Hints of active deformation in the southern Adriatic foreland: Holocene tectonics along the Apulia offshore (Italy)

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Special session: Seismotectonics and seismic hazard of the Adria region
What are we going to talk about?

The issue: active tectonics W of the Gargano Promontory (?)

Geological and geophysical framework

The VHR seismic reflection data

Some results and ...

... some concluding remarks
The issue: Is the Gondola Line active?

- The 2002 Molise seismic sources are located along the western part of a regional fault system, the Molise-Gondola shear zone (MGsz; Di Bucci et al., Tectonics, in press)

- On land, this system is mainly represented by the Mattinata Fault, with a polyphase activity since the Mesozoic. Present-day activity with right-lateral motion is confirmed by recent seismicity (1975, 1995 and 2006 earthquakes), GPS data, geomorphological and paleoseismological data

- Off-shore, the Mattinata Fault is aligned with the regional, E-W to NW-SE oriented Gondola Line. Its multi-history deformation pattern closely resembles the long-term complex evolution of the Mattinata Fault, except for the lack of significant seismicity
Main historical and instrumental seismicity
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(from: Di Bucci et al., Tectonics, in press)
Main geological features of southern Italy

Analogue experiment of the right-lateral reactivation of the Mattinata-Gondola sz

(from: Di Bucci et al., Tectonics, in press)
Regional shear zones offshore Apulia

(from: Morelli, Mem. SGI, 2002)
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Our dataset – on map

ADRIATIC SEA
Our dataset – characteristics

- A network of high-resolution seismic profiles (2-7 kHz Chirp-Sonar, 3.5 kHz Sub-bottom, 500 joule Uniboom, 1 kjoule Sparker) and core data

- Chirp-Sonar seismic lines, with very high vertical resolution (ca. 50 cm) and vertical exaggeration up to 100 times

- Sedimentological and chrono-stratigraphic constraints provided by sediment cores and borehole (PRAD 1-2)

- This dataset allows to investigate the upper 80-100 m of the Quaternary succession, i.e. the middle-late Pleistocene and Holocene interval
**Depositional sequences**

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Oxygen Isotope Stage</th>
<th>Age (ka)</th>
<th>Erosional Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequence 1</td>
<td>OIS 2-6</td>
<td>20/30 – 130/140</td>
<td>ES1</td>
</tr>
<tr>
<td>Sequence 2</td>
<td>OIS 6-8</td>
<td>130/140 – 230/250</td>
<td>ES2</td>
</tr>
<tr>
<td>Sequence 3</td>
<td>OIS 8-10</td>
<td>230/250 – 330/350</td>
<td>ES3</td>
</tr>
<tr>
<td>Sequence 4</td>
<td>OIS 10-12</td>
<td>330/350 – 430/450</td>
<td>ES4, ES5</td>
</tr>
</tbody>
</table>
Structural map – summary

-48 m

-150 m

main fold axis

faulting only on the northern limb

trackline
Seabed contours:
- dotted: each 5m
- green: fault
- red: fold top
- dotted red: fold inflexion line
- black, dashes: fault (uncertain)
- yellow: fault (inactive)

N

5 km
Close-up on structural map – 1

folding gives room to faulting

2 km
Close-up on structural map – 2

faulting not affecting Holocene deposits

faulting rupturing the seabed

1 km

Legend:
- Fault
- Fold top
- Fold inflexion line
- Fault (uncertain)
- Fault (inactive)
Close-up on structural map – 3

- Faulting not affecting Holocene deposits
- Faulting rupturing the seabed
- Folding gives room to faulting

Legend:
- Thick red line: Fault
- Green line: Fold top
- Dashed green line: Fold inflexion line
- Dashed red line: Fault (uncertain)
- Yellow line: Fault (inactive)

Scale: 2 km
An example of our VHR Chirp data
An example of our VHR Chirp data

This is a fault!

This is not a fault!

It’s not that easy, though ...
YD207

pre-tectonic strata

AMC155

Gondola fault

(mod., from: Ridente and Trincardi, Bas. Res., 2006)
Enlightening data, indeed but ... 

... how do they fit in the known picture?

(from: Gambini & Tozzi, 1995)
Gondola fault

MC Profile D452

Base PQ

1 sec TWT

A  B

10 km

3.2 km

NE  SW
What can be observed – I?

- Two main asymmetric similar folds, with E-W-oriented parallel crest lines. The northern limbs, i.e. those slightly more inclined, are also affected by faults.

- The northern anticline is more developed, and the deformation affecting its northern limb consists of a set of left-stepping, alternating faults and small anticlines.

- Faults exhibit very steep dip and a normal component of motion that causes their northern side to be downthrown to about ten metres.

- Mean vertical slip rate for the late Pleistocene and Holocene is ca. 0.05 mm/a. The comparison of the length of these faults with their limited vertical displacement suggests the possible occurrence of a significant horizontal component of motion.
What can be observed – II?

- Deformation pattern affects the middle and late Pleistocene deposits. In some places faults also displace Holocene deposits and the seabed.

- The two main fold show comparable shape, wavelength, amplitude, faulted northern limb, and this leads to interpret them jointly as evidence of one deformation system.

- Being the Gondola Line located below the analysed structures, we interpret the deformation pattern as due to the reactivation of this major inherited lineament caused by a compressional component of the stress field.
So, we are looking at an active fault... close to a well known seismogenic source

- Seismicity related to E-W dextral strike-slip tectonics along the Mattinata Fault, and very recent (< 5.5 ka) deformation features along the Gondola Line, suggest that the MGsz as a whole is being actively deformed, variably along-strike

- Gondola Line shows close affinities with the other parts of the MGsz on-shore. It is an E-W oriented inherited structure, reactivated during the late Pleistocene and Holocene. A strike-slip component of motion can be associated to this structure.

- The Gondola activity can be due to a stress field that, like in the case of the Mattinata fault and 2002 Molise earthquakes sources, is compatible with the NW-SE-oriented Africa-Europe convergence. Considering the seismogenic nature of the other parts of the MGsz, one can hypothesize the same behaviour also for the Gondola Line.
Thank you

Just A Quick Note To Say THANKS!

http://www.earth-prints.org