Agreement INGV-DPC 2007-2009

Project S1: Analysis of the seismic potential in Italy for the evaluation of the seismic hazard

Responsibles: Salvatore Barba, Istituto Nazionale di Geofisica e Vulcanologia, and Carlo Doglioni, Università di Roma "La Sapienza"

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Deliverable # 3.01.5
Results of tectonic validation
for the seismogenic source model (DISS)

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prepared by:
UR3.01, Resp. Roberto Basili, INGV, , Sezione di Sismologia e Tettonofisica
UR3.01, Salvatore Barba, Gianluca Valensise, INGV, Sezione di Sismologia e Tettonofisica

1. Description of the Deliverable

This deliverable materializes the results obtained in the Activity A3 that aims at a quantitative tectonic validation of the seismic source model contained in the DISS, version 3.1.0 (Basili et., 2008; DISS Working Group, 2009). The validation consists of three tests: 1) geometric; 2) kinematic; and 3) dynamic.

1) Geometric compatibility. This test compares the geometrical distribution of seismicity with the geometry of faults by quantifying seismicity as a function of distance from faults. For historical seismicity we used the CPTI04 earthquake catalog (Gruppo di lavoro CPTI, 2004) by selecting events from year 1000 to 1980 with $M \geq 5.5$, number of intensity points $Np \geq 5$ and events after year 1980 with $M \geq 5.5$. For instrumental seismicity we used the INGV Bulletin 1983-2007 with $M \geq 4.0$. Taking the 90% of seismicity as a reference value, our results show that the maximum distance from faults is 13-16 km in terms of number of earthquakes and 9 km in terms of seismic moment.

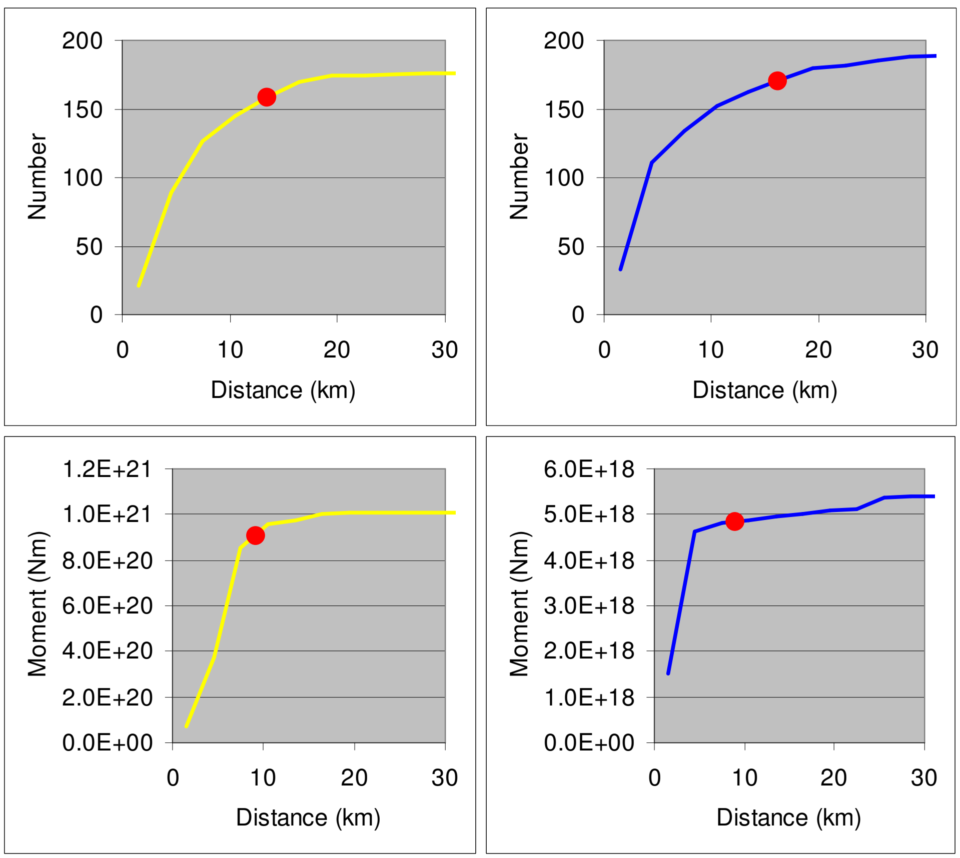

Figure 1 - Diagrams showing the cumulative number of earthquakes and the cumulative seismic moment as a function of distance from faults. The red dot marks the 90% of seismicity. Left: historical earthquakes; right: instrumental earthquakes.

2) Kinematic compatibility. This test compares the direction of P and T axes of observed earthquake focal solutions with the theoretical P and T axes of faults. We took c. 1500 observational P and T axes focal solutions (post-1970, Etna area excluded) from the EMMA database (Vannucci and Gasperini, 2004). Theoretical P and T axes of faults were calculated using the FPSPACK routines by Gasperini and Vannucci (2003). Figure Y shows the test results for earthquakes located within 10 km distance from faults. Angular separations are classified as totally compatible between 0-30°, fairly compatible between 0-45° and

incompatible between 45-90°. Results show total compatibility for 83% of the seismic moment which is represented less than 40% of all earthquakes. The seismic moment percentage is way larger than simple count thereby showing that only the smaller, and possibly less accurate, events tends to deviate from the model predictions. We also checked that similar relative percentage holds for different fault types (normal, reverse strike slip).

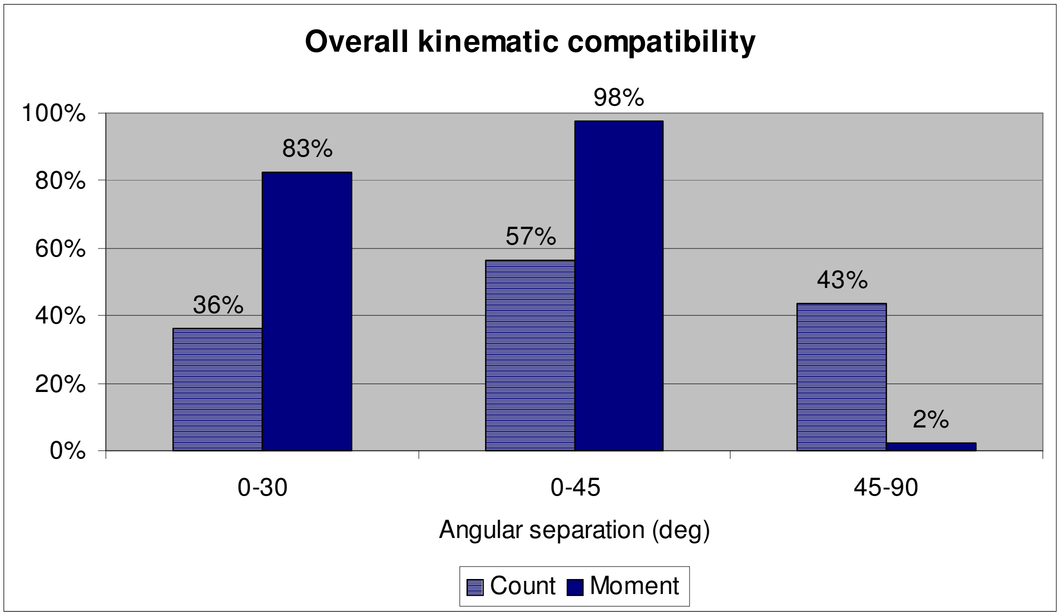

Figure 2 – Histogram showing the relative percentage of totally compatible, fairly compatible, and incompatible observational faulting mechanisms and theoretical mechanisms of faults.

3) Dynamic compatibility. This test compares geologic moment rates and seismic moment rates within eight regions with internally consistent tectonic mechanism. The latter is a fundamental requirement to reasonably cumulate seismic moment within a given region. Seismic moment rate was estimated using the CPTI04 earthquake catalog (Gruppo di lavoro CPTI, 2004). Geologic moment rate was determined using the fault parameters. Table 1 shows the test results.

Table 1 – Geologic and seismic moment rates (Nm/y) in the eight regions shown in figure Z.

ID	Macroregion Name	Mechanism	Geologic Moment rate	Seismic Moment Rate
1	Western Alps	Mixed	8.70E+17	6.95E+16
2	Eastern Alps	Mixed	7.33E+17	8.67E+16
3	Central Northern Apennines East	Thrust	8.96E+17	8.92E+16
4	Central Northern Apennines West	Normal	5.87E+17	3.00E+17
5	Southern Apennines - Apulia	Strike-slip	7.58E+17	9.67E+16
6	Southern Apennines West	Normal	8.31E+17	3.70E+17
7	Calabrian Arc	Mixed	3.43E+18	7.84E+17
8	Sicily	Mixed	1.74E+18	4.55E+17

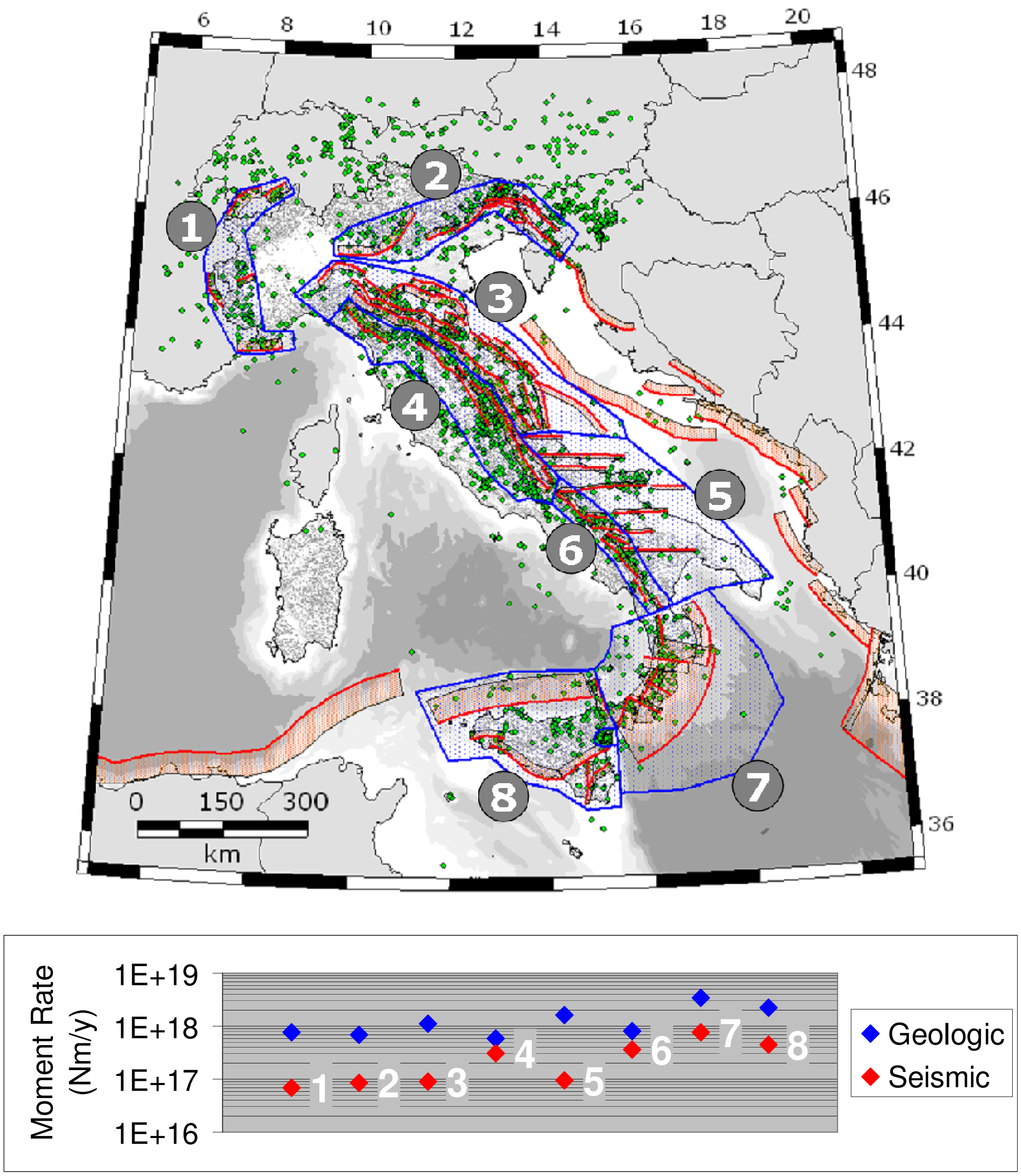

Figure 3 – Top: map showing the eight macroregions used for calculation of geologic and seismic moment rate; bottom: diagram showing results in each macroregion.

2. Relevance for DPC and/or for the scientific community

Ground shaking hazard studies rely on the use of tectonic information that needs to be consistent and accurate. As of today, there is not a common strategy among seismic source modelers on how to fulfill these needs. In most cases, validation is implied by the effort of putting together a large amount of data and generally warranted by the quality of science (or the scientists) behind each record. In this study, we tackled this problem introducing objective quantitative testing of the whole seismic source model.

3. Changes with respect to the original plans and reasons for it

There are no significant changes to the original plans.

4. References

Basili R., G. Valensise, P. Vannoli, P. Burrato, U. Fracassi, S. Mariano, M.M. Tiberti, E. Boschi, The Database of Individual Seismogenic Sources (DISS), version 3: summarizing 20 years of research on Italy's earthquake geology. Tectonophysics, 2008. 453, 20-43, doi:10.1016/j.tecto.2007.04.014.

DISS Working Group (2009). Database of Individual Seismogenic Sources (DISS), Version 3.1.0: A compilation of potential sources for earthquakes larger than M 5.5 in Italy and surrounding areas. http://diss.rm.ingv.it/diss/, © INGV 2009 - Istituto Nazionale di Geofisica e Vulcanologia - All rights reserved.

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5. Key publications/presentation

None.