1st Croatian Conference on Earthquake Engineering
1CroCEE
22-24 March 2021 Zagreb, Croatia

DOI: https://doi.org/10.5592/CO/1CroCEE.2021.228

Database of active faults in Slovenia: geologic input into seismic hazard assessment at national scale

Jure Atanackov[1], Petra Jamšek Rupnik[1], Miloš Bavec[1], Bogomir Celar[1], Jernej Jež[1], Anže Markelj[1], Blaž Milanič[1], Matevž Novak[1], Vanja Kastelic[2]

[1] Geological Survey of Slovenia, Ljubljana, Slovenia, *jure.atanackov@geo-zs.si*
[2] Istituto Nazaionale di Geofisica e Vulcanologia, L'Aquila, Italy

Abstract

Seismic hazard assessment requires seismic source models representative for time spans greater than the period of earthquake catalogue completeness. In order to include seismic deformation in a several hundreds to thousands of year time interval, we need to rely on long-term geologic input in the form of fault seismogenic sources. This is particularly valid for low to moderate seismic deformation rate areas, where strong earthquakes tend to have long return periods, as is the case in Slovenia.

Key words: active faults, seismogenic faults, composite seismogenic sources, fault database, seismic hazard assessment

Seismic hazard assessment requires seismic source models representative for time spans greater than the period of earthquake catalogue completeness. In order to include seismic deformation in a several hundreds to thousands of year time interval, we need to rely on long-term geologic input in the form of fault seismogenic sources. This is particularly valid for low to moderate seismic deformation rate areas, where strong earthquakes tend to have long return periods, as is the case in Slovenia.

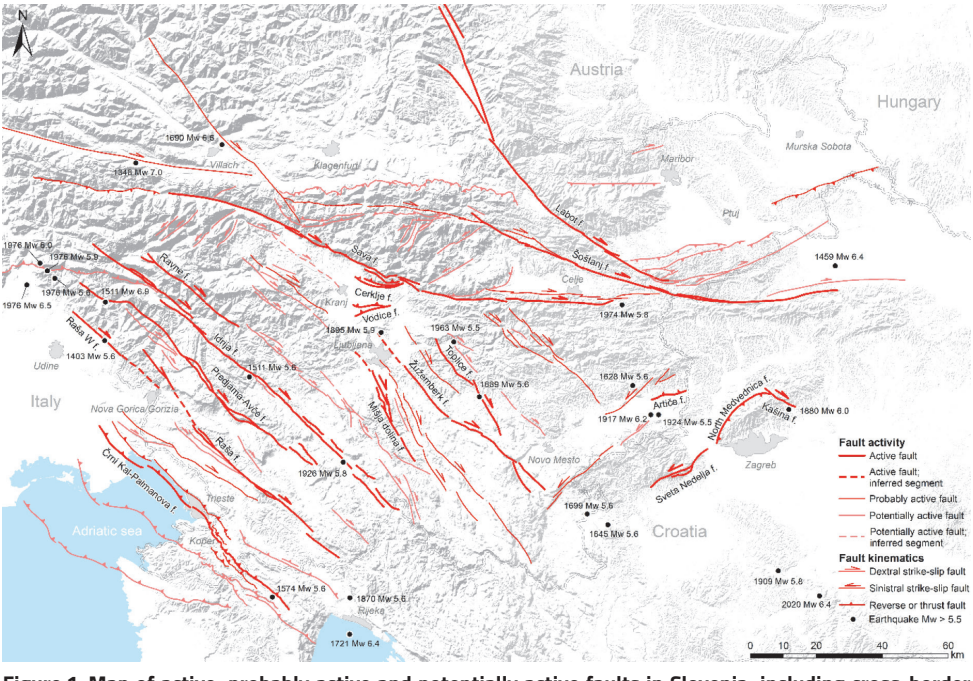

Figure 1. Map of active, probably active and potentially active faults in Slovenia, including cross-border faults and active faults in immediate vicinity that belong to cross-border fault systems. Earthquake epicenters from [6, 7]

Slovenia is a region of complex geologic structure and tectonic activity, resulting from the broader-scale collisional processes between the Eurasian plate and the Adriatic microplate and the interplay between a number of higher order tectonic elements, including the TISZA and ALCAPA mega-units [1-3]. GNSS data indicates generally northward motion vectors with respect to a fixed Eurasia and motion vector divergence across the region. Approximately 2-4 mm/yr of shortening is observed across the country [4, 5]. Maximum estimated fault slip rates reach ~1 mm/yr.

Slovenia and its immediate vicinity is a region of moderate seismicity. The strongest historic events include the 1348 M_w 7.0 (I_{max}=IX-X MCS) Villach earthquake and the 1511 M_w 6.9 (I_{max}=X MCS) Idrija earthquake [6]. Additionally, over twenty historic events with M>5.5 have been recorded in the past millennium (Fig. 1) [6, 7]. The record of strong historic earthquakes highlights the importance of a better understanding of the correla-

tions between earthquakes and active faults to assess their potential for future strong/damaging events and contribution to seismic hazard.

We compiled a new national database of active faults as input for a database of fault seismogenic sources to be used for the upcoming new national seismic hazard map. The database includes 96 active, probably active and potentially active faults with full geometric, kinematic and activity parametrization for all 240 fault segments (Fig. 1). Faults with surface traces >5 km long were included.

In the talk we present our experience, the pitfalls of using highly heterogeneous datasets, including geological maps, geomorphic maps and analyses, geological profiles, geophysical data, paleoseismological data, surface age data, various types of geodetic data and seismological data, and methodologies used to compile the data into a comprehensive and homogenous fault database, compatible with national fault databases elsewhere in Europe. The database of active faults is used as part of the geologic input for the upcoming new seismic hazard map of Slovenia. It was translated into a database of composite seismogenic sources, similar to widely used databases such as DISS and SHARE/EDFS [8, 9]. The database of composite seismogenic sources was also used as input on national level for the new European seismic hazard map (EHSM20). Further, the database is the basis for future fault-specific research, including structural mapping, geomorphological analyses, paleoseismological and geodetic investigations for improved constraints on fault activity and earthquake behaviour. The database is continuously updated as new data becomes available.

Acknowledgements

The project was financially supported by Slovenian Research Agency (Program P1-0011) and by the Slovenian Environment Agency (project Elaboration of Map of Active Faults). V.K. acknowledges the support from the Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe (SERA) project (European Union Horizon 2020 research and innovation program grant agreement No.730900).

References

[1] Brückl, E., Behm, M., Decker, K., Grad, M., Guterch, A., Keller, G.R., Thybo, H. (2010): Crustal structure and active tectonics in the Eastern Alps. *Tectonics*, **29**, 1–17. doi:10.1029/2009TC002491

[2] Schmid, S.M., Fügenschuh, B., Kounov, A., Maţenco, L., Nievergelt, P., Oberhäansli, R., Pleuger, J., Schefer, S., Schuster, R., Tomljenović, B., Ustaszewski, K., van Hinsbergen, D.J.J. (2020): Tectonic units of the Alpine collision zone between Eastern Alps and western Turkey. *Gondwana Research*, **78**, 308–374.

[3] Vrabec, M., Fodor, L. (2006) Late Cenozoic tectonics of Slovenia: structural styles at the Northeastern corner of the Adriatic microplate. In: Pinter, N. (ed.) [etc]. *The Adria microplate: GPS geodesy, tectonics and hazards (NATO Science Series IV, Earth and Environmental Sciences 61).* Dordrecht, Springer: p. 151–168.

[4] Serpelloni, E., Vannucci, G., Anderlini, L., Bennett, R.A. (2016): Kinematics, seismotectonics and seismic potential of the eastern sector of the European Alps from GPS and seismic deformation data. *Tectonophysics*, **668**, 157–181.

[5] Weber, J., Vrabec, M., PavlovičPrešeren, P., Dixon, T., Jiang, Y., Stopar, B. (2010): GPSderived motion of the Adriatic microplate from Istria Peninsula and Po Plain sites, and geodynamic implications. *Tectonophysics*, **483**, 214–222. doi: 10.1016/j.tecto.2009.09.001

[6] Stucchi, M., Rovida, A., Capera, A. A. G., Alexandre, P., Camelbeeck, T., Demircioglu, M. B., Gasperini, P., Kouskouna, V., Musson, R. M. W., Radulian, M., Sesetyan, K., Vilanova, S., Baumont, D., Bungum, H., Fah, D., Lenhardt, W., Makropoulos, K., Solares, J. M. M., Scotti, O., Živčić, M., Albini, P., Batllo, J., Papaioannou, C., Tatevossian, R., Locati, M., Meletti, C., Vigano, D., Giardini, D. (2013): The SHARE European Earthquake Catalogue (SHEEC) 1000-1899. *Journal of Seismology*, **17** (2), 523–544.

[7] Grünthal, G., Wahlström, R. (2012): The European-Mediterranean Earthquake Catalogue (EMEC) for the last millennium. *Journal of Seismology*, **16** (3), 535–570.

[8] Basili, R., Kastelic, V., Demircioglu, M. B., Garcia Moreno, D., Nemser, E. S., Petricca, P., Sboras, S. P., Besana-Ostman, G. M., Cabral, J., Camelbeeck, T., Caputo, R., Danciu, L., Domac, H., Fonseca, J., García-Mayordomo, J., Giardini, D., Glavatovic, B., Gulen, L., Ince, Y., Pavlides, S., Sesetyan, K., Tarabusi, G., Tiberti, M. M., Utkucu, M., Valensise, G., Vanneste, K., Vilanova, S., Wössner., J. (2013): The European Database of Seismogenic Faults (EDSF) compiled in the framework of the Project SHARE. http://diss.rm.ingv.it/share-edsf/ doi:10.6092/INGV.IT-SHARE-EDSF (accessed 15.3.2013).

[9] DISS Working Group 2015. Database of Individual Seismogenic Sources (DISS), Version 3.2.0: A compilation of potential sources for earthquakes larger than M 5.5 in Italy and surrounding areas. http://diss.rm.ingv.it/diss/, Istituto Nazionale di Geofisica e Vulcanologia; DOI:10.6092/INGV.IT-DISS3.2.0