

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/344462654>

EARTHQUAKE RUPTURE ON THE FIANDACA FAULT, DEC. 26, 2018, MW 4.9: FAULT FABRIC ANALYSIS, INTENSITY VS. SURFACE FAULTING, AND HISTORICAL SEISMICITY AT MT. ETNA VOLCANO, ITALY

Conference Paper · October 2020

CITATIONS

0

READS

89

12 authors, including:



Domenico Bella

10 PUBLICATIONS 70 CITATIONS

[SEE PROFILE](#)



Giorgio Tringali

Università degli Studi dell'Insubria

4 PUBLICATIONS 0 CITATIONS

[SEE PROFILE](#)



Rosario Pettinato

2 PUBLICATIONS 0 CITATIONS

[SEE PROFILE](#)



Franz Livio

Università degli Studi dell'Insubria

117 PUBLICATIONS 783 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



Special Issue "The November 23rd, 1980 Irpinia-Lucania, Southern Italy Earthquake: Insights and Reviews 40 Years Later" https://www.mdpi.com/journal/geosciences/special_issues [View project](#)



Natural Hazards: historical floods in Campania (italy) [View project](#)

- Grünthal G. (Ed.); 1998: *European Macroseismic Scale 1998 (EMS-98)*. European Seismological Commission, sub commission on Engineering Seismology, Working Group Macroseismic Scales. Conseil de l'Europe, Cahiers du Centre Européen de Géodynamique et de Séismologie 15. Luxembourg, pp. 99, <http://www.ecgs.lu/cahiers-bleus/>.
- Haas J. E. and Ayre R.S.; 1969: *The western Sicily earthquake of 1968*. Committee on Earthquake Engineering Research, National Academy of Sciences, Washington, D. C., 77 pp.
- Hanks T.C., Kanamori H.; 1979: *A moment magnitude scale*. J. Geoph. Res., 84 (B5), 2348–50.
- Rovida A., Locati M., Camassi R., Lolli B. and Gasperini P. (Eds); 2016: *CPTI15, the 2015 version of the Parametric Catalogue of Italian Earthquakes*. INGV, doi:<http://doi.org/10.6092/INGV.IT-CPTI15>.

EARTHQUAKE RUPTURE ON THE FIANDACA FAULT, DEC. 26, 2018, MW 4.9: FAULT FABRIC ANALYSIS, INTENSITY VS. SURFACE FAULTING, AND HISTORICAL SEISMICITY AT MT. ETNA VOLCANO, ITALY

D. Bella¹, G. Tringali¹, R. Pettinato¹, F. Livio², M.F. Ferrario², A.M. Michetti², S. Porfido^{3,4}, A.M. Blumetti⁵, P. Di Manna⁵, E. Vittori⁵, L. Guerrieri⁵, G. Groppelli⁶

¹ Registered Geologist, Acireale, Italy

² Università dell'Insubria, Como, Italy

³ CNR-ISA, Avellino, Italy

⁴ INGV-Osservatorio vesuviano, Napoli, Italy.

⁵ ISPRA, Roma, Italy

⁶ CNR – IGAG, Milano, Italy

Introduction. On December 26, 2018, a Mw 4.9 earthquake hits the eastern flank of Mount Etna volcano (Sicily). The epicenter is located between the Fleri and Pennisi villages, and focal depth is estimated at 0.3 km (<http://cnt.rm.ingv.it/event/21285011>). This earthquake is part of a seismic sequence begun on December 23, 2018 and a concurrent phase of volcanic eruption, eventually resulting in lava flows and a dyke intrusion (De Novellis *et al.*, 2019).

The earthquake is the result of the activation of the Fiandaca Fault; it is accompanied by widespread surface faulting and secondary environmental effects (Emergo Working Group, 2019; Figs. 1 - 3), and have a maximum intensity of VIII EMS (Quest WG, 2019).

Partial or complete ruptures of the Fiandaca Fault are well-documented in the last 150 years (Fig. 1). The last event that activated the entire structure, as happened in 2018, occurred in 1894 and generated extensive surface faulting and secondary effects (Riccò, 1894; Baratta, 1894; Imbò, 1935).

Despite the abundant documentation of previous events, the Fleri earthquake represents the first opportunity to document coseismic effects of a strong, shallow seismic event at Mt. Etna through modern field techniques, sustained by accurate remote-sensed data, including unprecedented InSar measurements.

Methods. We started mapping ground ruptures in the morning of December 26, 2018, few hours after the earthquake. We collected original structural data on ground break length and orientation, amount of displacement and slip vectors. We compared field data with InSAR imaging, showing coseismic surface rupture and afterslip on some known capable faults on Mt. Etna eastern and southern slopes.

We then compared field measurements with other surface (slope, aspect, elevation) and subsurface (slope and aspect of the basement, thickness of volcanic deposits) data, to evaluate the factors ruling surface faulting occurrence and fabric. We plotted data along the rupture

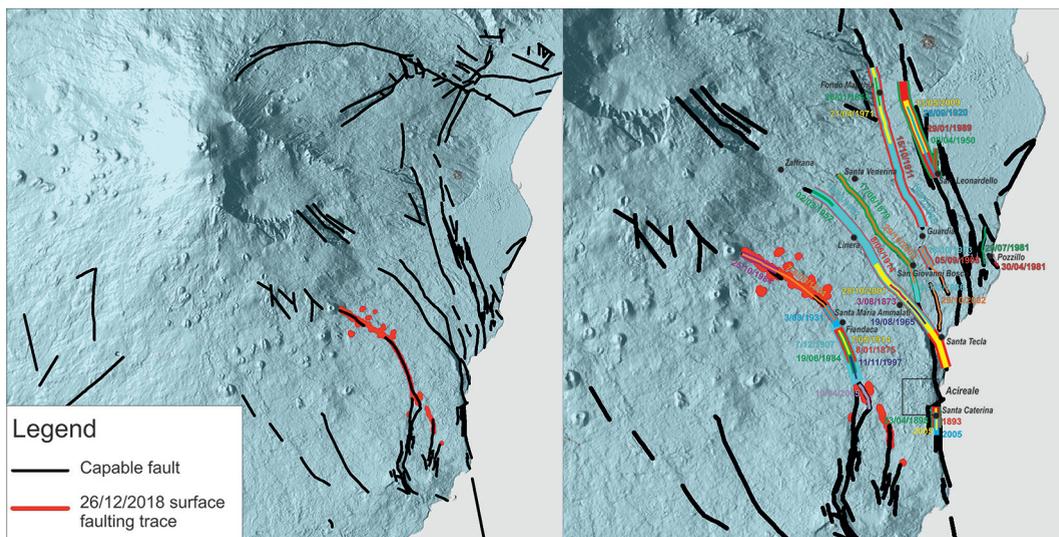


Fig. 1- Left: surface rupture of the December 26, 2018, Mw 4.9 earthquake along the Fiandaca Fault in the southeastern flank of Mt. Etna volcano. Right: recent to historical surface faulting in the same area. The capable faults in the area are also shown, taken from the ITHACA database.

trace, by projecting the data location on a baseline. Fault width was measured across-strike, with a 50-m resolution.

We finally compared our results with macroseismic and surface faulting observations of previous events on Mt. Etna eastern flank.

Results. We map surface faulting for a length of about 5 km, along 3 main sectors, namely the Fleri, Fiandaca and Aci Platani segments. We collected a total of 400 observation points, mainly located along the Fiandaca segment (Fig. 2 and 3). We also documented afterslip during the weeks following the mainshock, in particular affecting the Aci Platani segment.



Fig. 2 - Earthquake surface rupture across the road (right) and a house (left) located a few meters apart in the vicinity of Santa Maria La Stella; notably, the main rupture is located approximately in the middle of a scarp which is the long-term morphological expression of the fault, already censored and mapped with great detail in the Ithaca Database of ISPRA, available since 20 years ago. In spite of this knowledge, the house, built right on the fault trace, was restored and licensed to be widened just before the event. Following the December 26, 2018, earthquake, the house is no longer habitable, being crossed by severe fractures and slightly tilted.



Fig. 3 - Coseismic ground rupture (throw ca. 20 cm) in a field west of Fleri (via Nava), not far from the northwestern tip of the 2018 rupture.

Ground breaks broadly coincide with faults previously included in the database of capable faults (ITHACA database, <http://sgi2.isprambiente.it/ithacaweb/viewer/>), but in some places the newly formed breaks allowed to better define the fault trace.

Rupture is arranged in several segments, trending N-S to NW-SE. Slip vectors show a dominant dip-slip component, with secondary dextral strike slip motion.

We analyze the across-strike width along the entire rupture: the width can be either very narrow, with ruptures concentrated on a single strand, or distributed in up to 100-m-wide zones, including several en-echelon segments.

Maximum vertical displacements reach 30 cm and right-lateral displacement 15 cm. We estimate the maximum intensity as IX on the ESI-07 scale (Michetti *et al.*, 2007).

The comparison with topographic and subsurface factors allowed to evaluate the role of gravity and geological setting in driving shallow deformation. We found an influence of topography (elevation and slope) in the northernmost sector, whereas the overall pattern of deformation is controlled by slope and aspect of the top of basement lying below the volcanic deposits.

Discussion and comparison with previous events. Typically, surface ruptures and environmental effects accompanying strong (Mw 4 to 5) earthquakes at Mt. Etna are clearly confined in a narrow belt around the causative fault. The 2018 earthquake is no exception, as testified by our original results and by macroseismic surveys (Quest WG, 2019).

We compare the macroseismic field of the 2018 event with previous earthquakes that hit the Etnean region, in particular the 2002 Santa Venerina earthquake. In both cases, the very shallow focal depth favors a strong attenuation of intensity with distance.

We argue that in such settings, surface faulting and other environmental effects can tightly define the trace of the causative fault and thus provide complementary information with respect to traditional macroseismic investigations: an integrated approach can foster a more comprehensive understanding of the extremely active volcano-tectonic settings of the Etnean region, and of similar areas affected by very shallow-focus earthquake ruptures, such as the Casamicciola sector at Ischia volcano (Nappi *et al.*, 2018).

References

- Baratta M. (1894). Intorno ai recenti fenomeni endogeni avvenuti nella regione etnea agosto 1894. Boll. Soc. Geografica Italiana, Ottobre 1894.
- De Novellis, V., Atzori, S., De Luca, C., Manzo, M., Valerio, E., Bonano, M., *et al.* (2019), DInSAR analysis and analytical modeling of Mount Etna displacements: The December 2018 volcano-tectonic crisis. Geophysical Research Letters, 46, 5817–5827. <https://doi.org/10.1029/2019GL082467>.

- Emergeo Working Group, (2019). Photographic collection of the coseismic geological effects originated by the 26th December 2018 Etna (Sicily) earthquake. Misc. INGV, 48: 1-176.
- Imbo' G., (1935). I terremoti della Regione Etna. Reale Acc. Dei Lincei, Pubbl. della Commissione It. per lo studio delle grandi calamità, 5, part. 1, Firenze.
- Michetti A.M., E. Esposito, L. Guerrieri, S. Porfido, L. Serva, R. Tatevossian, E. Vittori, F. Audemard, T. Azuma, J. Clague, V. Commerci, A. Gürpınar, J. McCalpin, B. Mohammadioun, N.A. Mörner, Y. Ota, E. Roghazin (2007). Environmental Seismic Intensity Scale 2007 - ESI 2007. Memorie Descrittive della Carta Geologica d'Italia, 74, 7-54, Servizio Geologico d'Italia – Dipartimento Difesa del Suolo, APAT, Roma, Italy.
- Nappi, R., Alessio, G., Gaudiosi, G., Nave, R., Marotta, E., Siniscalchi, V., Civico, R., Pizzimenti, L., Peluso, R., Belviso, P., and Porfido, S. (2018). The 21 August 2017 M d 4.0 Casamicciola earthquake: First evidence of coseismic normal surface faulting at the Ischia volcanic island. *Seismological Research Letters*, 89(4), 1323-1334.
- QUEST WG (2019). Il terremoto etneo del 26 dicembre 2018, Mw4.9: rilievo degli effetti macrosismici. Rapporto INGV n. 1 del 06/02/2019, 9 pp., doi:10.5281/zenodo.2558168
- Riccò A. (1894). Breve relazione sui terremoti del 7 e 8 agosto 1894 avvenuti nelle contrade etnee. *Boll. Soc. Meteor. Ital.*, 14, 145-148.

EVIDENZE GEOLOGICHE DI LIQUEFAZIONE DURANTE FORTI TERREMOTI IN SEDIMENTI LACUSTRI A GRANA FINA (FUCINO, ITALIA CENTRALE)

P. Boncio¹, S. Amoroso^{2,3}, F. Galadini³, A. Galderisi^{2,4}, G. Iezzi^{2,3}, F. Liberi¹

¹ CRUST-DiSPuTer, Università "G. d'Annunzio" di Chieti - Pescara, Italy

² InGeo, Università "G. d'Annunzio" di Chieti - Pescara

³ Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy

⁴ Istituto di Geologia Ambientale e Geoingegneria, CNR, Roma

Introduzione. La liquefazione di terreni a grana fina (particelle di diametro nelle classi del silt e dell'argilla) è un argomento di particolare interesse con implicazioni sia per la pericolosità sismica locale (normativa tecnica, microzonazione sismica, pratica professionale) che per la geologia dei terremoti in generale, cioè per il riconoscimento e l'interpretazione di strutture geologiche sismo-indotte. La liquefazione di sedimenti fini è stata documentata a seguito di vari terremoti forti nel mondo. Tuttavia, la percezione che la liquefazione sismo-indotta avvenga esclusivamente, o quasi, in sedimenti sabbiosi sciolti è molto diffusa. Certamente lo studio di casi reali di liquefazione di sedimenti fini può contribuire ad una migliore comprensione del fenomeno e al trasferimento delle conoscenze.

Nel presente lavoro sono illustrati i risultati di un lavoro svolto in una località situata nel bacino del Fucino, alla periferia di Avezzano (Borgo Via Nuova, Fig. 1), dove un canale di drenaggio ha messo alla luce una serie di dicchi di materiale sedimentario fino all'interno della successione lacustre, interpretati come dovuti a liquefazione sismo-indotta.

Metodi. Il sito è stato studiato con approccio multidisciplinare, al fine di caratterizzare in dettaglio la successione stratigrafica, i meccanismi di messa in posto dei dicchi e la probabile sorgente del materiale fino liquefatto. A questo scopo, sono stati realizzati: 1) uno studio di terreno dettagliato, con approccio paleosismologico; 2) un sondaggio a carotaggio continuo fino a 20 m di profondità; 3) una serie di indagini geotecniche e geofisiche in situ (CPTU, SPT, SDMT); 4) analisi di laboratorio su campioni derivanti dai dicchi e dalla successione stratigrafica ospite per definirne granulometria, limiti di Atterberg e composizione mineralogica tramite diffrazione a raggi X (XRPD); e 5) stima della suscettibilità a liquefazione mediante analisi CRR/CSR sulle indagini in situ.

Risultati. Lo studio svolto indica che i dicchi sono formati prevalentemente da silt, liquefatto e trasportato verso l'alto da forze idrauliche improvvise, di breve durata, come nel caso