







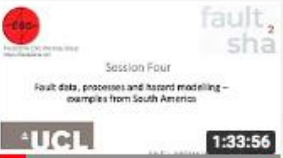









## FAULT2SHA Working group – 5th Annual Report – 2020-2021

By Oona Scotti & Laura Peruzza

With contributions from:

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 <p>1:01:36</p>	 <p>56:09</p>	 <p>1:04:08</p>	 <p>1:09:11</p>
<p><b>Fault2SHA Learning Series (6) measuring fault...</b> 40 views • Streamed 1 week ago</p>	<p><b>Fault2SHA Learning Series (5) - False Friends in SHA</b> 129 views • Streamed 1 month ago</p>	<p><b>Fault2SHA Learning Series (4) Earthquakes Converse...</b> 388 views • Streamed 2 months ago</p>	<p><b>Fault2SHA Learning Series (3) Fault displacement...</b> 218 views • Streamed 3 months ago</p>
 <p>1:10:11</p>	 <p>1:20:41</p>	 <p>1:33:56</p>	 <p>28:31</p>
<p><b>Fault2SHA Learning Series (2) Palaeoseismic studies ...</b> 252 views • Streamed 4 months ago</p>	<p><b>Fault2SHA Learning Series (1) Cosmogenic nuclides a...</b> 248 views • Streamed 5 months ago</p>	<p><b>Fault2SHA 5th Workshop Day 2 Session Four</b> 234 views • Streamed 7 months ago</p>	<p><b>Fault2SHA 5th Workshop Day 2 Session Three Part...</b> 106 views • Streamed 7 months ago</p>
 <p>1:28:56</p>	 <p>27:36</p>	 <p>1:19:56</p>	 <p>11:50</p>
<p><b>Fault2SHA 5th Workshop Day 2 Session Three Part...</b> 172 views • Streamed 7 months ago</p>	<p><b>Fault2SHA 5th Workshop - Day 1 Session 2 Part 2</b> 141 views • Streamed 7 months ago</p>	<p><b>Fault2SHA 5th Workshop - Day 1 Part 1 Unedited</b> 261 views • Streamed 7 months ago</p>	<p><b>Fault2SHA 5th Workshop Day 1 Session 2 Part 1</b> 92 views • 7 months ago</p>
 <p>47:36</p>	 <p>1:15:40</p>		
<p><b>Fault2SHA 5th Workshop - Day 1 Session 1 Part 2</b> 109 views • 7 months ago</p>	<p><b>Fault2SHA 5th Workshop - Day 1 Session 1 Part 1</b> 181 views • 7 months ago</p>		



<b><u>SCOPE &amp; KEY ISSUES</u></b>	<b>2</b>
<b><u>2020-2021 THE COMMUNITY GROWS</u></b>	<b>2</b>
SUBSCRIPTIONS AND GOVERNING BOARD	3
MEETINGS & WORKSHOP	3
FUNDING	5
FAULT2SHA TEST LABS	6
DISSEMINATIONS & ACTIVE STUDENTS	7
<b><u>ONGOING AND FUTURE ACTIVITIES</u></b>	<b>8</b>
FUNDING/WORKSHOPS/MEETINGS/SESSION/WEBSITE	8

## SCOPE & KEY ISSUES

The aim of the ESC Fault2SHA working group is to motivate exchanges between field geologists, fault modellers and seismic hazard practitioners.

The Key Questions for the Working Group remain the ones declared at its approval by the European Seismological Commission, in 2016: they are listed in the home page of the Fault2SHA website (<http://fault2sha.net/info/>).

Annual Reports are available online at: <http://fault2sha.net/what/>.

## 2020-2021 THE COMMUNITY GROWS

The fifth year of activity continued the process of enlargement of the community inside and outside Europe, the consolidation of natural test areas, and the search for funds to support the network. The existence of the FAULT2SHA network was fundamental in organising, in spite of the Covid-19 pandemic and the cold winter, a « EU team » to plan a first series of field surveys following the December 29, 2020, Mw 6.4 earthquake that shook the region of Petrinja in northern Croatia, 45 km south from Zagreb (see [A first week of field survey after the Petrinja earthquake \(Croatia\) confirms surface rupturing – FAULT2SHA](#)). Considering the high magnitude of the earthquake and the potential occurrence of co-seismic deformations over large areas, fault2sha members contacted Croatian colleagues from the Geological Institute of Croatia (HGI) to participate in the field investigations and establish the first bases for scientific collaboration.



## SUBSCRIPTIONS AND GOVERNING BOARD

People are asked to join to Fault2SHA working group by a form, accessible since Jan 2018 on the website (<http://fault2sha.net/join-fault2sha/>). As of July 1, 2021, we reached the threshold of 217 members, from 38 countries; they regularly receive news and info about the on-going activities, via e-mail messages and social platforms (Twitter, Facebook) too.

The governing board (Executive Committee, ExCom) was elected with a ballot in 2017; it continues its duties of leading some activities, always as voluntary, non-paid contributors. The Fault2SHA ExCom is composed of the following members:

- Oona Scotti and Laura Peruzza (coordinators of the Working Group activities and responsible for reporting to the ESC)
- Bruno Pace
- Francesco Visini
- Lucilla Benedetti
- Julian Garcia-Mayordomo
- Maria Ortuño
- Graeme Weatherill
- Joanna Faure Walker

The proposal of adding 2-3 members to the ExCom, considering the growth of the subscribers, will be discussed after the renewal of the WG by the ESC Board, to be held during the 2021 ESC General Assembly in September 2021, Corfù and online.

## MEETINGS & WORKSHOP

The WG promotes the organization of sessions during well-known International Conferences.

The 2020-2021 activities continued to face the worldwide difficulties posed by the COVID-19 pandemic. Nevertheless, Fault2SHA members remained very active with the following initiatives.

1. A very successful 5<sup>th</sup> Fault2SHA Workshop (“All Hands on Deck: Promoting Faults in Seismic Hazard Assessment”) was held on-line on the 12th and 13th November 2020, and 2nd December 2020. This was an occasion to expand further the network (e.g. contacts with T. King, responsible for the development of the COMET Central Asian Fault database, and with of some South-America research groups). The status of the central Asia fault database can be followed on the blog (<http://quakesincentralasia.org/research-updates/the-comet-central-asia-fault-database-progress-report/>). The workshop was attended by 90-130 live participants, and there have since been 100-270 views of the streamed event on youtube.



2. A new monthly Learning Series was launched in January 2021 by Joanna Faure Walker (invited lectures up to July 2021 by: L. Benedetti, F. Cinti, P. Boncio, R. Stein, L. Peruzza, Y. Bock, J. Douglas). YouTube videos are available at Fault2SHA - YouTube channel. The live events have been attended by 40-230 participants, with the streamed events on youtube watched by a further 80-400 viewers.
3. Following the December 2020 earthquake (Mw=6.4) in Croatia, a team composed of several earthquake geologists from France, Italy and Slovenia assisted the Croatian colleagues of the Croatia Geological Survey (HGI) to map the surface ruptures and assess the source of this event. Several Fault2SHA members were in this team and ongoing joint projects emerged from this initiative (see <https://fault2sha.net/2021/01/31/m6-4-petrinja-earthquake-a-first-week-of-geological-survey/> and <https://www.insu.cnrs.fr/fr/cnrsinfo/seisme-du-29-decembre-2020-en-croatie-les-premieres-observations-de-terrain>).
4. Fault2SHA related talks were given: by J. F. Walker at EDITH (an INQUA TERPRO Projec - EDITH Kickoff Meeting online: 14-16 April 2021 - International Union for Quaternary Research - INQUA); by F. Visini and O. Scotti at the 39<sup>th</sup> Gruppo Nazionale di Geofisica della Terra Solida - GNGTS Meeting online, 14-16 June 2021. Fault displacement hazard related talks were given: by S. Baize at GSA in October 2020 following the Surface Deformation Associated with the August 9th, 2020 Mw 5.1 Earthquake Near Sparta, North Carolina Late-Breaking Session - GSA2020; by Fault2SHA member F. Nurminen at the EGU 2021.
5. An ESC virtual session will be held in September 2021 (S14: Imaging and modeling 3D fault complexities in Fault2SHA) at the 37<sup>th</sup> General Assembly of the European Seismological Commission. The ESC2021 GA will be held virtually on 19-24 September 2021 (<https://www.erasmus.gr/microsites/1193>).
6. A Fault2SHA training day will be given on September 14<sup>th</sup>, 2021 by F. Visini and O. Scotti at the Young Seismologist Training Course of the ESC2021.
7. A workshop “Hands on fault-based PSHA: data and approaches to build models” will take place in Pisa (Italy) from 27 to 30 September 2021 (supported by the Istituto Nazionale di Geofisica e Vulcanologia and the Italian Civil Protection Department).
8. A special session (SE04) coordinated by some of the fault2SHA members in Europe and Latin America has been included in the Annual meeting of the Mexican Union of Geophysical Sciences (UGM), in Guadalajara, Mexico (and also online). It will focus on the development of the IGCP669 project derived from the fault2sha activities and will be devoted to “Central Mexico: Seismic Threat in the Trans-Mexican Volcanic Belt: Advances in neotectonics, paleoseismology, historical and instrumental seismicity”. <https://www.raugm.org.mx>



## FUNDING

As mentioned in previous reports, the ESC WGs are not financially supported, their activities and member participation are based on voluntary contributions, in terms of time or economic resources. The funds for organizing sessions and workshops derive from research resources and host institutions of the promoters. From July 2019 on, no live Fault2SHA workshops have been organized, due to the pandemics. Nevertheless, as expanding the community, organizing meetings and workshops, and providing the group with a more long-term vision continue to be central actions for the Fault2SHA ExCom members, they submitted the following actions/proposals:

- ✓ The ANR-EQ-TIME project, financed by the French research agency (ANR) entitled “Quantifying the temporal and spatial slip variability in the earthquake cycle spanning months to million years timescales” and involving partners from France (Cerege, IRSN, Gesociences Montpellier, ISTERRE) and Italy (OGS, University of Chieti, INGV). The project is dedicated to improving our understanding of how successive earthquakes accrue on faults to produce tectonic landforms in the Apennines of Italy, host of the 2016 seismic sequence (5 shocks Mw5-6.5 over 9 months), where the accumulation and release of slip over multiple seismic cycles, wide time (1yr-1 Myr) and spatial (1m-100km) scales can be determined. Frontier methodologies in geochronology, remote sensing, geodesy, geophysics, high-resolution topographical data acquisition, seismic hazard modelling, will be combined to quantitatively constrain how portions of the seismic cycle scale up over multiple cycles to produce the cumulative escarpments we see in the landscape.
- ✓ OLLIN-Fault2SHA in Latin America (see project description here: <http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/international-geoscience-programme/igcp-projects/geohazards/igcp-project-712/>) aims at establishing a strong interaction between the Fault2sha group and modellers/data providers from Europe and Latin America. Funds released in 2021 are frozen and will be transferred by Unesco in 2022. Even if there is no economic support for the activities, the network has grown to 103 members from 17 countries, most of them from Latin America. A mentoring program to introduce scientists to fault2SHA tools in Latin America laboratories has been initiated. Two special issues have been edited by members of the network, focused on seismogenic faults in Latin America (in the [Journal of South American Earth Sciences](#) and in the [Boletín de la Sociedad Geológica Mexicana](#)). The IGCP-669 project was present in the 5th fault2SHA workshop (November 2020) and in the IGCP projects and infographics workshop (July 2021).
- ✓ The COST Action proposal, re-submitted by the ExCom Italian representative (Laura Peruzza) in the call OC-2020 in November 2020, received the Evaluation



Report in June 2021, and it was not approved.

- ✓ Similarly, the ITN proposal re-submitted by the ExCom French representative (Lucilla Benedetti) in the call H2020-MSCA-ITN received an excellent score but it was not retained. A new proposal is being prepared to be submitted to the next MSCA-DN 2021 call by the ExCom Italian representative Bruno Pace as coordinator.

## FAULT2SHA TEST LABS

- CENTRAL ITALY LAB (<http://fault2sha.net/fault2sha-central-apennines-lab/>)

The central Apennines Fault2SHA laboratory is composed of 8 core researchers. It has been set up to provide a forum within the Fault2SHA ESC Working Group for collaboration between those with research relating to fault-based seismic hazard in the central Apennines region. In particular, the central Apennines Fault2SHA laboratory aims to resolve and understand discrepancies and make data accessible, bringing together fault data from different research groups.

A first version of the central Italian Apennines fault trace and slip measurements database is now published (Faure Walker et al., *Scientific Data*, 2021). Building an open-access database on active faults, in particular tracing in a database how to account for the debate regarding which faults are active has been a major challenge.

The central Apennines Fault2SHA laboratory devoted many online meetings to discuss data-collection and their representation for hazard calculations. The back and forth discussion between data providers and hazard modellers within the group has proven very effective for both sides although quite time-consuming because it involved changing the structure of the database and of the codes that attack the database. An endeavour well worth the effort because it allows (1) end users to know where the inputs for fault models are coming from and (2) comparisons between different modelling approaches at different stages of modelling because the outputs are based on the same inputs. In addition, the database offers the opportunity to identify priorities for reducing the uncertainties on poorly known or debated/doubtful faults and thus where future fieldwork may be focused. A paper illustrating the methodology that can be used to attack the database and construct fault models for hazard purposes was also recently published (Scotti et al., *Frontiers in Earth Science*, 2021).

The central Apennines lab will now focus on (1) expanding the database to cover a larger geographical region, including blind faults, (2) expanding the database to include details on palaeoseismicity in the region, (3) incorporating physics-based simulations to estimate the probability of multiple-fault rupture and (4) incorporating geodetic data to constrain fault models in PSHA.



It is the hope that our academic research will help to reduce both the human and economic losses from earthquakes in the future in this seismically active region of central Italy.

- BETICS LAB (<http://fault2sha.net/fault2sha-eastern-betics-shear-zone-lab/>)

The Betics Lab group was established in November 2017 and is composed of 20 people with research interests in the earthquake geology of the Eastern Betics Shear Zone (EBSZ) and the application of geological data in fault hazard modelling. During 2021, two local meetings have taken place: 1) online meeting on the 21<sup>st</sup> January 2021 (2h long, 11 fault2sha members from 4 institutions: UCM, UB, IGME, CSIC). Focused on the election of sections preferred to geophysical study the on-depth geometry of faults within the ESSZ, planned for next autumn); 2) on-site meeting at the University of Barcelona, UB, Earth Sciences Department, 3h long, devoted to establish the first contact among geologist/geodesists from the UB and three new members from the Barcelona Supercomputer Center, who are SHA modellers: Otilio Rojas, Marisol Monterrubio and Josep de la Fuente. This meeting will be continued in September 2021.

## DISSEMINATIONS & ACTIVE STUDENTS

As a reminder, all Fault2SHA members are invited to contact the web administrators (bruno.pace@unich.it, lperuzza@inogs.it) to suggest new entries to the Paper Gallery, periodically updated (see <http://fault2sha.net/paper-gallery/>).

The fault2sha.net website in the last year has been visited about 6,600 times, with a mean of about 500 visits per month, by about 2,800 different visitors, from 70 different countries.

The number of PhD and PostDocs working on the Fault2SHA topics is growing, namely:

- Hugo Sanchez-Reyes – “On the use of Physics-based simulations to evaluate the probability of multi-fault ruptures” (Post doctorate started in January 2020 ANR-EQ-Time and IRSN support).
- Magali Riesner Post-doctorate focused on quantifying the deformation across the Apennines over the long-term (100 ka to 2 Ma) (started in February 2020 ANR EQTime funded).
- Fiia Nurminen “ Probabilistic fault displacement hazard: improved methodology and applications” , Chieti University, Italy and Institut de radioprotection et Sûreté Nucléaire, France - Contract ends November 2021
- Octavi Gomez-Novel – “Implications of the integration of paleoseismic data into seismic hazard assessments at the Eastern Betic Cordillera, SE Spain” – Facultat de Ciències de la Terra, Universitat de Barcelona, Spain – PhD final exam in October 2021.
- Giulia Alessandrini, Univ di Bologna (Italy). PhD focused on the integration



of geological data in the SHA of two hydroelectric dams in Insubria, Italy. Giulia has been working with Maria Ortuño through an exchange (internship) program at the Univ. of Barcelona from March to July 2021. She's been implementing the Sheriffs approach in the Insubria region

- Thomas Chartier – “ Modeling earthquake rates on faults for the probabilistic seismic risk assessment, Ecole Normale Supérieure de Paris and Institut de radioprotection et Sûreté Nucléaire, France – PhD completed on 31st October 2019

## ONGOING AND FUTURE ACTIVITIES

### FUNDING/WORKSHOPS/MEETINGS/SESSION/WEBSITE

The activity of the WG will continue next year with the aim at improving further the network of interested researchers, the sharing of tools and information within and outside of the group. Efforts will be devoted to search for funds, by means of:

- Resubmittal of a COST proposal, now that a wide network of supporting members is established: the deadline is October 2021, the main proposer remains Laura Peruzza (OGS, Italy).
- Resubmittal of the ITN proposal (now MSCA-DN), given the great motivation of all personnel involved: deadline is November 2021, the main proposer is Bruno Pace (U. Chieti).
- Contributing to the workshop “Hands on fault-based PSHA: data and approaches to build models” that will take place in Pisa (Italy), from 27 to 30 September 2021 (supported by the funds raised from an agreement between INGV and the Italian Civil Protection Department). The objective of the workshop is to provide participants with a common understanding of fault-based probabilistic seismic hazard models. The concepts of fault and multi-fault ruptures models will be the key topics and the workshop will be arranged in talks and interactive hands-on sessions.
- The OLLIN-Fault2SHA group will be present at the 27 Meeting of Earth Sciences of France (next November, session 18.8, Lyon). The 2021 annual meeting will be held onsite and online during the PATA-days of the INQUA meeting in Chile (November 2021). For the 2022 annual meeting, the VIII Argentinean congress of Quaternary and Geomorphology (September 2022, San Juan, Argentina) has been proposed. A training course (summer school) is planned for 2022 in Bogotá (Colombia) as part of the OLLIN-Fault2SHA group and through an agreement between the Spanish IGME and the Colombian Geological Survey.