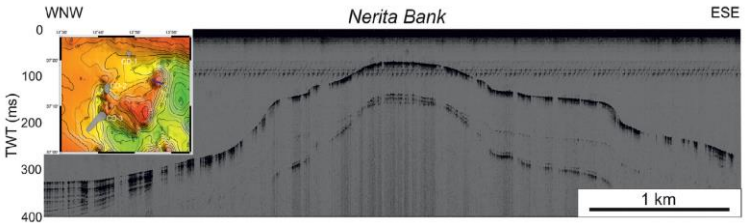
Fedorik et al., in press

Active tectonics

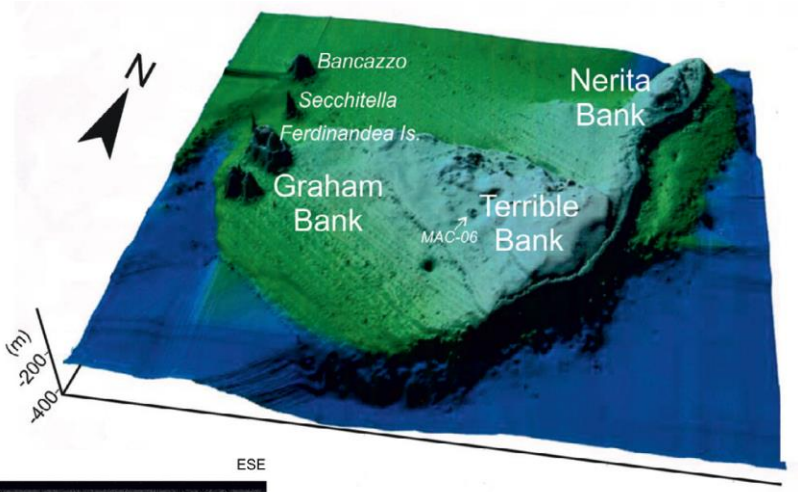
Calò and Parisi (2014) provide evidence, through seismological analysis, of a wide active sub-vertical fault zone (at least 200–250 km long) crossing western Sicily and the Sicilian Channel







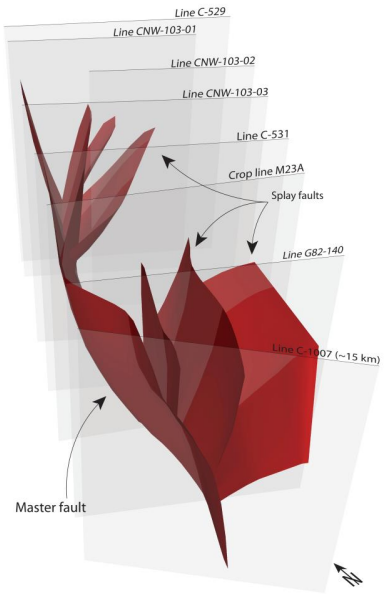
Lodolo et al., 2017



Falzone et al., 2009

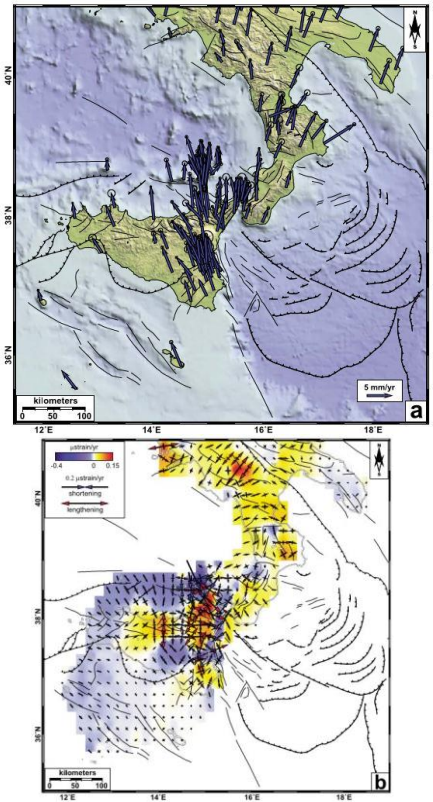
Validation through numerical models

3D fault pattern



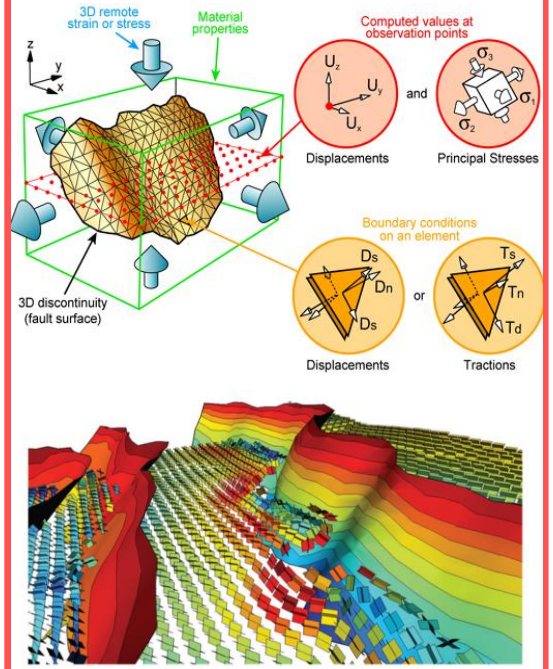
Fedorik et al., in press

boundary conditions



Palano et al., 2012

Software (Poly 3D)

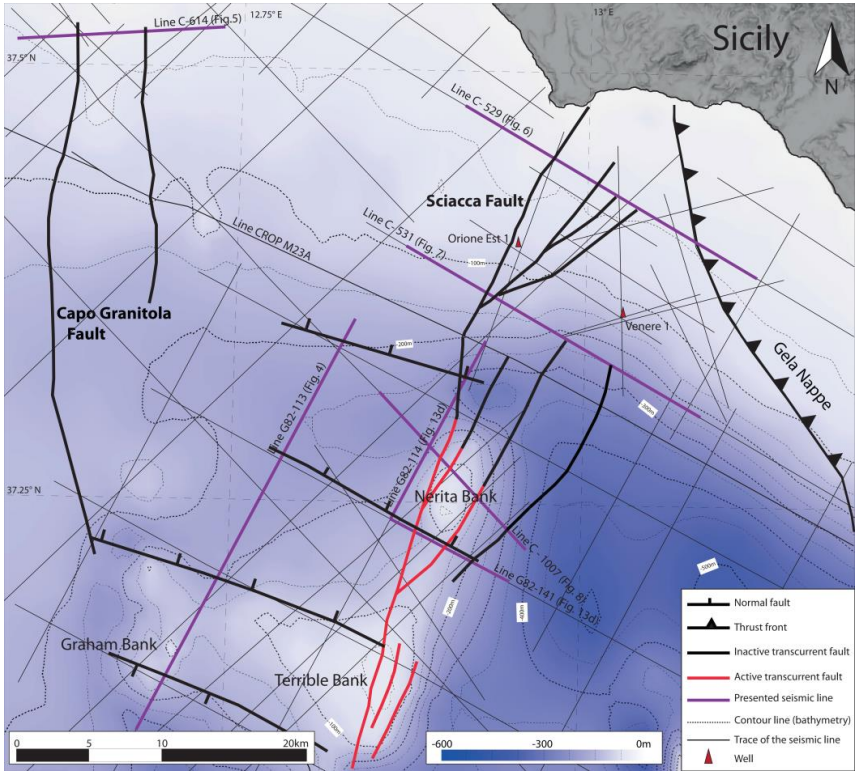


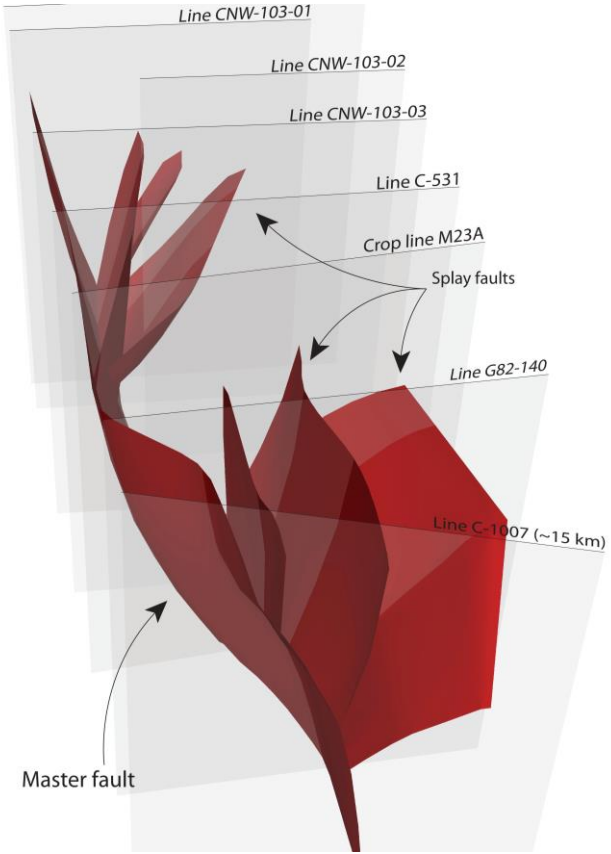
Poly 3D-Courtesy of TOTAL

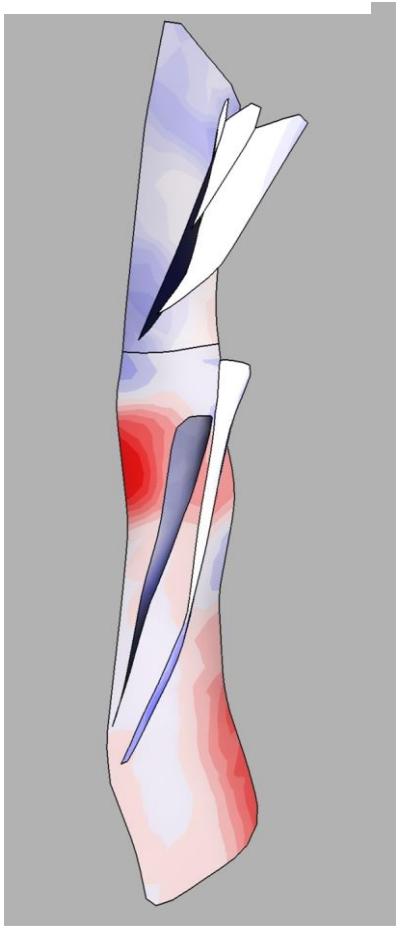
Mentoring

Prof. Michele Cooke

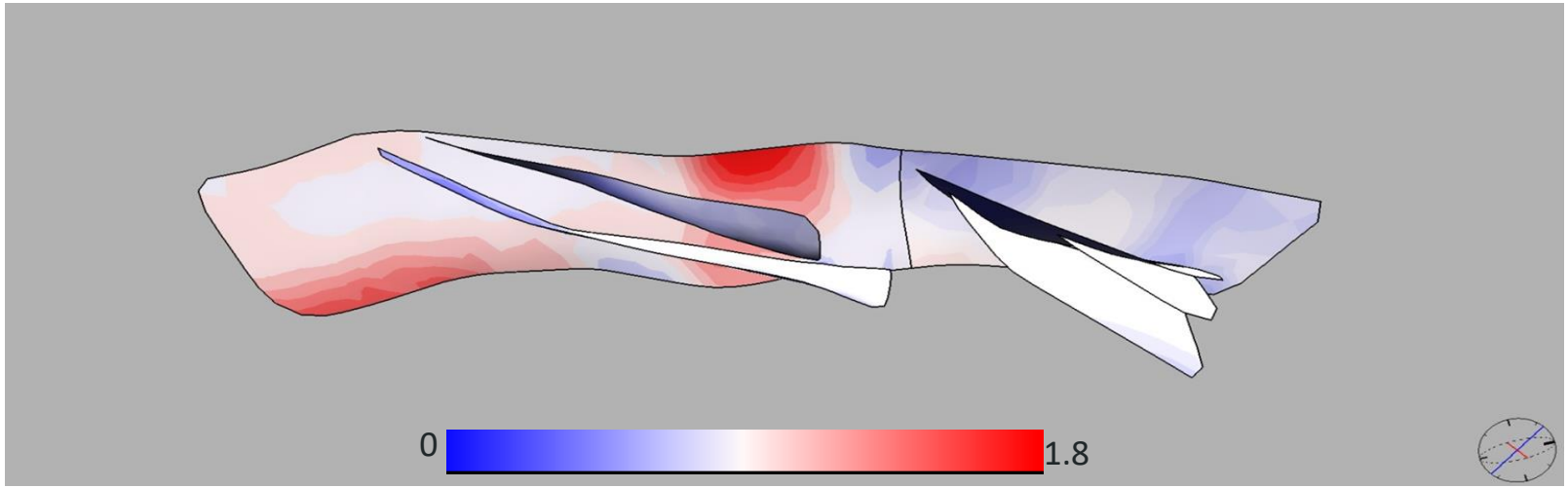
From structural map to 3D model to numerical model







Numerical model: first results



Fedorik et al., in prep

- All faults locked
- Azimuth of εH:N147
- Strain: εH= 0.01865

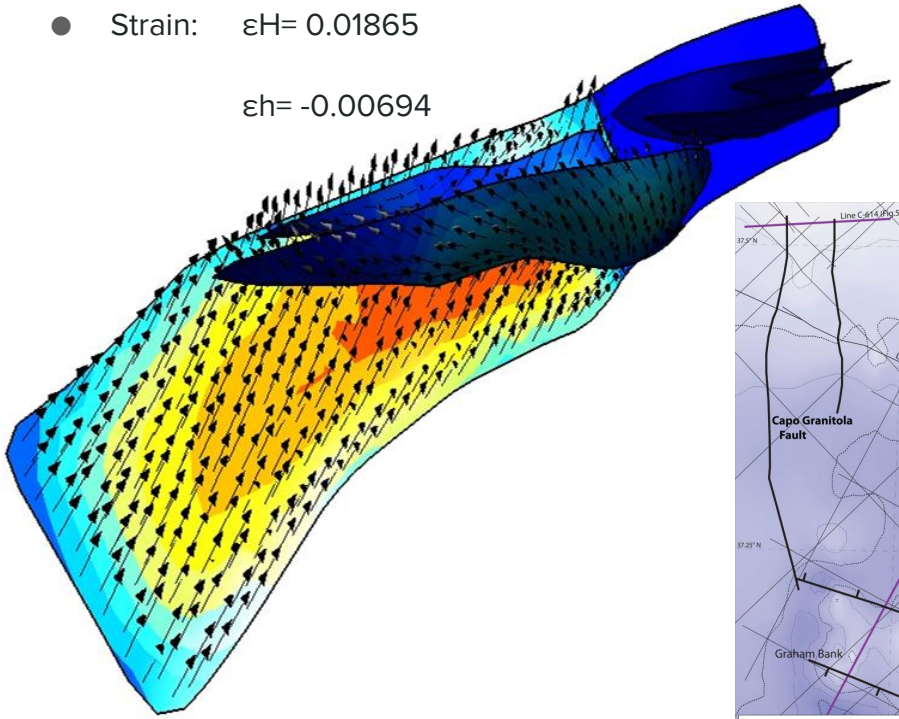
  εh= -0.00694

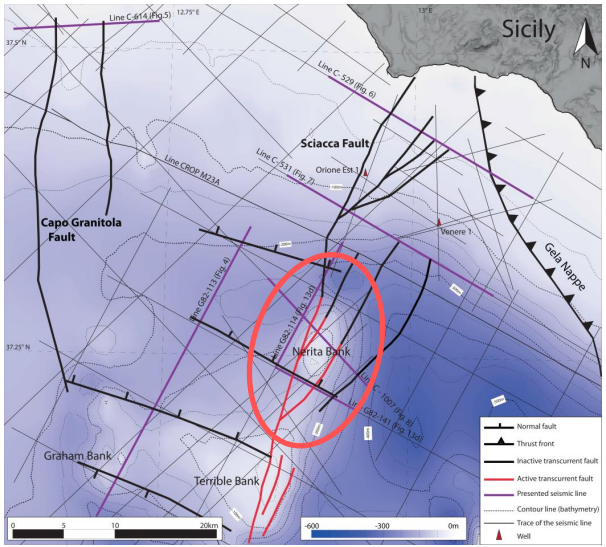
Slip potential = σ_s/σ_n

Uplift pattern

- Northern faults locked
- Azimuth of εH:N147
- Strain: εH= 0.01865

  εh= -0.00694





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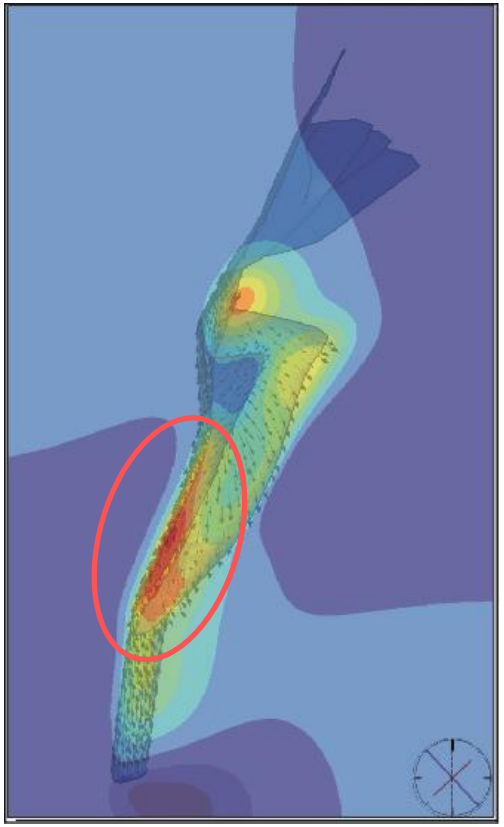
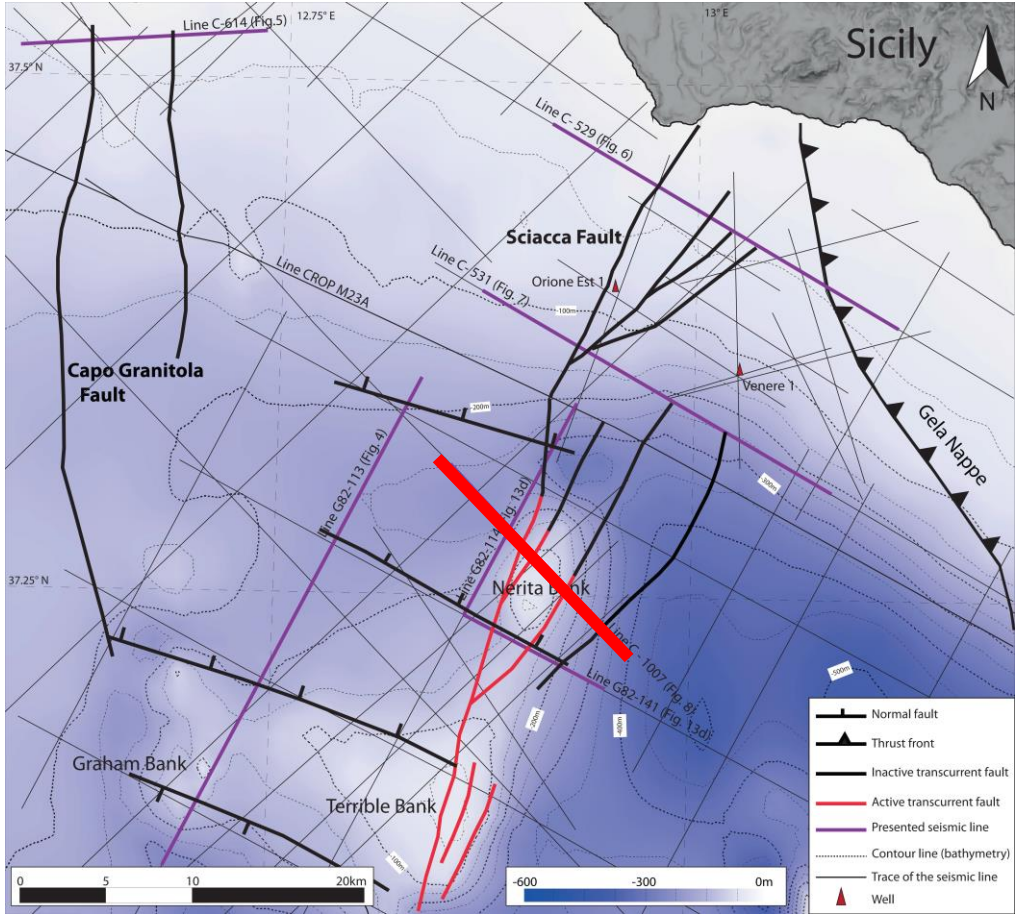
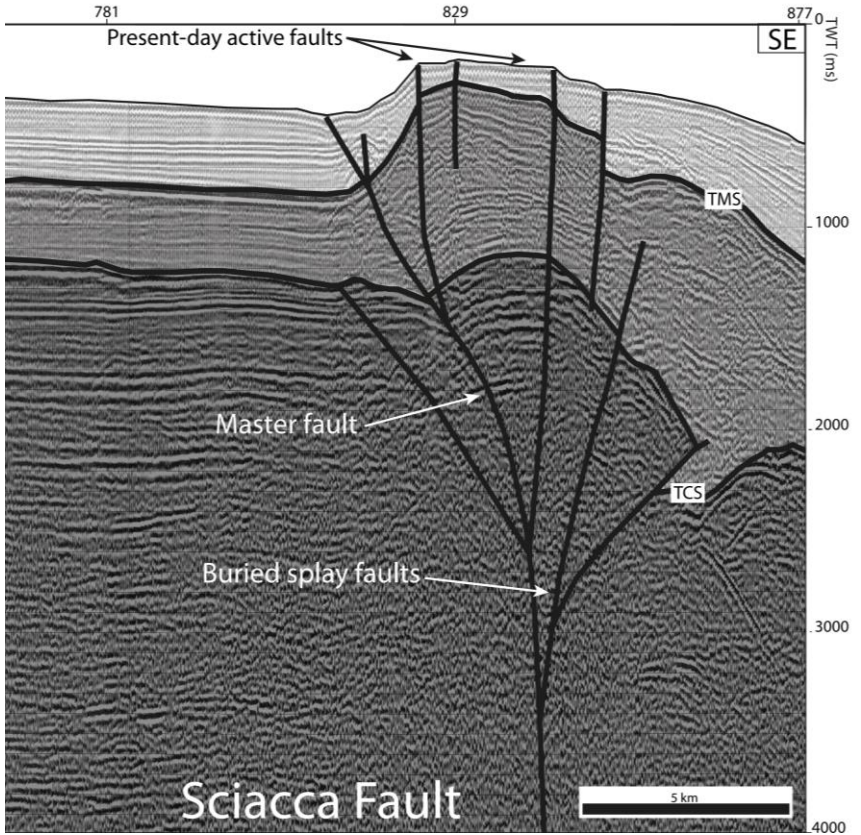
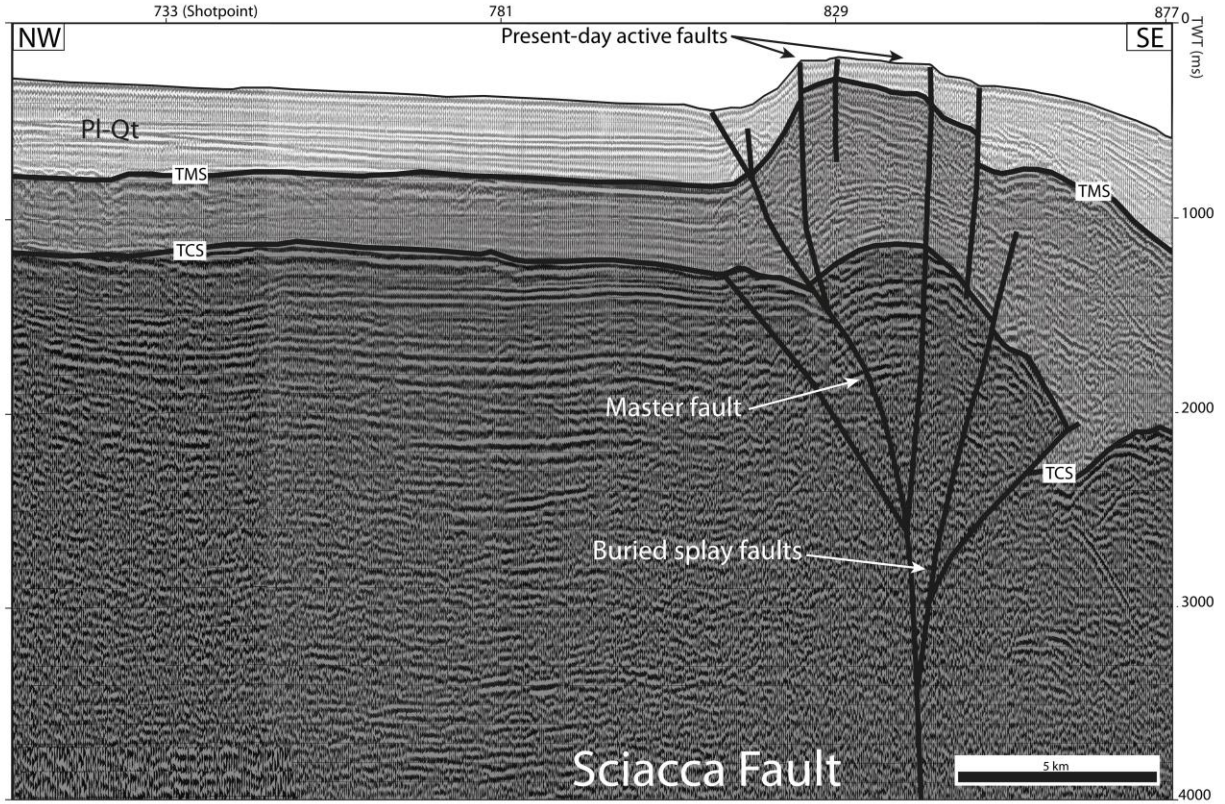


Back to data


Sicily
N
Line C-614 (Fig.5)
12.75° E
13° E
37.5° N
37.25° N
Line C-529 (Fig. 6)
Sciacca Fault
Orione Est 1
Line CROP M23A
Line C-531 (Fig. 7)
Capo Granitola Fault
Venere 1
Gela Nappe
Line G82-113 (Fig. 4)
Nerita Bank
Line G82-141 (Fig. 13d)
Graham Bank
Terrible Bank
Normal fault
Thrust front
Inactive transcurrent fault
Active transcurrent fault
Presented seismic line
Contour line (bathymetry)
Trace of the seismic line
Well
0 5 10 20km
-600 -300 0m


781
829
877
Present-day active faults
SE
TWT (ms)
0
1000
2000
3000
4000
TMS
Master fault
TCS
Buried splay faults
Sciacca Fault
5 km

Back to data


733 (Shotpoint)
781
829
877
NW
SE
Present-day active faults
Pl-Qt
TMS
TCS
TMS
Master fault
TCS
Buried splay faults
Sciacca Fault
5 km
0
1000
2000
3000
4000
TWT (ms)

Conclusions

- Available seismic data have been interpreted to build up a new structural map of the Sciacca fault system
- A digital 3D model has been carried out
- Analogue models helped us to constrain the past kinematics and tectonic evolution of the Sciacca fault system
- Seismological+GPS data were used to constrain the present day kinematics of the Sciacca fault system
- Numerical models were used to test the effects of the Sciacca fault system activity and validate our interpretation
- We suggest that the Sciacca fault system was deformed as right-lateral fault during the Late Miocene –Early Pliocene
- Nowadays the southern part of the Sciacca fault system shows clear evidences of activity (with left-lateral kinematics)
- Numerical models show similar uplift pattern as seen along the Nerita and Eastern side of the Terrible banks
- New and more refined data (chirp) can be of help to detect tectonic activity also along the northern sectors of the Sciacca fault system.

Thank you