Comment on "The 21 August 2017 M_d 4.0 Casamicciola Earthquake: First Evidence of Coseismic Normal Surface Faulting at the Ischia Volcanic Island" by Nappi et al. (2018)

by V. De Novellis, S. Carlino, R. Castaldo, A. Tramelli, C. De Luca, N. A. Pino, S. Pepe, V. Convertito, I. Zinno, P. De Martino, M. Bonano, F. Giudicepietro, F. Casu, G. Macedonio, M. Manunta, M. Manzo, G. Solaro, P. Tizzani, G. Zeni, and R. Lanari

ABSTRACT

We are writing this comment because many aspects of the analysis presented by Nappi *et al.* (2018) are debatable. In particular, a major issue is relevant to the conclusion suggested by Nappi *et al.* (2018) about a seismogenic normal fault with northward dip. This finding is not well-founded because the authors do not really present a causative source model. In addition, their statement is clearly not consistent with the Differential Interferometric Synthetic Aperture Radar (DInSAR), Global Positioning System (GPS) and seismological measurements presented in the article previously published by De Novellis *et al.* (2018). Moreover, we also report an evident error in the geologic map proposed by Nappi *et al.* (2018, their fig. 3).

DISCUSSION AND CONCLUSIONS

In their recent article, Nappi *et al.* (2018) study the causative source of the earthquake (M_w 3.9) that occurred on 21 August 2017 at Casamicciola Terme (Ischia Island, Italy). In particular, the authors agree with De Novellis *et al.* (2018) about the hypocentral depth (ca. 1.2 km) and the EW-striking dip-slip fault plane, but they disagree with their final model that provides an EW plane with south-dipping high-angle plane. Moreover, in their work, Nappi *et al.* (2018) conclude that their model with a subvertical fault with dip toward north is a reasonable hypothesis for the Casamicciola earthquake source because it is based on: (a) the relevant and large collected geological dataset, with the whole coseismic ruptures found in the hanging wall, as usually observed for normal faults; (b) the comparison with previous historical events, which deformation field pattern is in good agreement with their data; and (c) the conformity with existing long-term geological models (Tibaldi and Vezzoli, 1998, and references therein). Finally, Nappi *et al.* (2018) affirm that the geometry and regularity of the structural pattern, together with constant kinematics of the coseismic ruptures with the north side down, strongly suggest a primary tectonic origin for the mapped ruptures and strongly supports an EW normal-faulting focal mechanism (presented by De Novellis *et al.*, 2018) for the 2017 Casamicciola earthquake.

Many aspects of the analysis presented by Nappi *et al.* (2018) are debatable, as discussed in the following.

Let us first highlight an evident error in the geologic map proposed by Nappi *et al.* (2018), *including two geological sections* originally presented by Tibaldi and Vezzoli (1998). *Indeed*, the position of these two traces does not correspond to the original ones published in Tibaldi and Vezzoli (1998) (see Fig. 1a). In particular, the section AA′, which appears crossing the main deformation pattern retrieved through the Differential Interferometric Synthetic Aperture Radar (DInSAR) analysis, is misplaced about 1150 m eastward. These errors at least require an errata corrige by the authors to avoid the propagation of their mistake through the future literature.

A major issue is relevant to the conclusion suggested by Nappi *et al.* (2018) about a normal fault with northward dip; this finding is not well-founded because the authors do not really present a causative source model, and above all, their statement is clearly not consistent with the DInSAR, continuous Global Positioning System (cGPS), and seismological measurements presented by De Novellis *et al.* (2018) (see Fig. 1b). The projection on the surface of the Okada solution retrieved by De Novellis *et al.* (2018) occurs right in the area where Nappi *et al.* (2018) measure the surface ruptures (Fig. 1b), which are very likely influenced by local phenomena (the slope, for instance). Therefore, given the subsidence pattern imaged through the DInSAR analysis, if a north-dipping normal fault should be considered as a viable solution, according to Nappi *et al.* (2018), the surface projection of the fault top should be located south of the subsided area and, as a consequence, the

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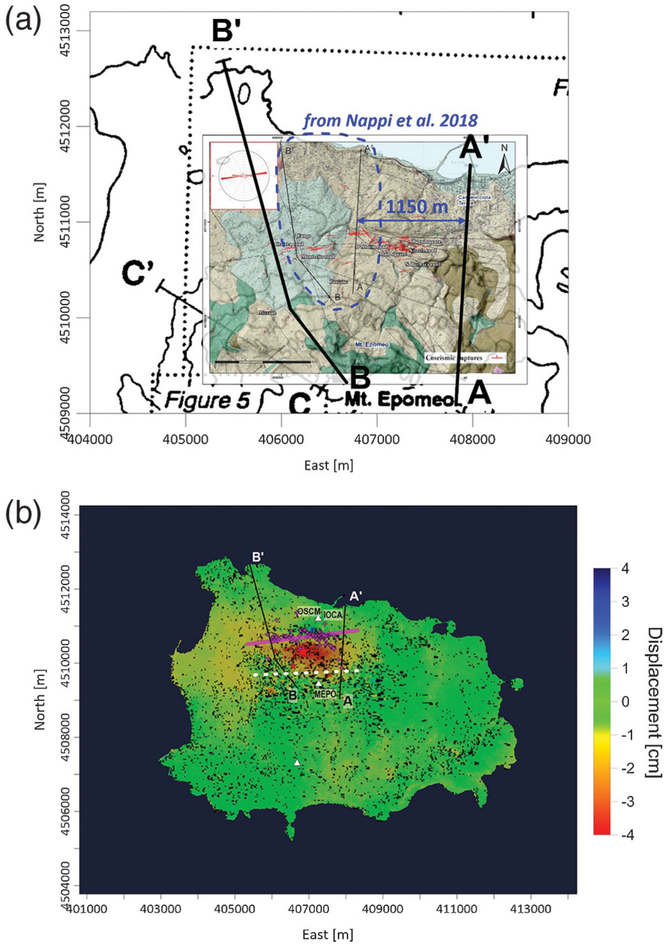

▲ **Figure 1.** (a) Geological map presented by Nappi *et al.* (2018) superimposed on a portion of the map of Tibaldi and Vezzoli (1998); the misplacement of the two traces AA′ and BB′ (particularly the former one) is evident in the map of Nappi *et al.* (2018). (b) Differential Interferometric Synthetic Aperture Radar (DInSAR) map (radar line of sight) originally presented in De Novellis *et al.* (2018) obtained from Sentinel 1 data (descending orbits on 16–22 August 2017) with superimposed the AA′ and BB′ traces originally drawn by Tibaldi and Vezzoli (1998). Moreover, the coseismic ruptures observed by Nappi *et al.* (2018) are highlighted by using magenta crosses, and the surface projection of the Okada fault plane retrieved by De Novellis *et al.* (2018) is indicated with the magenta solid line; the projection on the surface of an Okada solution in agreement with a north-dipping normal fault source consistent with Nappi *et al.* (2018) is represented by the white dashed line. The continuous Global Positioning System (cGPS) (MEPO, OSCM) and the IOCA seismometric station are presented by the white triangles. The biggest red star indicates the location of the 21 August 2017 mainshock, and the smaller ones indicate the main aftershocks recorded in the time interval 21–30 August 2017.

fracture interpreted by Nappi *et al.* (2018) as surface primary effects of the rupture either would be in the wrong position or could not be related to primary effects. We further remark that the leveling data, to which Nappi *et al.* (2018) refer, are not presented in their paper; in any case, however, we do not see how these data could change the interpretation of the scenario arising from the results presented by De Novellis *et al.* (2018). In addition, Nappi *et al.* (2018) do not take into account others resurgent models proposed for Ischia Island (e.g., Acocella and Funiciello, 1991; Orsi *et al.*, 1991), in which different kinematics of the faults associated to the resurgence are proposed.

Another debatable question arises from the comment of Nappi *et al.* (2018) on the cGPS data. Indeed, Nappi *et al.* (2018) affirm that the cGPS data are affected by uncertainty due to the location of the used instruments (cGPS Monte Epomeo [MEPO] and Osservatorio di Casamicciola [OSCM] stations), because those are not close to the hanging wall and footwall of the seismogenetic fault, so that they could not provide a reliable measurement of the slip distribution. We completely disagree with this statement.

Given the seismogenic source characteristics and the retrieved surface deformation pattern (De Novellis *et al.*, 2018), it is evident that the MEPO and OSCM stations are in the near field at 1- and 0.75-km distance from the earthquake epicenter, respectively. The cGPS coseismic offsets have been computed at two Istituto Nazionale di Geofisica e Vulcanologia (INGV) analysis centers and the two displacement results have been combined in a least-squares sense (consensus solution) to minimize possible sources of systematic errors. Accordingly, the average errors associated to the offsets in the vertical and horizontal components are of 8 and 2.5 mm, respectively. The coseismic displacement obtained from the cGPS data processing is noticeable at the MEPO and OSCM stations. In particular, the horizontal offsets are directed toward north (15.6 mm) and north–northeast (10.3 mm), respectively. Moreover, only the MEPO station is affected by a vertical displacement with a slight subsidence (−10.6 mm). Therefore, the measured offsets computed at both the cGPS stations reliably support the analysis presented by De Novellis *et al.* (2018). Moreover, although not accounted by Nappi *et al.* (2018), we remark that De Novellis *et al.* (2018) also investigated the seismic waveforms recorded by the accelerometer installed at the Casamicciola Terme Observatory (IOCA station), at less than 1-km distance from the epicenter (collocated with cGPS station OSCM); specifically, the analysis performed on the seismic waveforms highlights a vertical uplift of about 0.7 cm, which is also in good agreement with the modeled displacements.

It is also useful to underline that the multidisciplinary approach proposed by De Novellis *et al.* (2018) is able to provide an estimate, through analytical modeling (Okada solution), of the subsurface causative source. Conversely, in the case of the source model proposed by Nappi *et al.* (2018), based on field evidence, it is not clarified how the observed fracturing process at ground surface can be extended to the mentioned hypocentral depth. In other words, in their work, Nappi *et al.* (2018) do not explain which are the physical assumptions that allow them to extend, at depth, the distribution of the superficial stress tensor reconstructed by the field analyses and to consider the best fault configuration as a northward one.

Summing up, the speculations proposed by Nappi *et al.* (2018) on the seismogenetic source seem to be not well-founded because they are inconsistent with respect to the main findings presented by De Novellis *et al.* (2018) for (1) the coseismic displacements retrieved through the DInSAR measurements, (2) the horizontal and vertical coseismic displacements recorded by the MEPO and OSCM cGPS stations, and (3) the upward first impulse recorded by the IOCA seismic station.

DATA AND RESOURCES

All data used in this article came from published sources listed in the references.

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V. De Novellis
R. Castaldo
C. De Luca
S. Pepe
I. Zinno
F. Casu
M. Manunta
M. Manzo
G. Solaro
P. Tizzani
G. Zeni
R. Lanari
National Research Council (CNR)
Istituto per il Rilevamento Elettromagnetico dell'Ambiente (IREA)
Via Diocleziano 328
Naples 80124, Italy
de novellis.v@irea.cnr.it
castaldo.r@irea.cnr.it
de luca.c@irea.cnr.it
pepe.s@irea.cnr.it
zinno.i@irea.cnr.it
casu.f@irea.cnr.it
manunta.m@irea.cnr.it
manzo.m@irea.cnr.it
solaro.g@irea.cnr.it
tizzani.p@irea.cnr.it
zeni.g@irea.cnr.it
lanari.r@irea.cnr.it

S. Carlino
A. Tramelli
N. A. Pino
V. Convertito
P. De Martino
F. Giudicepietro
G. Macedonio
Istituto Nazionale di Geofisica e Vulcanologia (INGV)
Via Diocleziano 328
Naples 80124, Italy
stefano.carlino@ingv.it
anna.tramelli@ingv.it
alessandro.pino@ingv.it
vincenzo.convertito@ingv.it
prospero.demartino@ingv.it
flora.giudicepietro@ingv.it
giovanni.macedonio@ingv.it

M. Bonano
National Research Council (CNR)
Istituto di Metodologie per l'Analisi Ambientale (IMAA)
Contrada Santa Loja
Tito Scalo (Potenza) 85050, Italy
bonano.m@irea.cnr.it

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