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Seismogenic sources of the Adriatic domain: an overview from the Database of Individual Seismogenic Sources (DISS 3.1.0)

VANJA KASTELIC (*), PAOLA VANNOLI (*), PIERFRANCESCO BURRATO (*), SALVATORE BARBA (*), ROBERTO BASILI (*), UMBERTO FRACASSI (*), MARA MONICA TIBERTI (*) & GIANLUCA VALENSISE (*)

RIASSUNTO

Sguardo d'insieme sulle sorgenti sismogenetiche della regione adriatica dal Database delle Sorgenti Sismogenetiche Individuali (DISS 3.1.0)

Il Database delle Sorgenti Sismogenetiche Individuali (DISS) contiene sorgenti capaci di generare terremoti con Mw > 5.5 e fornisce una visione sinottica della sismogenesi in Italia e nelle aree limitrofe. In questo lavoro presentiamo un dettaglio sulle sorgenti dell'alto Adriatico, che possono essere visionate in dettaglio sul sito web e scaricate nei principali formati GIS (http://diss.rm.ingv.it/diss). DISS è per sua natura aperto a continui aggiornamenti tecnologici e soprattutto scientifici, pertanto beneficia di tutti gli input provenienti dalla comunità scientifica, nazionale ed internazionale.

Key words: Adria microplate, active tectonics, Seismogenic Sources.

We present an overview of the seismogenic sources belonging to the interior and the border zones of the Adriatic microplate, included in the latest version of the Database of Individual Seismogenic Sources (DISS, v. 3.1.0; DISS WORKING GROUP, 2009).

DISS is a large repository of geologic, tectonic and active fault data on Italy and surrounding areas (Fig. 1) that result from its authors' first-hand experience and from a large amount of literature data (BASILI *et alii*, 2008).

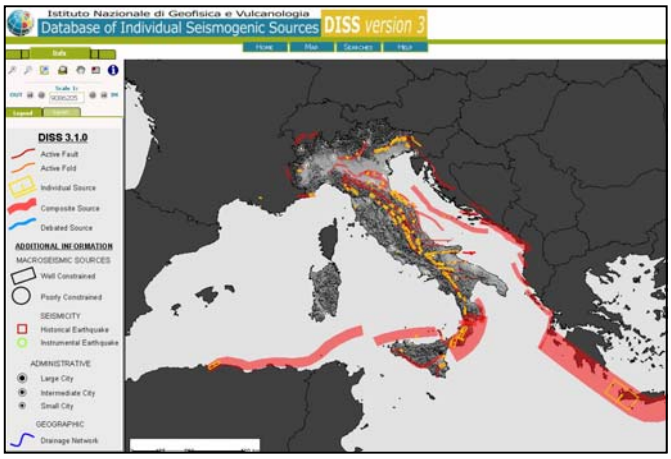

Fig. 1: Screenshot of the web-page of the DISS, http://diss.rm.ingv.it/diss.

(*) Istituto Nazionale di Geofisica e Vulcanologia,
Via di Vigna Murata, 605 – 00143 Roma, Italy.

The main content of DISS is the Seismogenic Source. DISS Seismogenic Sources are active faults capable of generating Mw > 5.5 earthquakes. We distinguish three main categories of Seismogenic Sources (BASILI *et alii*, 2008):

- the "Individual Seismogenic Sources" are obtained from geological and geophysical data and are characterized by a full set of geometric (strike, dip, length, width and depth), kinematic (rake) and seismological parameters (average displacement, magnitude, slip rate, recurrence interval). Individual Seismogenic Sources are assumed to exhibit "characteristic" behaviour with respect to rupture length/width and expected magnitude. These Sources are tested against worldwide databases for internal consistence in terms of length, width, average displacement and magnitude, and can be complemented with information on fault scarps when present. This category of sources favours accuracy of the information supplied over completeness. As such, they can be used for deterministic assessment of seismic hazard, for calculating the probability of the occurrence of strong earthquakes for the sources themselves (AKINCI *et alii*, 2008), for calculating earthquake and tsunami scenarios (LORITO *et alii*, 2008; TIBERTI *et alii*, 2008), and for tectonic and geodynamic investigations (e.g. BURRATO & VALENSISE, 2008).

- the "Composite Seismogenic Sources" are obtained from geological and geophysical data and are characterized by geometric (strike, dip, width, depth) and kinematic (rake) parameters, but their length is more loosely defined and spans an unspecified number of Individual Sources. They are not assumed to be capable of a specific earthquake but their potential can be derived from existing earthquake catalogues. A Composite Source is essentially identified on the basis of regional surface and subsurface geological data. This category of sources favors completeness of the record of potential earthquake sources over accuracy of source description. In conjunction with seismicity and modern strain data, Composite Sources can thus be used for regional probabilistic seismic hazard assessment and for investigating large-scale geodynamic processes (e.g. BARBA *et alii*, 2008; MELETTI *et alii*, 2008).

- "Debated Seismogenic Sources"; these are active faults that have been proposed in the literature as potential seismogenic sources but were not yet considered reliable enough to be included in the database. They may include:

- sources for which only minimal surface evidence is supplied in the literature;
- sources based on inherently ambiguous geological evidence;
- sources for which the literature offers highly contrasting views;
- sources that occur in low or very low seismicity areas;
- sources whose characteristics are in open contrast with those of nearby, better known and established sources, or that violate established tectonic and seismological evidence.

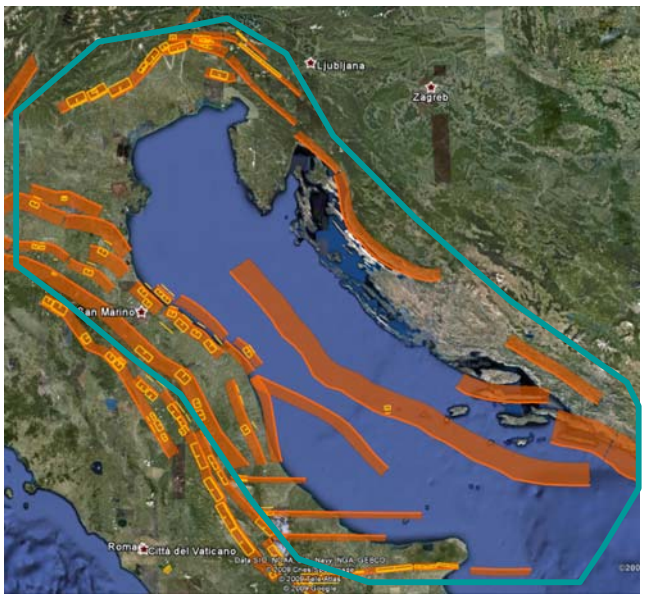

Fig. 2 Overview of the seismogenic sources of the Adria microplate included in DISS 3.1.0. The Individual Seismogenic Sources are represented with yellow rectangles, Composite Seismogenic Sources with red ribbons. The cyan polygon highlights the studied area.

The Adriatic domain is surrounded by active fold-and-thrust belts that developed within the regional convergence, ca. N-S oriented, between the African and European plates. However, the distribution of seismicity reveals that active deformation follows not only the Adria margins but it is present also in its inner sector.

Along the western side of Adria, active deformation is testified by faulting along the NE-verging shallow thrust fronts of the Central and Northern Apennine belt. This process occurs along the on-shore and off-shore areas of northern Abruzzo, Marche and Emilia-Romagna (LAVECCHIA *et alii*, 2007; SCROCCA *et alii*, 2007; VANNOLI *et alii*, 2004), as well as along the thrust fronts buried underneath the Po Plain (BURRATO *et alii*, 2003). Toward the inner sector of the chain, active thrusting is being released by deeper portions of the same SW-dipping thrust system. More to the South, the western Adria margin is deformed by E-W trending strike-slip regional faults, deep-seated in the crust (DI BUCCI *et alii*, 2006; FRACASSI & VALENSISE, 2007).

At the northern boundary zone, indentation of Adria in Veneto and Friuli results in thrusting on generally E-W striking thrusts of the Eastern Southalpine Chain (BURRATO *et alii*, 2008). Moving to Western Slovenia, active deformation is taken up by dextral strike-slip faulting along steep NE dipping fault planes (KASTELIC *et alii*, 2008; BURRATO *et alii*, 2008). Along the eastern side of Adria thrusting occurs along the shallow SW-verging thrust fronts of the external Dinarides in the coastal as well as off-shore areas (PRELOGOVIC *et alii*, 2003; HERAK *et alii, 2005*; KUK *et alii*, 2000).

The outermost thrust fronts of the Apennine and Dinaric belts reach the central portion of the Adriatic Sea, showing that Adria deforms also within its interior and not only along its boundaries.

New feature included in DISS 3.1.0 are the composite seismogenic sources covering areas of the external part of the Dinaric belt.

The sources included in DISS were constrained taking into consideration all available geological and geophysical data both original and from the literature (i.e. traces of active faults, drainage anomalies, studies of coastal geomorphology, data on historic and instrumental seismicity, geodetic data).

Such approach will also be used to characterise and parameterise active sources across Europe for the E.U. Project Seismic Hazard Harmonization in Europe (SHARE), within which DISS has been chosen as the template for constructing and populating the regional databases of seismogenic sources.

This paper cannot substitute a complete in-depth visit of the DISS web site (http://diss.rm.ingv.it/diss).

REFERENCES

AKINCI A., PERKINS D., LOMBARDI A. M. & BASILI R. (2008) - *Uncertainties in probability of occurrence of strong earthquakes for fault sources in the Apennines, Italy*. Journal of Seismology. doi: 10.1007/s10950-008-9142-y.

BARBA S., CARAFA M.M.C. & BOSCHI E. (2008) - *Experimental evidence for mantle drag in the Mediterranean*. Geophys. Res. Lett., **35**, L06302, doi:10.1029/2008GL033281.

BASILI R., VALENSISE G., VANNOLI P., BURRATO P., FRACASSI U., MARIANO S., TIBERTI M.M. & BOSCHI E. (2008) - The *Database of Individual Seismogenic Sources (DISS), version 3: summarizing 20 years of research on Italy's earthquake geology*. Tectonophysics, **453,** 20–43, doi:10.1016/j.tecto.2007.04.014.

BURRATO P., CIUCCI F. & VALENSISE G. (2003) - *An inventory of river anomalies in the Po Plain, Northern Italy: evidence for active blind thrust faulting*. Annals Geophys., **46**, 5, 865-882.

BURRATO P., POLI M.E., VANNOLI P., ZANFERRARI A., BASILI R. & GALADINI F. (2008) - *Sources of Mw 5+ earthquakes in northeastern Italy and western Slovenia: An updated view based on geological and seismological evidence.* Tectonophysics, **453**, 157-176, doi: 10.1016/j.tecto. 2007.07.009.

BURRATO P. & VALENSISE G. (2008) - *Rise and fall of a hypothesized seismic gap: source complexity in the 16 December 1857, Southern Italy earthquake (Mw 7.0).* Bull. Seism. Soc. Am., **98** (1), 139-148, doi: 10.1785/0120070094.

DI BUCCI D., RAVAGLIA, A., SENO, S., TOSCANI, G., FRACASSI, U. & VALENSISE G. (2006) - *Seismotectonics of the Southern Apennines and Adriatic foreland: Insights on active regional E-W shear zones from analogue modeling.* Tectonics, **25**, TC4015, 10.1029/2005TC001898.

DISS WORKING GROUP (2009) - Database of Individual Seismogenic Sources (version 3.1.0): *A compilation of potential sources for earthquakes larger than M 5.5 in Italy and surrounding areas.* Available at: http://diss.rm.ingv.it/diss.

FRACASSI, U. & VALENSISE, G. (2007) - *Unveiling the sources of the catastrophic 1456 multiple earthquake: Hints to an unexplored tectonic mechanism in Southern Italy.* Bull. Seismol. Soc. Am., **97**, 3, 725-748, 10.1785/0120050250.

HERAK, D., HERAK, M., PRELOGOVIC, E., MARKUSIC, S. & MARKULIN, Z. (2005) - *Jabuka island (Central Adriatic Sea) earthquakes of 2003.* Tectonophysics, **398**, 167-180.

KASTELIC, V., VRABEC, M., CUNNINGHAM, D. &. GOSAR, A. (2008) - *Neo-Alpine structural evolution and present-day tectonic activity of the eastern Southern Alps: The case of the Ravne Fault, NW Slovenia*. J. Struct. Geol., **30**, 963–975. doi:10.1016/j.jsg.2008.03.009

KUK, V., PRELOGOVIC, E. & DRAGICEVIC, I. (2000) *Seismotectonically active zones in the Dinarides*. Geologia Croatica, **53**, 2, 295-303.

LAVECCHIA, G., DE NARDIS, R., VISINI, F., FERRARINI, F., & BARBANO S.M. (2007)- *Seismogenic evidence of ongoing compression in eastern-central Italy and mainland Sicily: a comparison.* Boll. Soc. Geol. It., **126**, 209-222.

LORITO S., TIBERTI M.M., BASILI R., PIATANESI A. & VALENSISE G. (2008) - *Earthquake-generated tsunamis in the Mediterranean Sea: scenarios of potential threats to Southern Italy*. Journal of Geophysical Research, **113**, B01301, doi:10.1029/2007JB004943.

MELETTI C., GALADINI F., VALENSISE G., STUCCHI M., BASILI R., BARBA S., VANNUCCI G. & BOSCHI E. (2008) - *A seismic source zone model for the seismic hazard assessment of the Italian territory*, Tectonophysics, **450** (1-4), 85-108, doi:10.1016/j.tecto.2008.01.003.

PRELOGOVIC, E., PRIBICEVIC, B., IVKOVIC, Z., DRAGICEVIC, I., BULJAN, R. & TOMLJENOVIC, B. (2003) - *Recent structural fabric of the Dinarides and tectonically active zones important for petroleum-geological exploration in Croatia*. Nafta, **55**, 155-161.

SCROCCA, D., CARMINATI, E., DOGLIONI, C., & MARCANTONI, D. (2007) - *Slab retreat and active shortening along the Central-Northern Apennines*. O. Lacombe, J. Lavé, F. Roure and J. Verges (Eds): Thrust belts and Foreland Basins. From Fold Kinematics to Hydrocarbon Systems, Frontiers in Earth Sciences, Springer, 471-487.

TIBERTI M.M., LORITO S., BASILI R., KASTELIC V., PIATANESI A. & VALENSISE G. (2008) - *Scenarios of earthquake-generated tsunamis in the Adriatic Sea.* P. Cummins, L. Kong and K. Satake (Eds): Topical Issue on Tsunamis. Pure and Applied Geophysics, doi: 10.1007/s00024-008-0417-6.