Presented at the COMSOL Conference 2009 Milan

ELASTOPLASTIC MODELS OF THE INTERACTION BETWEEN ACTIVE FRONTS OF THE SOUTHERN ALPS AND DINARIDES (NE Italy and NW Slovenia).

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Talk outline

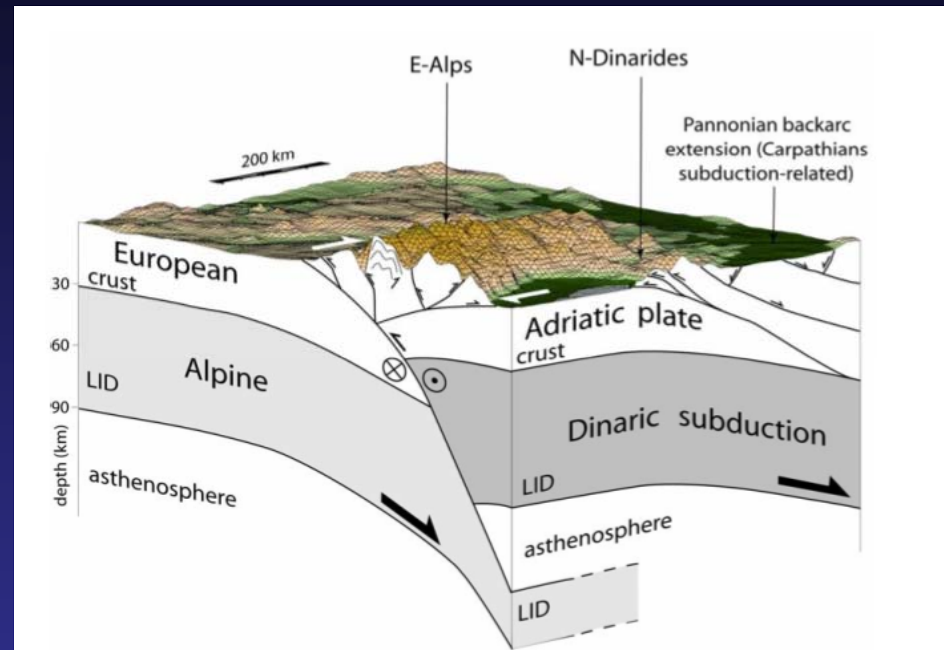
- Stress triggering and earthquakes in the NE Alps
- Building up the model
  - GPS measurements
  - 3D geometry and topography with Mesh ALE
- Comparison with field data
- Results and conclusions

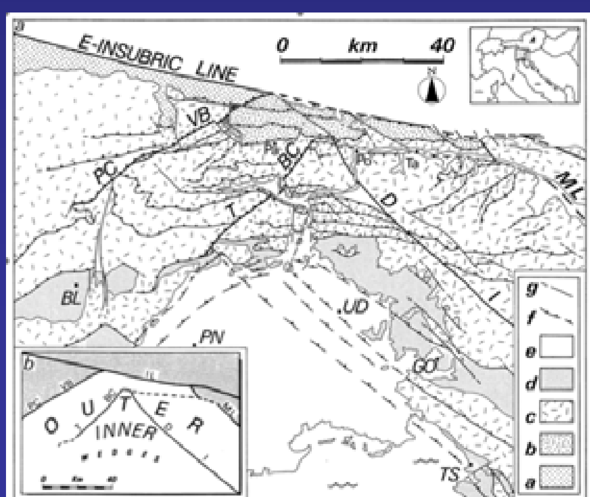
Geodynamic setting

- anticlockwise rotation of the Adriatic microplate with respect to Eurasia

- four indipendent Neogene subductions

- most of the effects related to Southern Alps and Dinarides





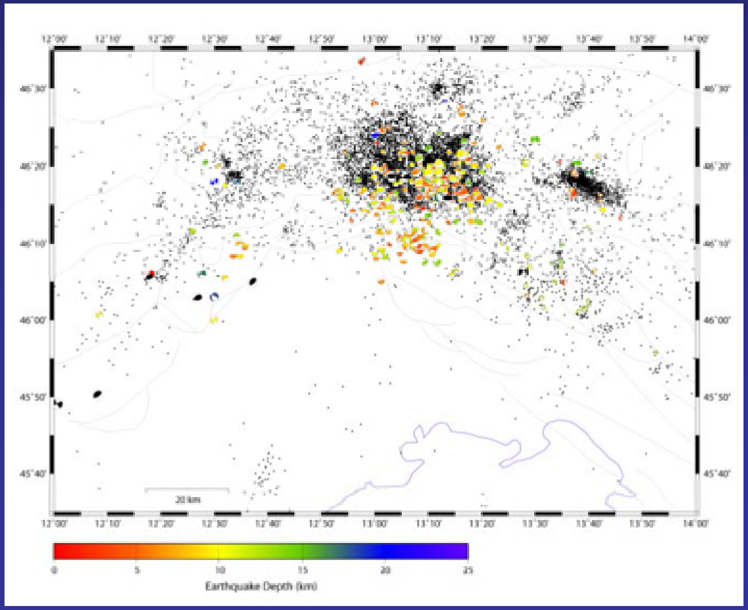
- deformation pattern driven by the tectonic model of 'cone-in-cone' indented wedges, inherited from the reactivation of early syn-sedimentary fault system.

Seismicity

The Eastern Southern Alps are one of the most seismically active regions in Europe.

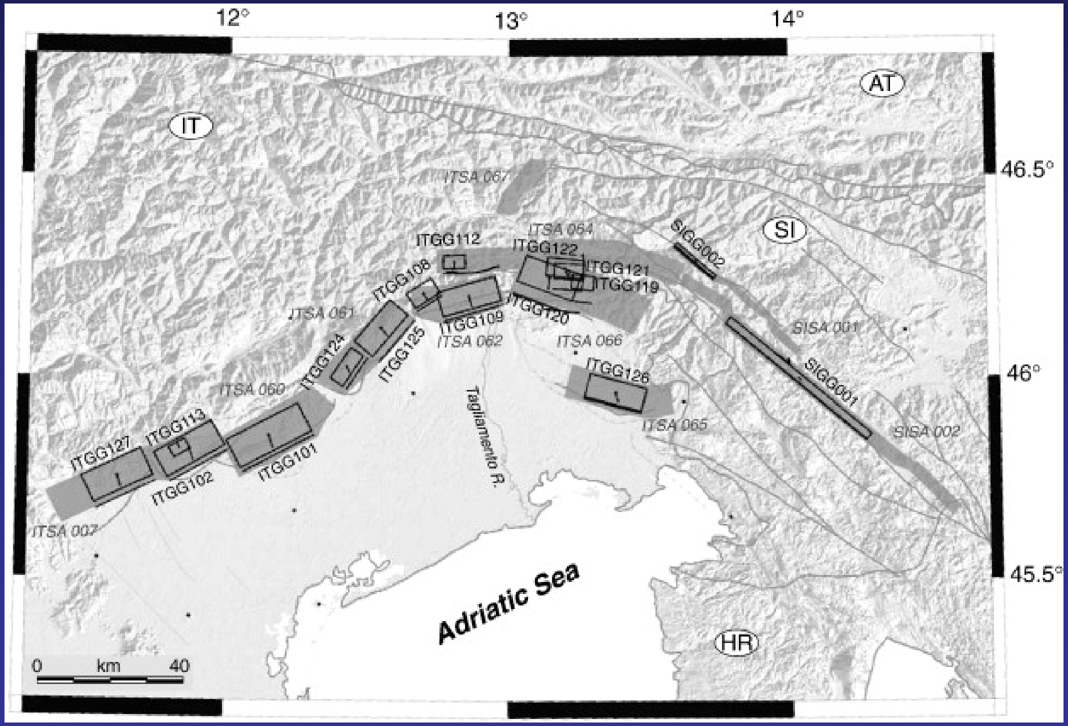
In the last 1000 years the Eastern Southern Alps were affected by at least 8 earthquakes with magnitudes between 6 and 7.

Date	Me
25/01/1348	6.98
26/03/1511	6.88
25/02/1695	6.67
29/06/1873	6.34
06/05/1976	6.34
15/09/1976	6.22

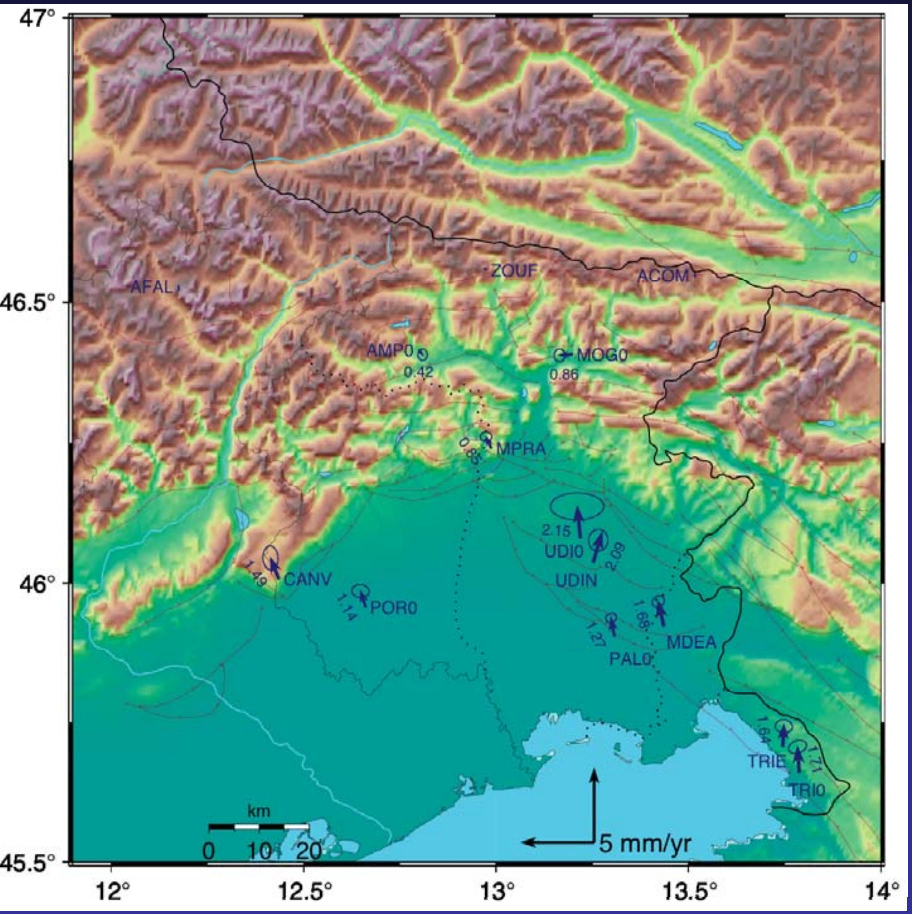


Seismogenic sources

Seismogenic sources located along the active fronts of Southern Alps and Dinarides



Deformation velocities from CGPS measurements



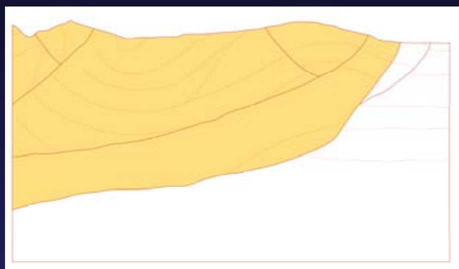
- two regional networks FreDNet and FVG

- procedure by McClusky et al. (2002) with the *software GAMIT /GLOBK*

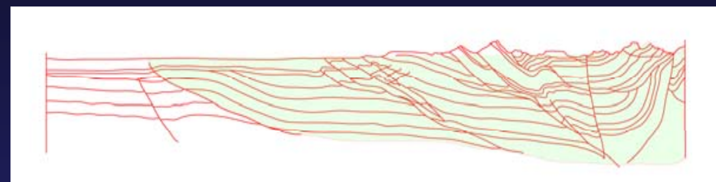
- solution stabilized for Southern Alps stations

- horizontal shortening 1.7± 0.4 mm/yr in NNW direction and collision angle of 330°

Building the 3D geometry...



Merlini *et al., 2002*

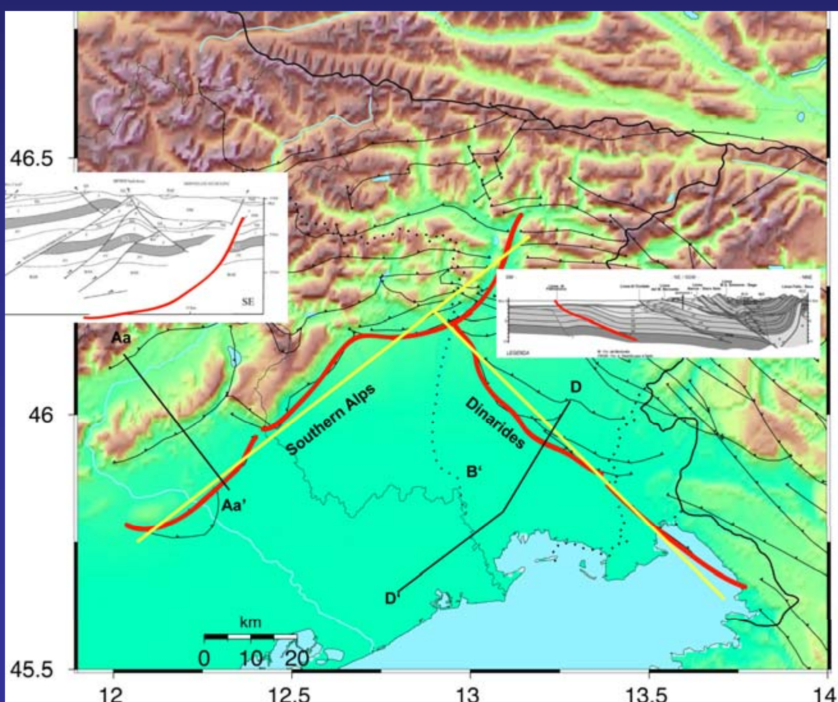


Galadini *et al., 2005*

- Using CAD import module, we import the crustal structure from a .dxf file

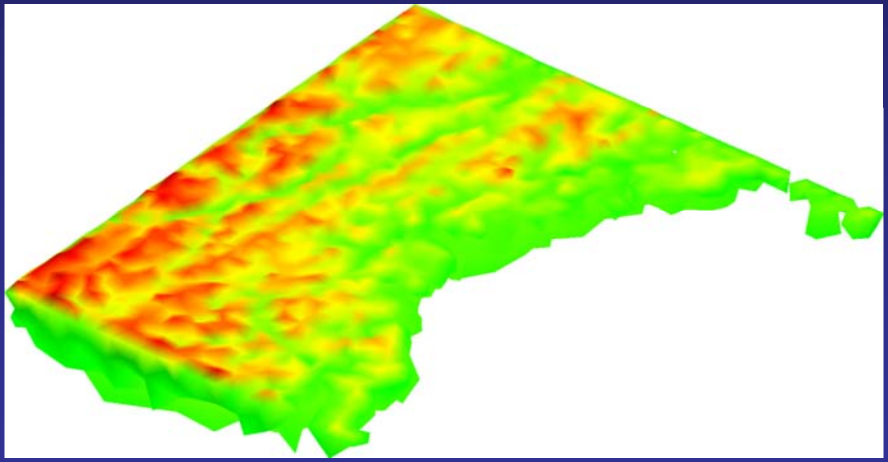
- we extrude geometry in the third dimension

- the final model is 150 km long, 160 km wide and 40 km deep.

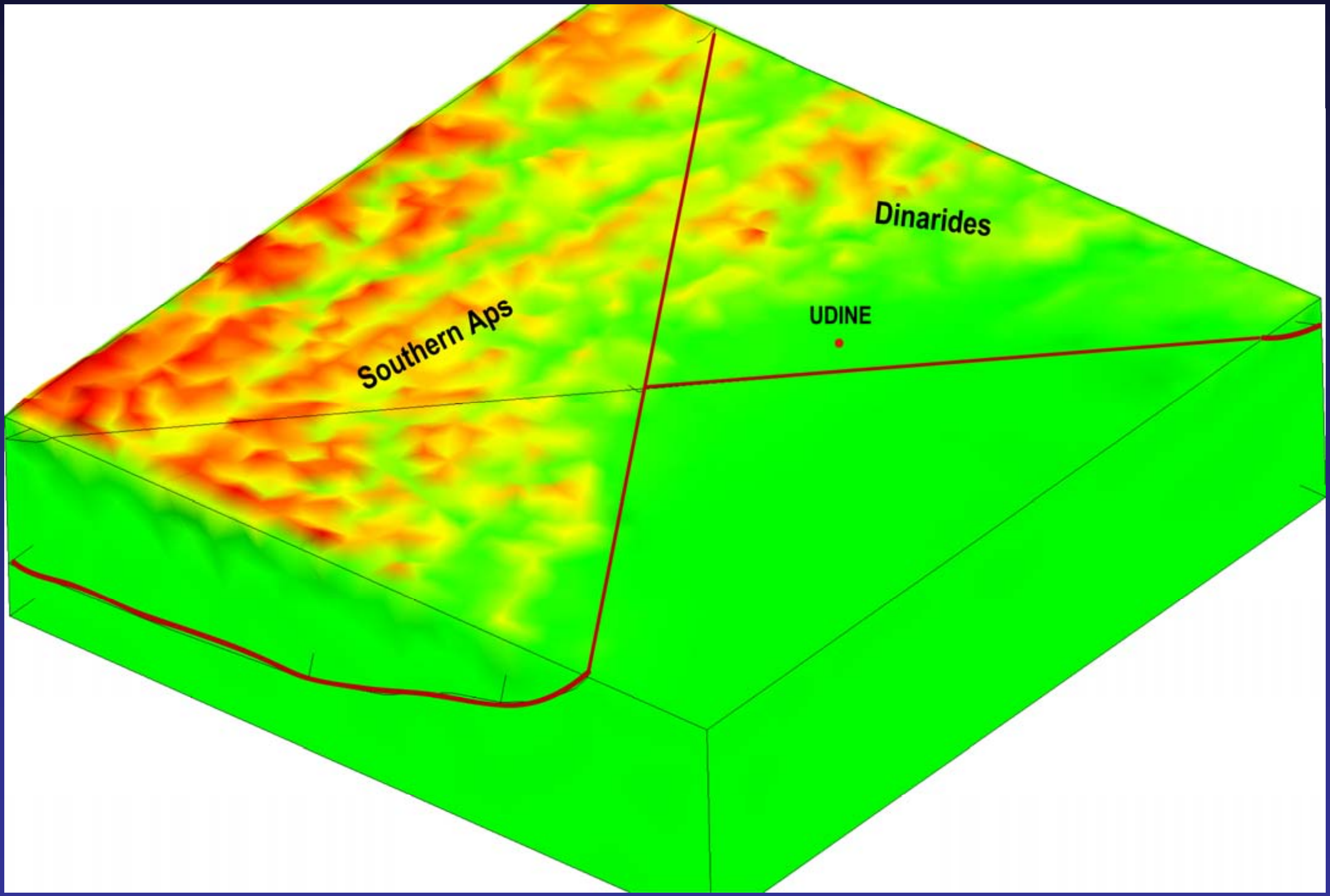


importing topography...

Moving Mesh ALE module → elevation data from ETOPO2



...the final model



Setup of the model

Density $\rho = 0.541 + 0.3601 V_P$ (Christensen and Mooney, 1995)

Young's modulus $E = 2.5\mu$

Poisson's ratio $u = \frac{(V_P / V_S)^2 - 2}{(V_P / V_S)^2 - 1}$

(Brocher, 2005)

Friction $\mu = 0.6$

- Material properties are inferred from a seismic reflection profile
- We use an elasto-plastic reology

Boundary conditions

Topography: free

Southern side: prescribed displacement

Others sides: roller

Bottom: Winkler foundation

Winkler foundations simulation:

$$F_z = -K \cdot v$$

$$K = \frac{(E \cdot A)}{L}$$

A= base area, L=Thickness, E=Young's modulus

Assembly the model

Application of gravity:

$$F_z = -9.81 \cdot \rho$$

Springs between subdomains:

$$Fx = -K \cdot u$$

$$Fy = -K \cdot v$$

$$Fy = -grav \cdot \rho + \left(-K \cdot v\right)$$

Step by step assembly:

We first apply an elastic rheology, then an elatoplastic, scaling manually the variables u v w and, by a values of 1E10, the contact pressure in the Advanced Solver Parameters.

Then we apply the friction, scaling the friction pressure by a values of 1E10

Finally we gradually decrease the stifness of springs.

Applying the displacement

We apply the displacement due to tectonic deformation measured by CGPS data

To obtain a significant displacement, we consider a time span of 1000 years.

Comparison with field data

We compare our model with other experimental stress measurements:

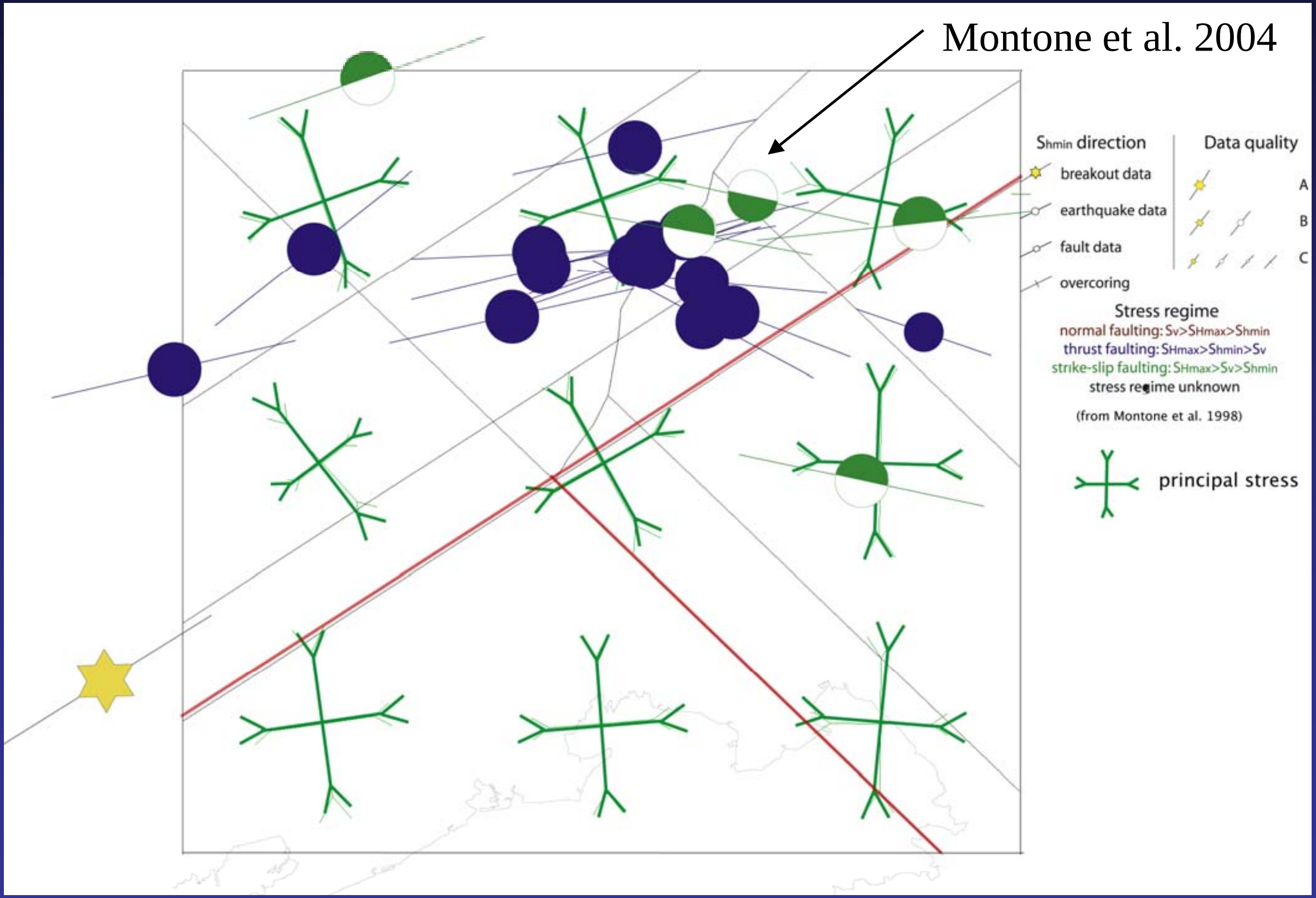
- seismic distribution

- CGPS velocities

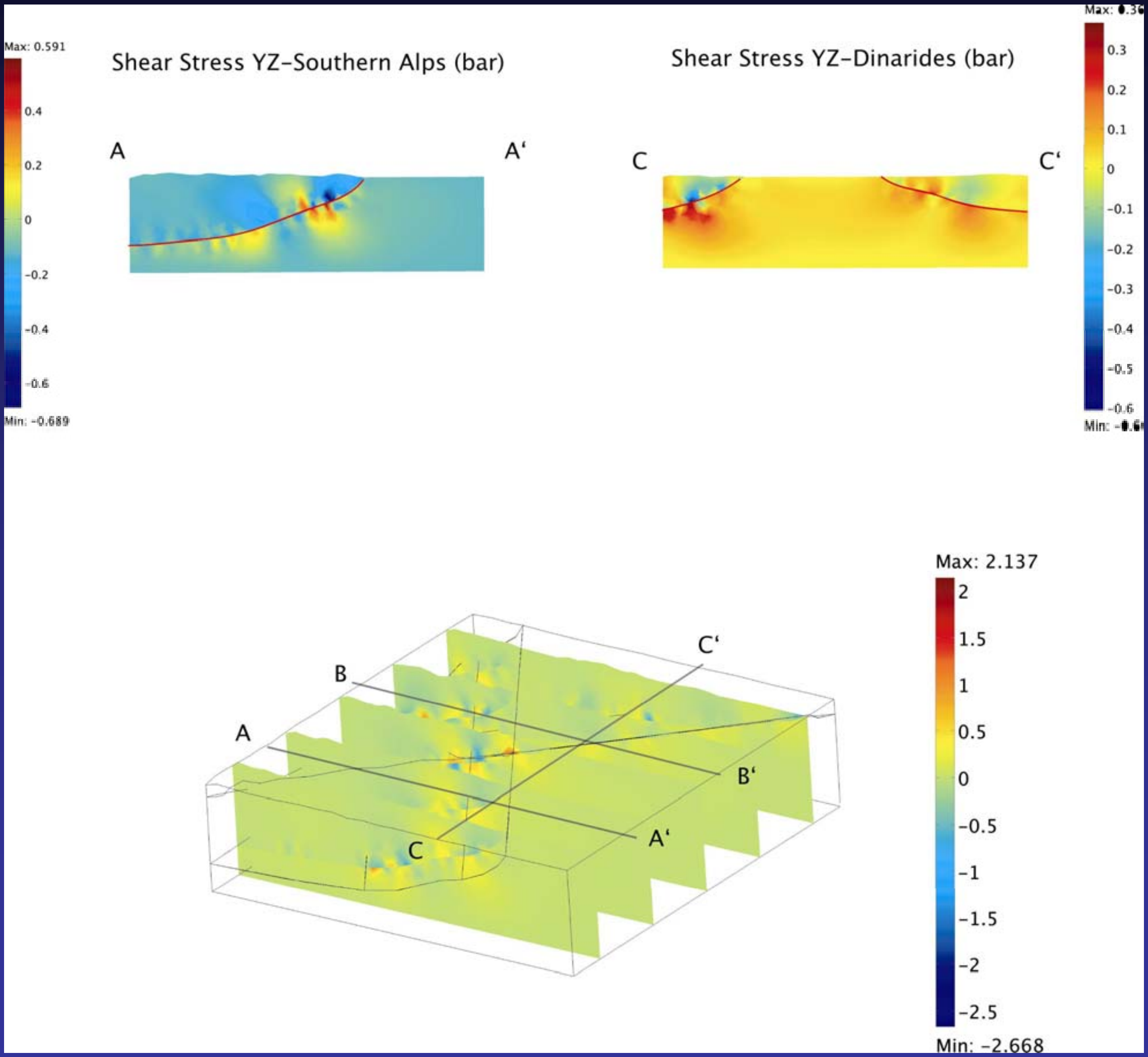
- rotation of active stress field from Montone et al. 2004

- stress distribution from other experimental measurements (i.e. Bressan et al., 2008)

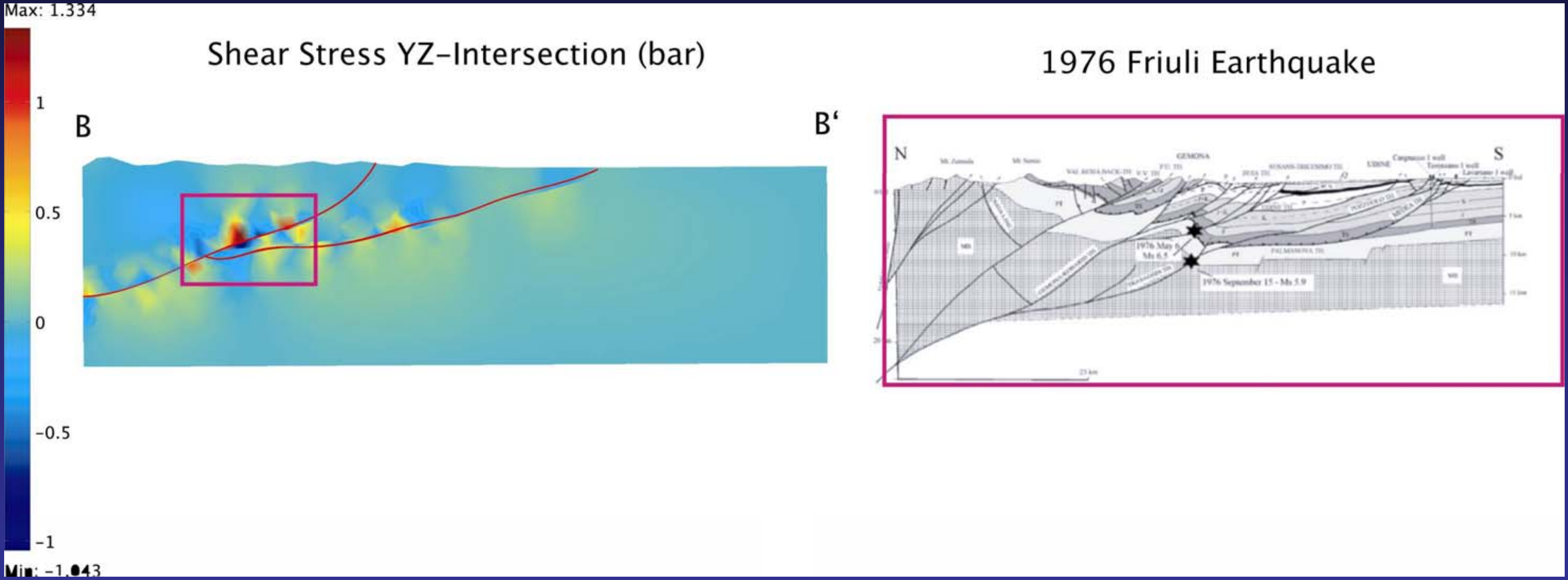
Comparison with field data



Shear stress distribution



Shear stress distribution



Conclusions

- highest values of shear stress in the intersection of Southern Alps and Dinarides

- accumulation of about 1 bar in 100 years in the area close to seismogenic area of 1976 earthquakes

- According to Perniola *et al.*(2004), the stress drop due to the 1976 earthquakes was in order to 1 bar. This suggests that it is enough energy to trigger an earthquake every 100 years.

- the predicted pattern of deformation mainly results in a rotation of active stress field orientation with mechanisms from compressional to strike-slip

- Our model suggests that the tectonic model of oblique shaped indented wedges can explain the complex pattern deformation of the area