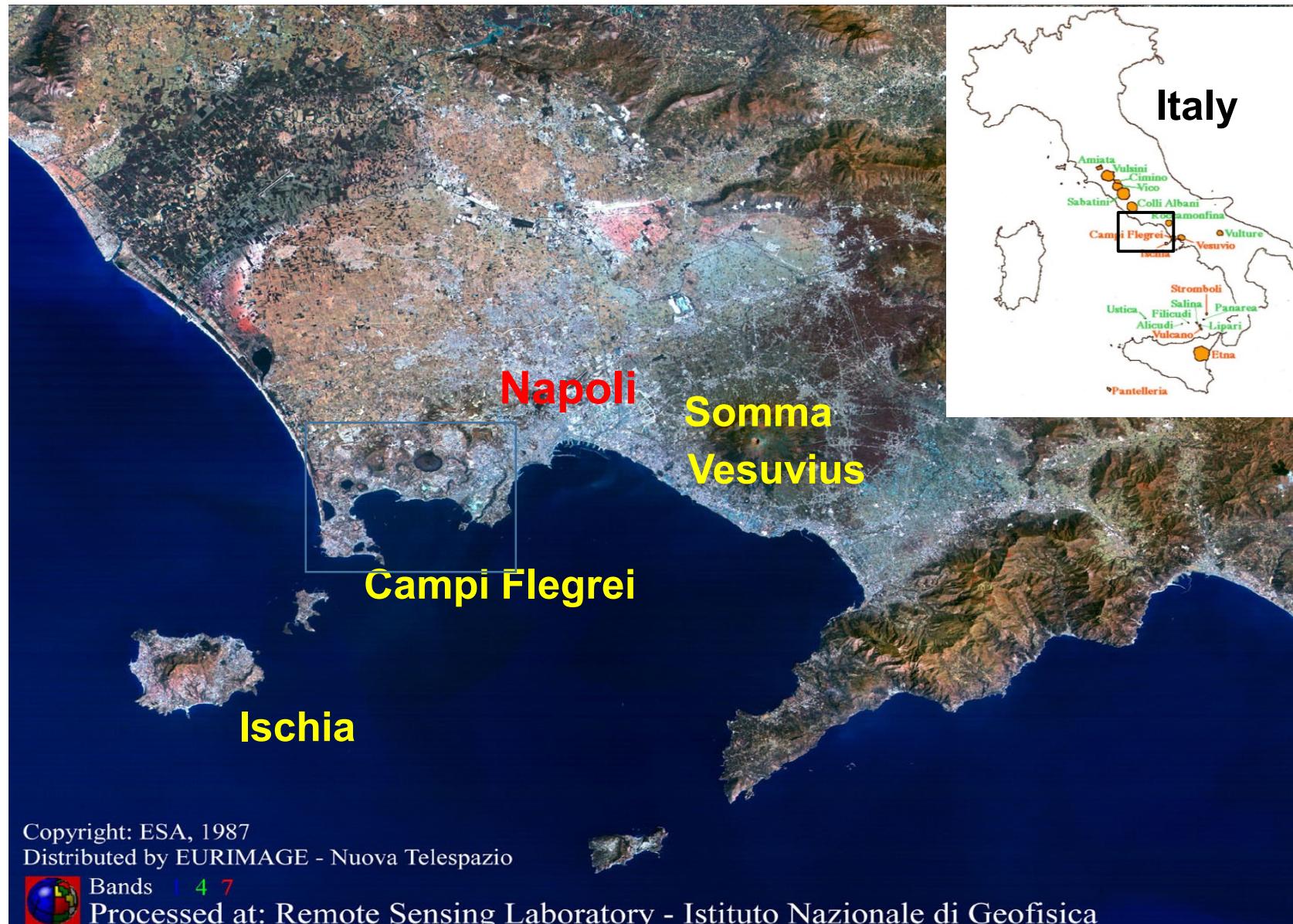


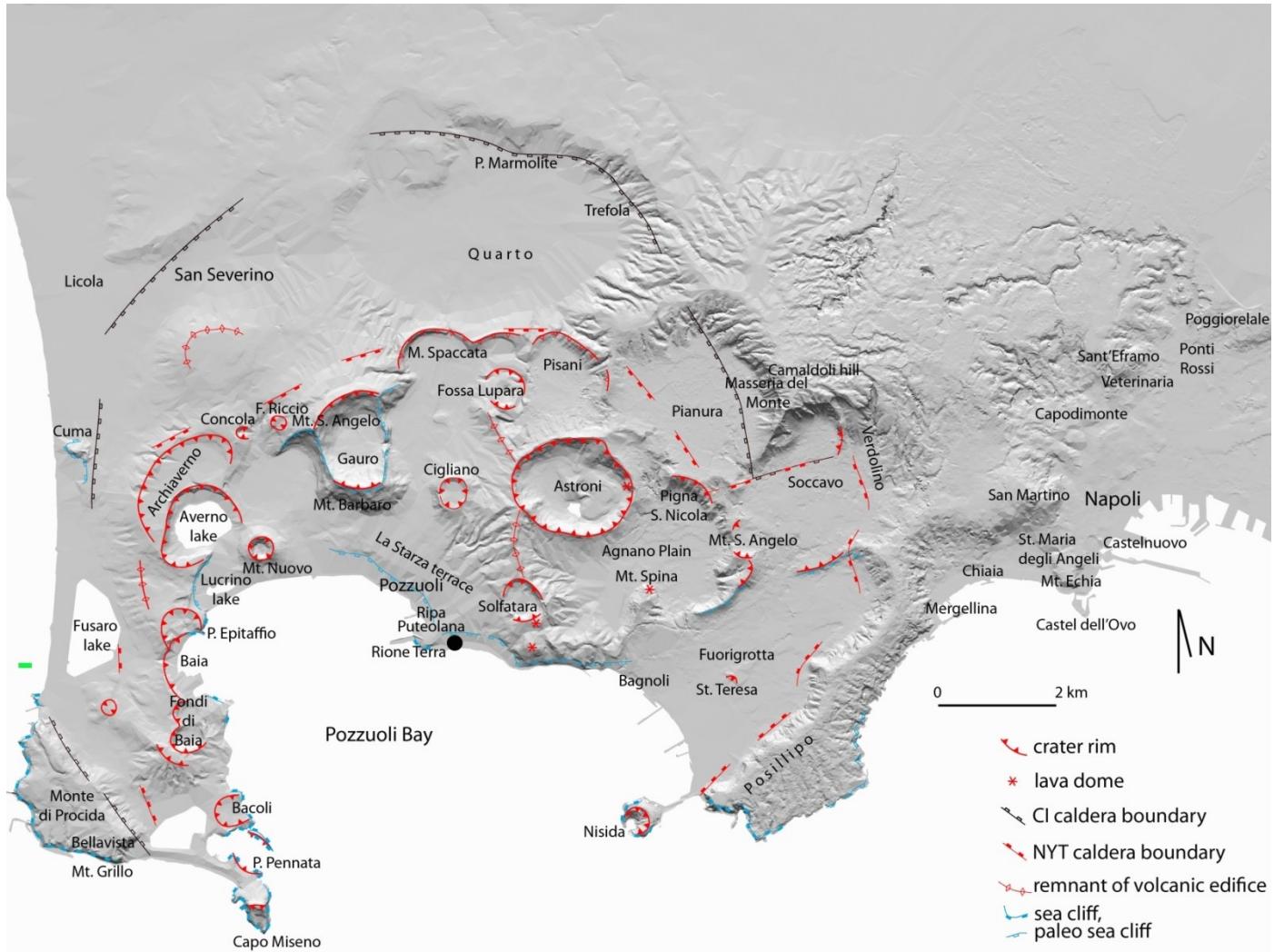


VOLCANIC HAZARD

The Campi Flegrei caldera:
structure, volcanism,
dynamics and hazard



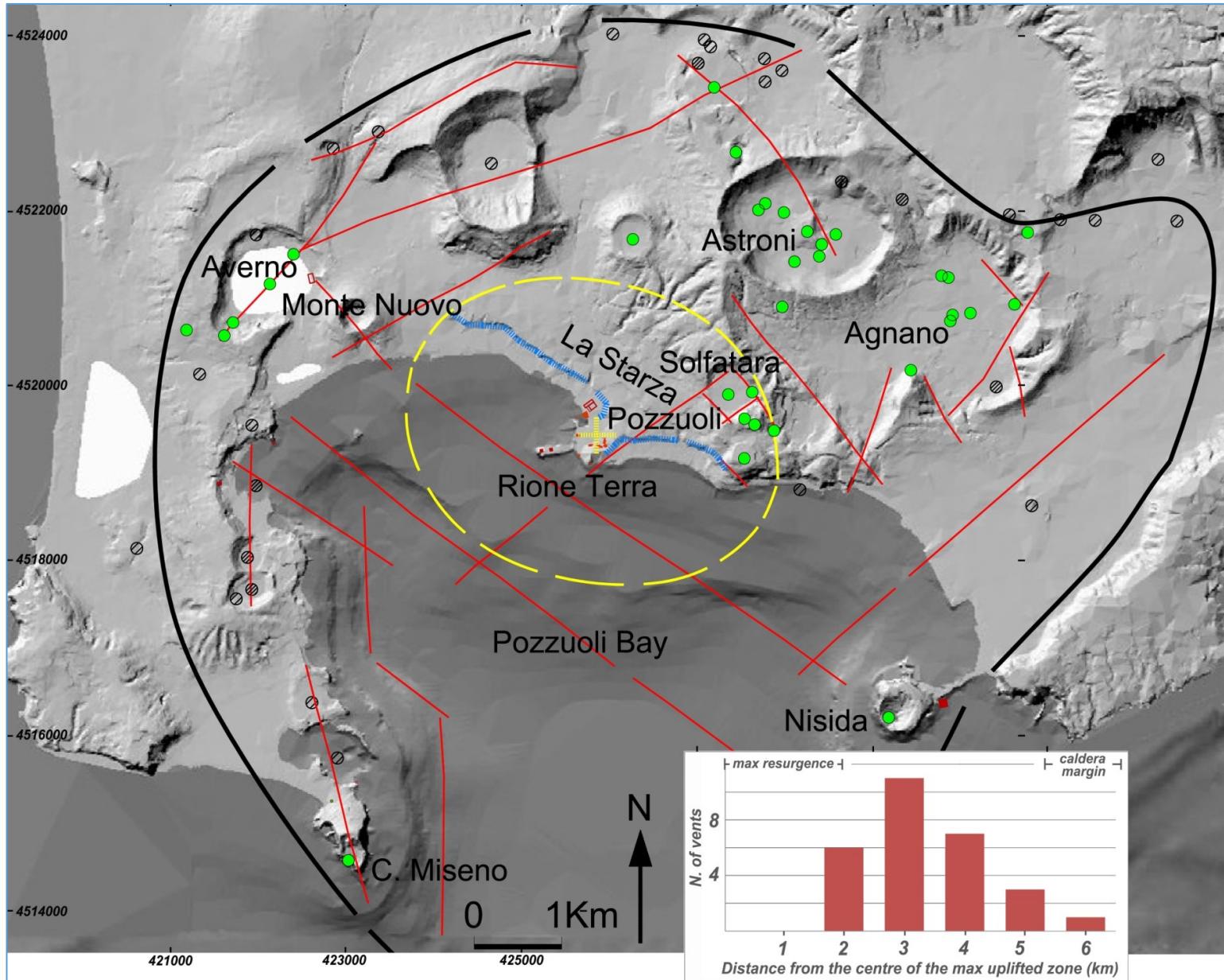
*The three Neapolitan
active volcanoes*



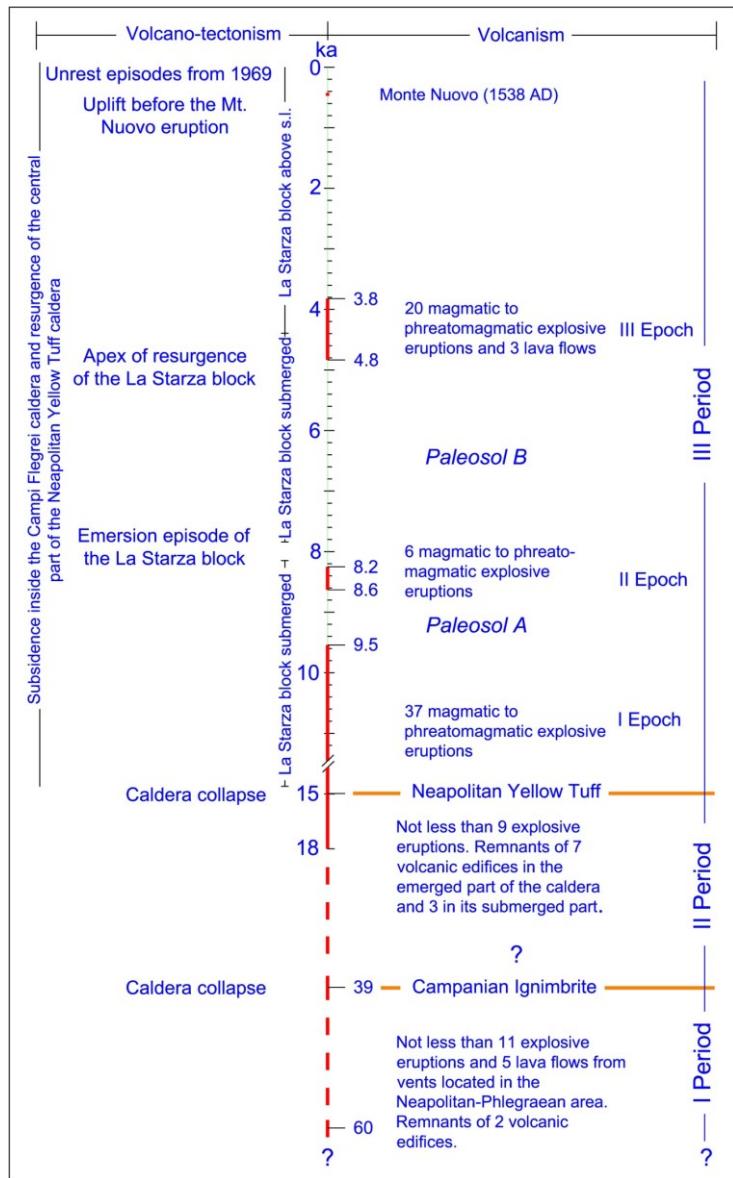
Morphological and structural sketch map of Campi Flegrei. The main geomorphological features and toponyms are reported (after Costa et al 2021, Bulletin of Volcanology, under review)

Campi Flegrei

The activity of the Campi Flegrei volcanic district began more than 80,000 years ago. It, in the densely inhabited metropolitan area of Naples (Italy), is commonly considered one of the most dangerous active volcanic systems. Campi Flegrei is a ~12 km wide depression hosting two nested calderas formed during the eruptions of the Campanian Ignimbrite (~39 ka) and the Neapolitan Yellow Tuff (~15 ka). The Campanian Ignimbrite eruption is the most violent known in the Mediterranean area. During the eruption pyroclastic currents buried two-thirds of Campania under a thick layer of tuff. Following this eruption, the Campi Flegrei subsided creating a caldera that was invaded by the sea. In subsequent millennia volcanic activity was concentrated in the area inside the caldera, with the formation of eruption centres and newly emergent land. The Neapolitan Yellow Tuff eruption devastated an area >1,000 km² and caused a new caldera collapse within the previous one. During the last 15,000 years, the central portion of this latter caldera has risen by about 100 m due to a process of resurgence that has profoundly affected subsequent volcanic activity, which has continued within the caldera with over 70 eruptions, mostly explosive and concentrated in three epochs of intense activity, separated by long periods of quiescence. The most recent eruption occurred in 1538, after a period of inactivity lasting more than 3,000 years, and gave rise to the tuff cone of Monte Nuovo. The eruption was preceded by evident precursor phenomena and lasted for a week; it was dominated by phreatomagmatic explosions, with the generation of pyroclastic currents and fall-out deposits. Today the Campi Flegrei is affected by fumaroles, seismic activity and a phenomenon known as bradyseism, a symptom of the general resurgence process, consisting of periodic slow upward and downward movements of the ground.



Morphological and structural sketch map of Campi Flegrei. Circles: eruption vents of the I epoch (15-9.5 ka BP; dashed), II epoch (8.6-8.2 ka BP; densely dashed) and III epoch (4.8-3.8 ka BP; green). Red: main faults and fractures; black line: Neapolitan Yellow Tuff caldera; ellipse: most uplifted area in the last 5 ka; blue line: cliff of the La Starza uplifted marine terrace. Inset: distance of the eruptive vents of the last 5 ka from the centre of the maximum uplifted zone in the same period (after Di Vito et al., 2016)

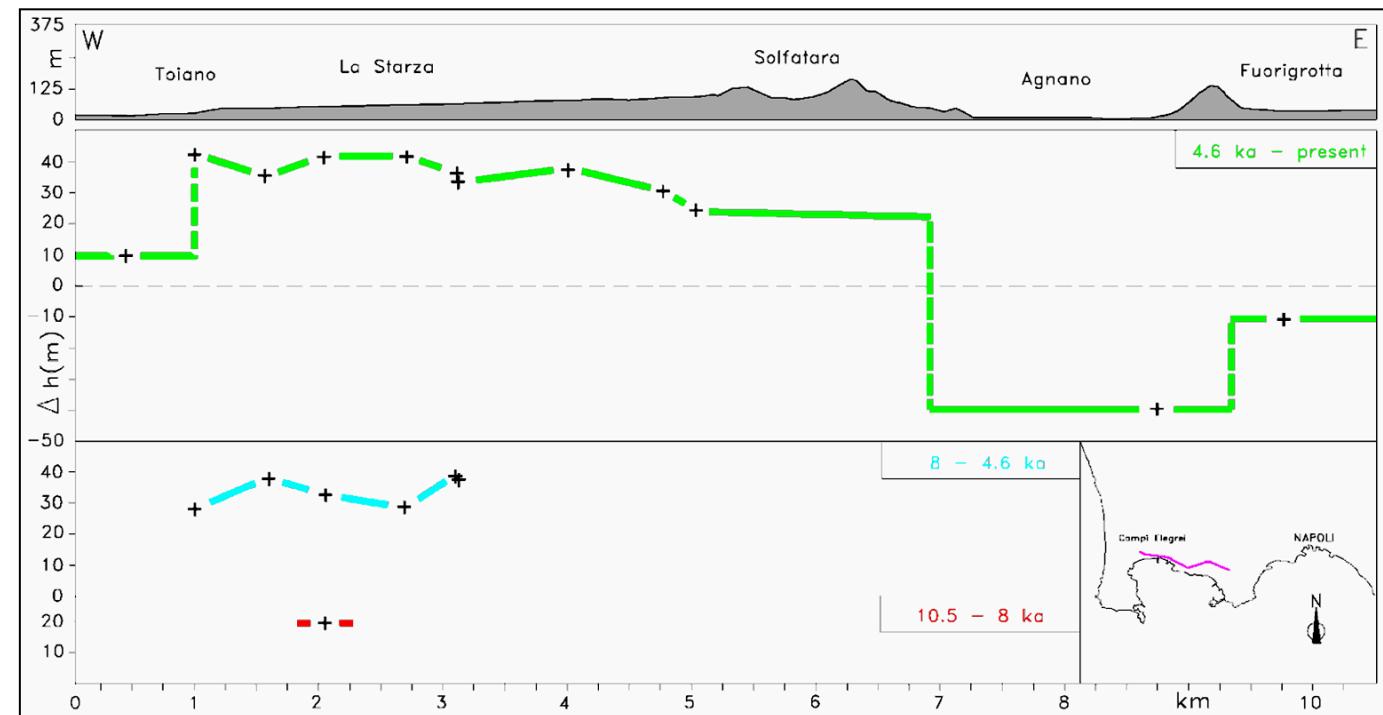


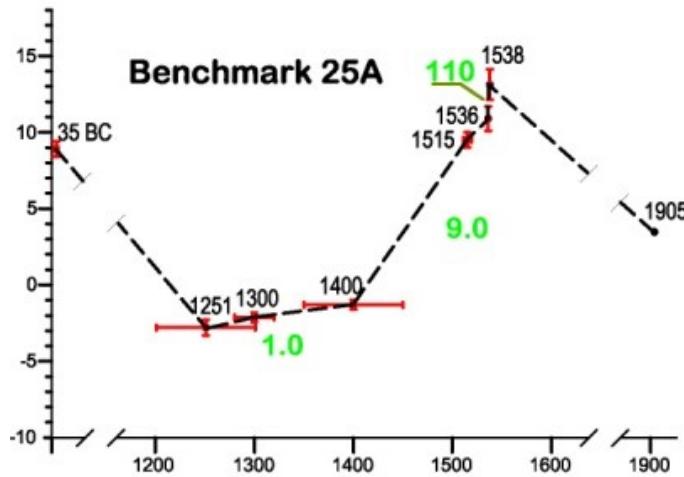
Chronostratigraphic scheme of the volcanic and deformational events of the Campi Flegrei caldera (modified after Di Vito et al., 1999)

Rapid ground deformations preceded the epochs of intense volcanism. Before and during the last epoch of activity the La Starza marine terrace (photo) was uplifted of about 50 m

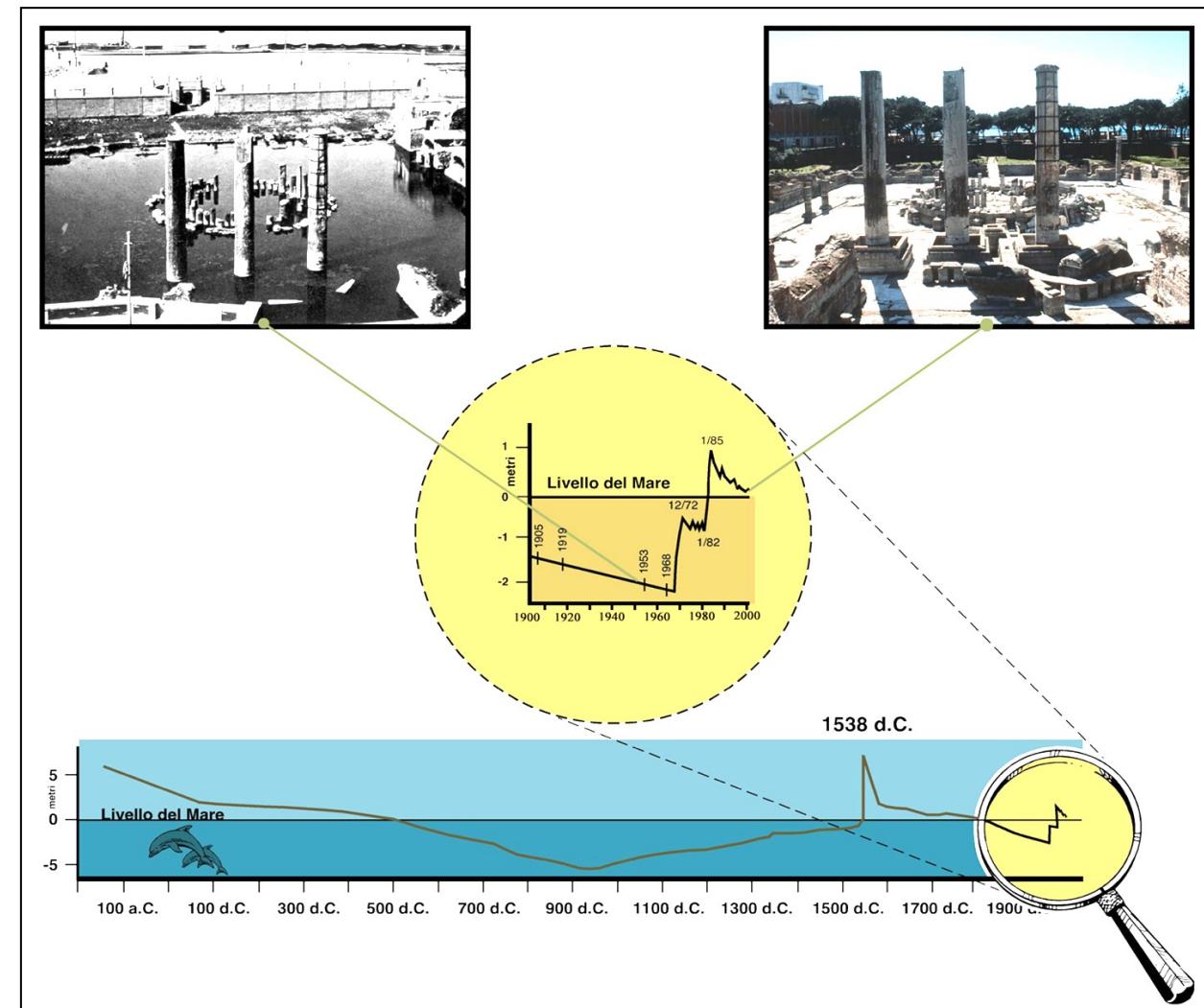


Net vertical displacement along the Pozzuoli coastline before and during the three epochs of intense volcanism of the caldera (after Di Vito et al., 1999)

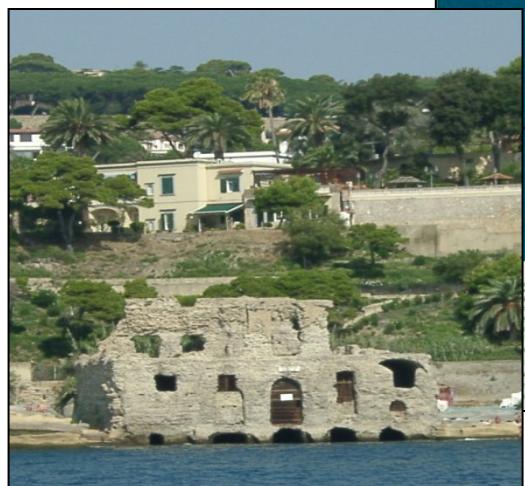




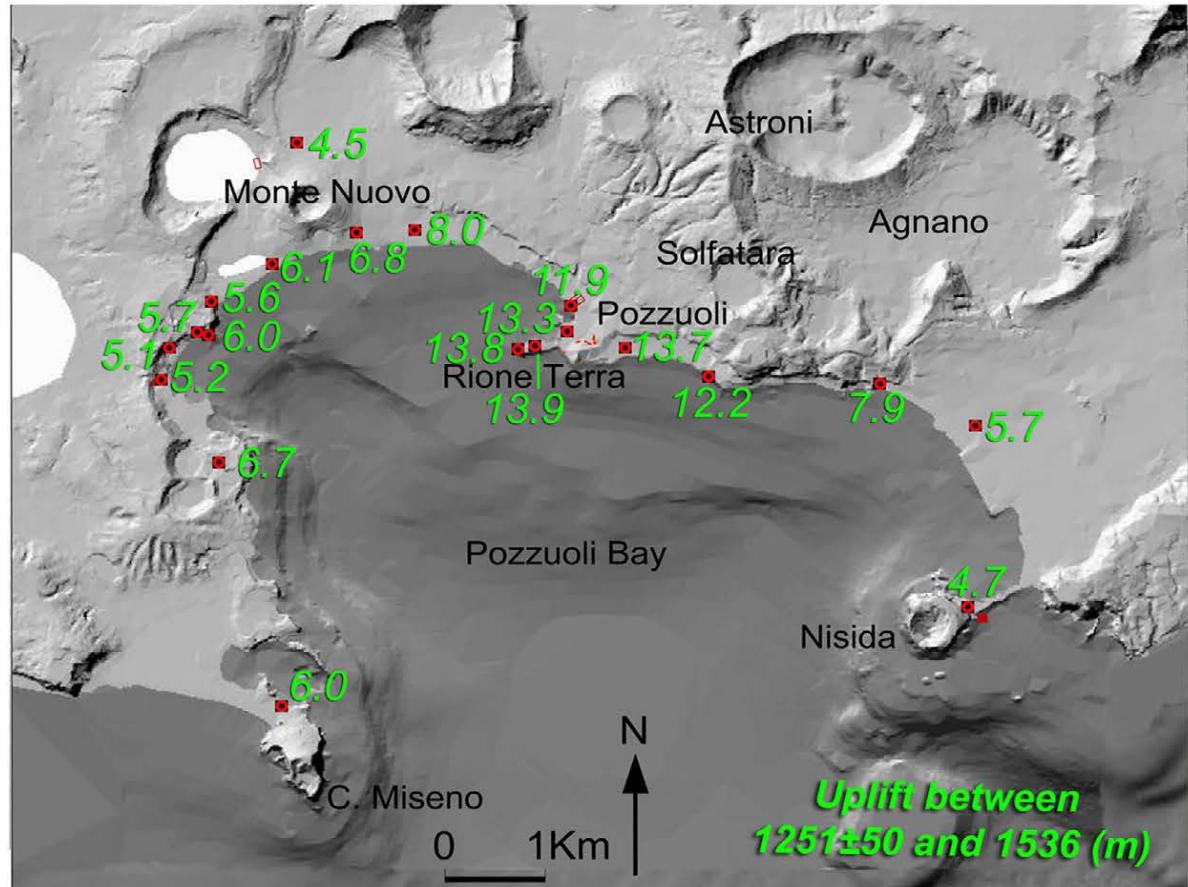
Ground movements at Serapeo from 35 bC to 1905
 (Di Vito et al., 2016)



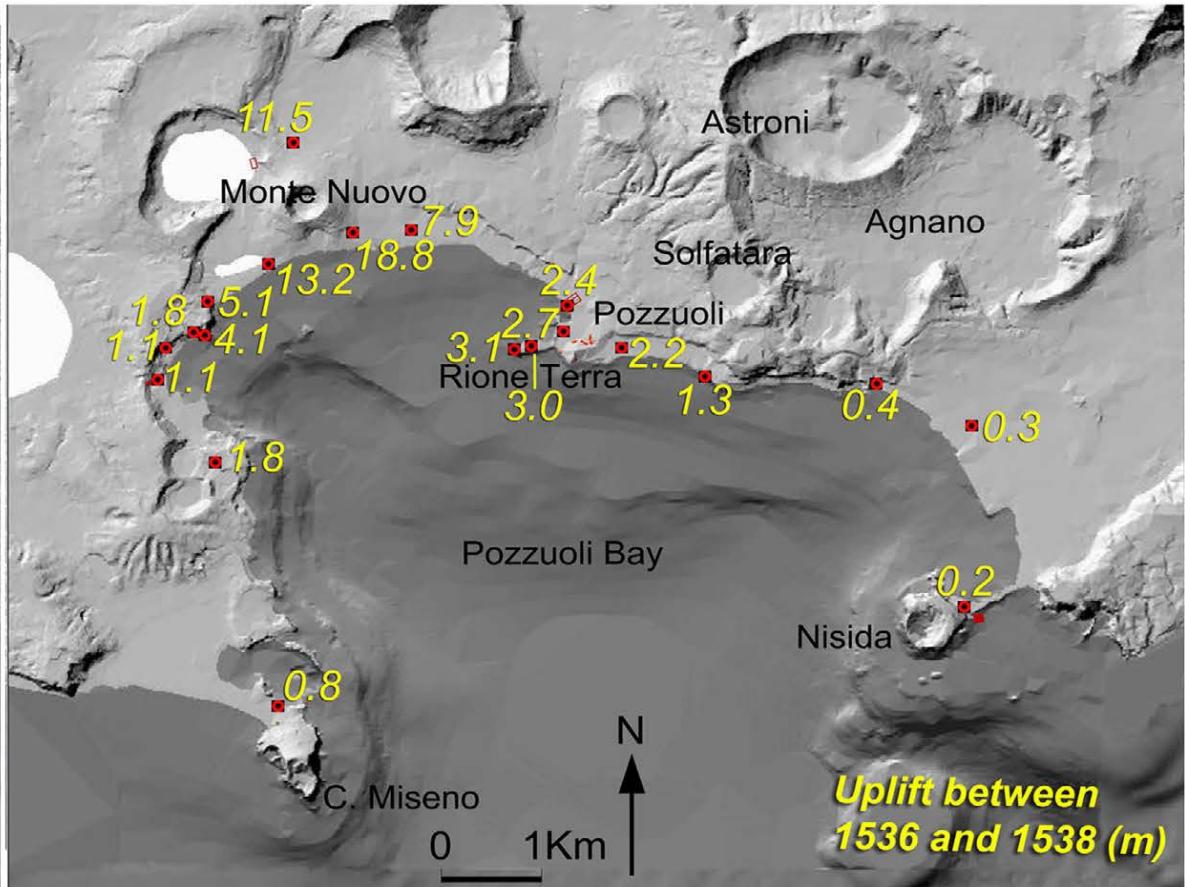
Subsidence, evidences along the coast



Vertical ground deformations preceding the last eruption

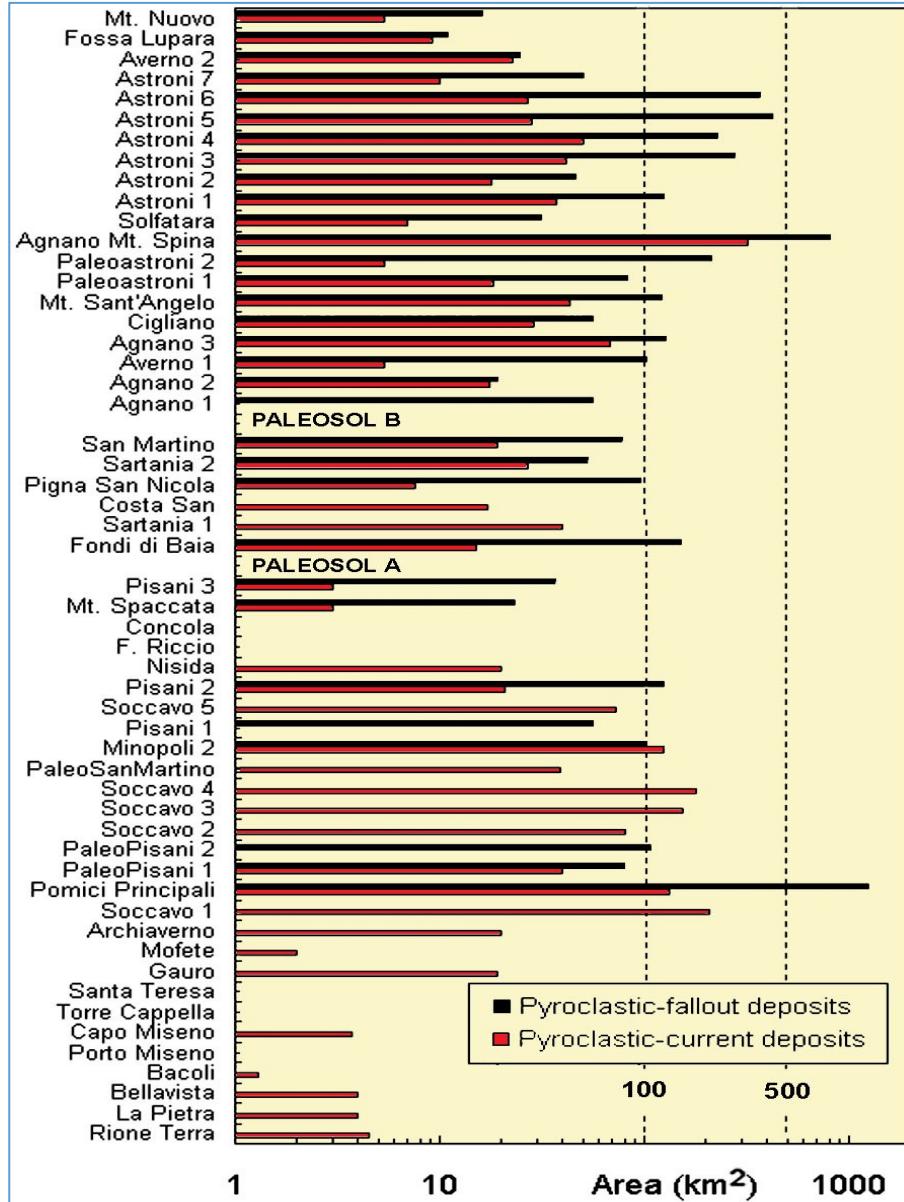


a



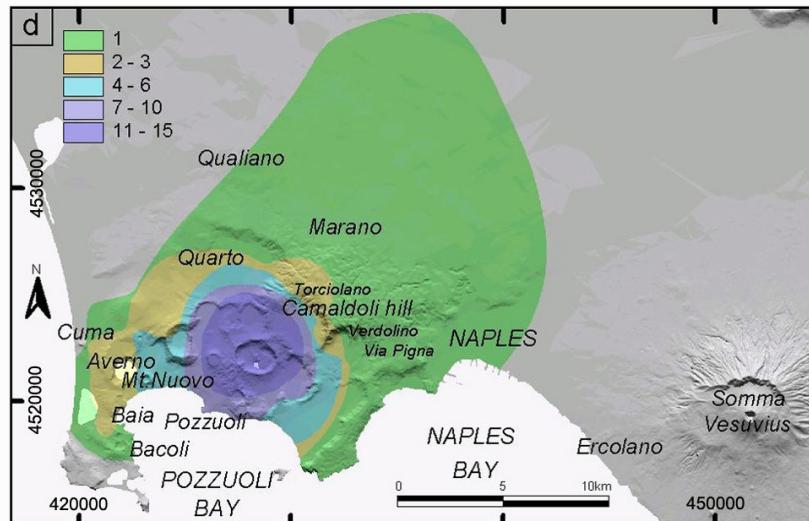
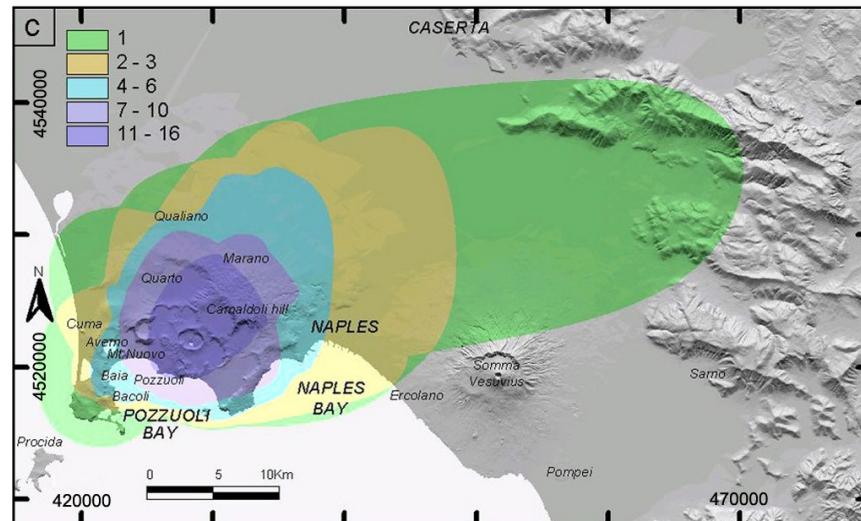
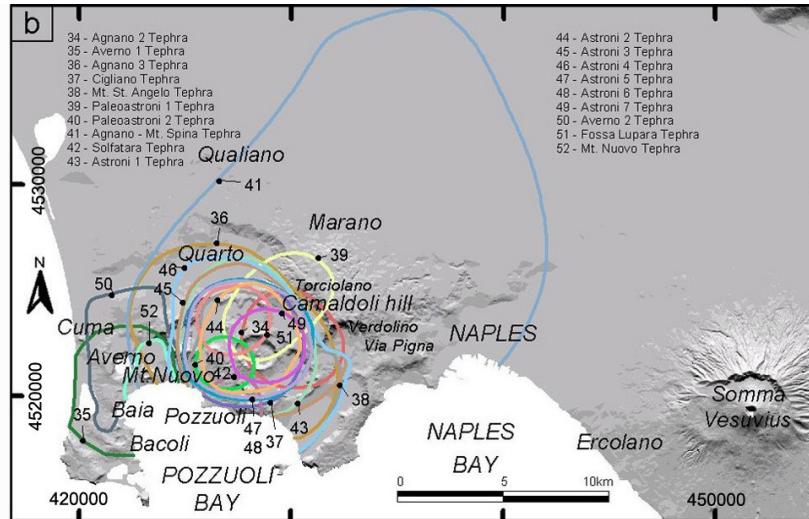
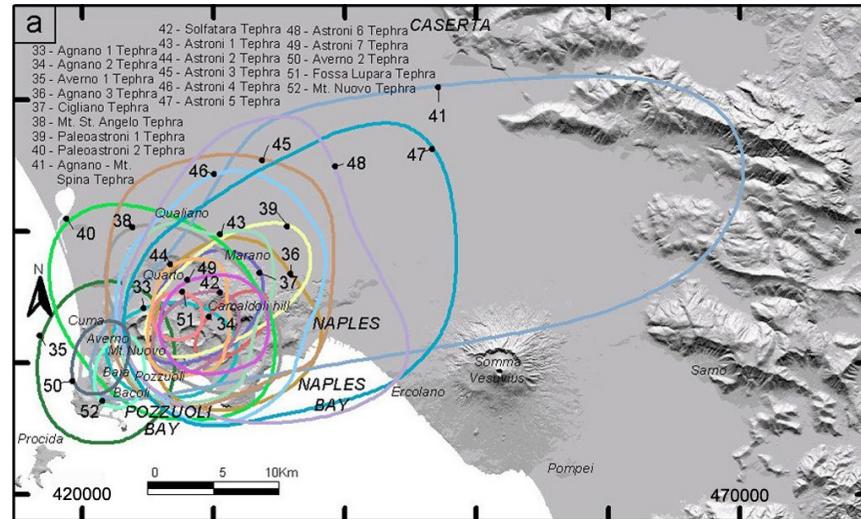
b

Distribution of the surface uplift preceding the Mt. Nuovo eruption. From 1251 to 1536 (a) the uplift affects the whole caldera, with a maximum in the Pozzuoli area. From 1536 to 1538 (b) the uplift is centered in the area of the future eruption (Monte Nuovo).



Distribution of products of the eruptions of the past 15 ka

Areas covered by pyroclastic-fallout and -current deposits of the Campi Flegrei caldera over the past 15 ka (Orsi et al, 2004)



Distribution of the pyroclastic deposits of the III epoch and of Monte Nuovo.

(a) 10 cm isopachs of the fallout deposits; (b) distribution of the pyroclastic-current deposits; (c) frequency of deposition of fallout beds thicker than 10 cm; (d) frequency of deposition of pyroclastic-current beds (Orsi et al., 2004)

Some recent volcanoes

Nisida



Averno



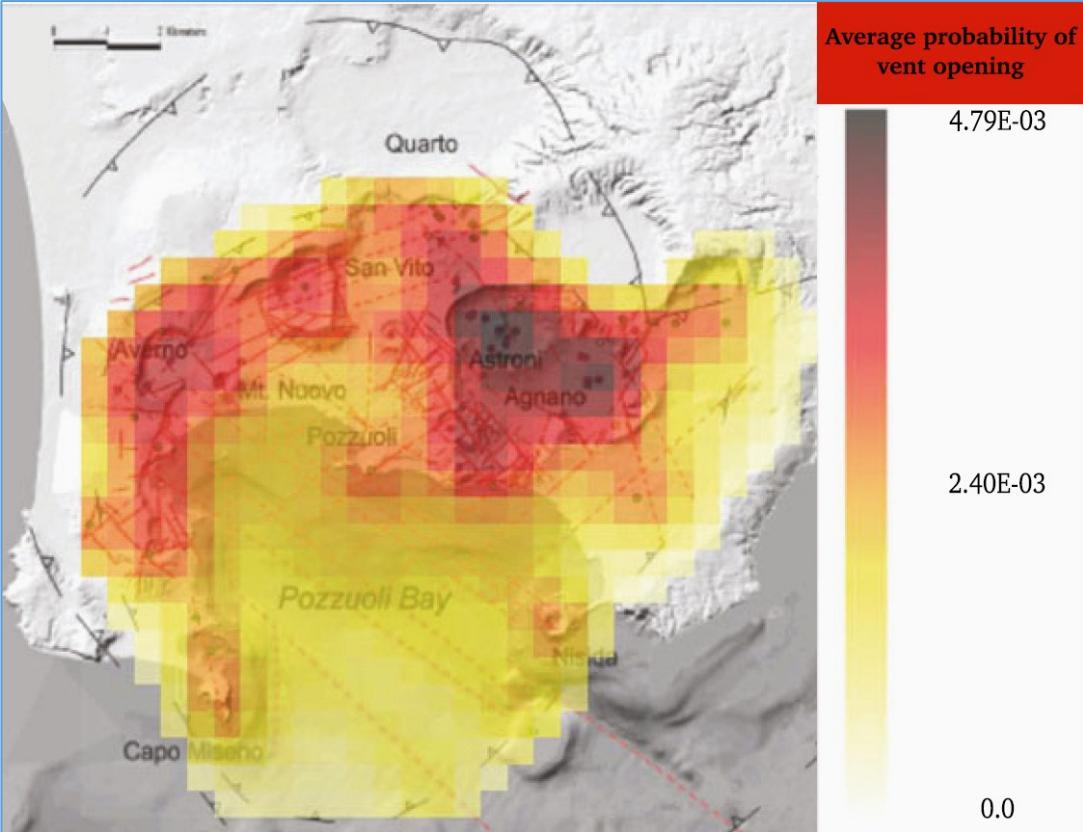
Solfatara



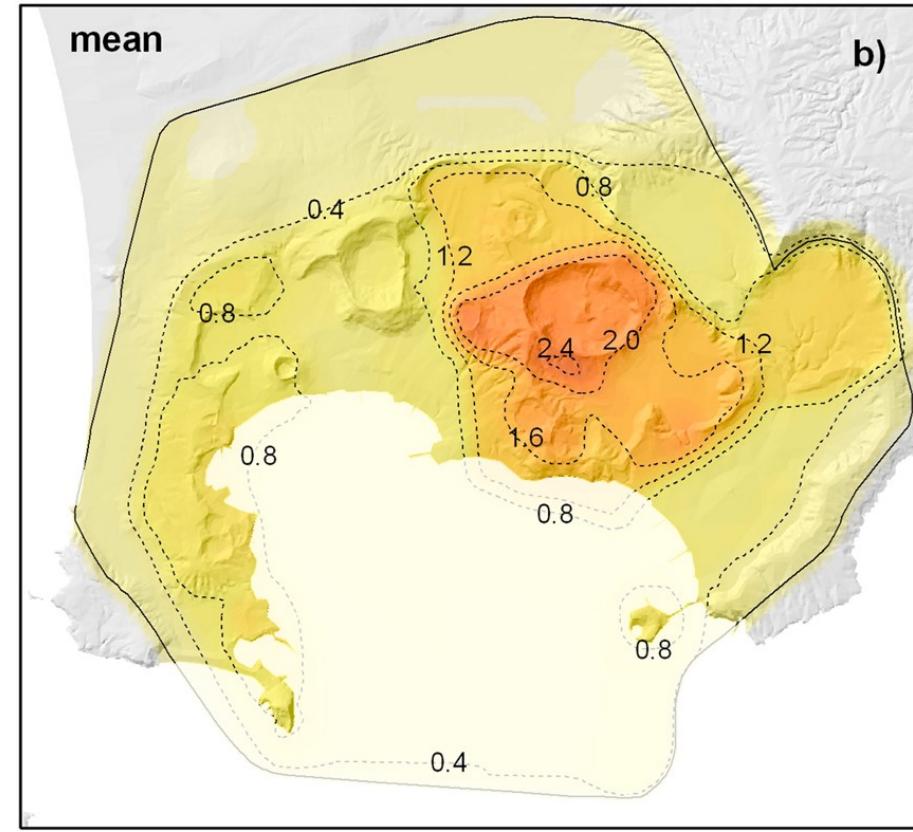
... and Monte Nuovo, the youngest volcano active in the caldera
September 1538



Probability of new vent opening



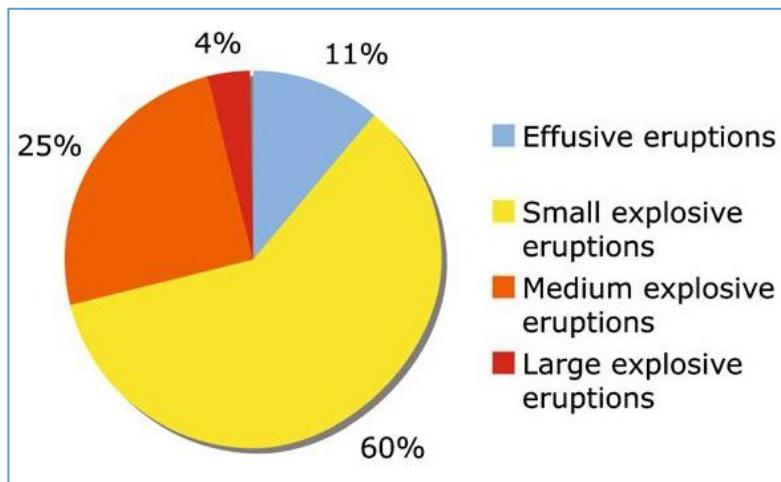
Best guess value of conditional probability of vent opening at Campi Flegrei (modified after Selva et al., 2012)



Map of background probability of future vent opening produced by incorporating the information on the distributions of past vents in the last 15 ka, fault displacement and surface fracture density (After Bevilacqua et al., 2015).

Eruption	Age (ka bp)	Area _{1cm} (km ²)	Area _{10cm} (km ²)	Volume Tephra (km ³)	Volume DRE (km ³)	Density (kg/m ³)	Total Erupted Mass (kg*10 ¹¹)	Magnitude	Mass Discharge Rate (kg/sec)
Agnano 1	4.80 ^a	107	56	0.033	0.018	1400	0.46	3.66	
Avemo 1	4.70 ^b	262	103	0.095	0.053	1400	1.33	4.12	
Agnano 2	4.60 ^b	58	19	0.025	0.014	1400	0.35	3.54	
Agnano 3	4.55 ^b	872	414	0.333	0.186	1400	4.66	4.67	
Cigliano	4.50 ^b	91	54	0.093	0.052	1400	1.30	4.11	
Pignatiello 2	4.45 ^b	29	18	0.028	0.016	1400	0.39	3.59	
Monte S. Angelo	4.40 ^a	230	121	0.125	0.070	1400	1.75	4.24	
Paleo Astroni 1	4.30 ^b	159	82	0.090	0.050	1400	1.26	4.10	
Paleo Astroni 2	4.20 ^a	648	218	0.178	0.010	1400	2.49	4.40	
Agnano-Monte Spina	4.10 ^a	2,237	882	1.940	0.854	1100	21.30	5.33	1.2*10 ⁸
Paleo Astroni 3	3.95 ^b	45	29	0.033	0.018	1400	0.46	3.66	
Solfatara	3.90 ^b	78	31	0.046	0.026	1400	0.64	3.81	
Astroni 1	3.88 ^b	223	127	0.108	0.060	1400	1.51	4.18	
Astroni 2	3.87 ^b	78	46	0.035	0.020	1400	0.49	3.69	
Astroni 3	3.86 ^b	593	274	0.281	0.157	1400	3.93	4.59	
Astroni 4	3.85 ^b	710	226	0.242	0.135	1400	3.39	4.53	
Astroni 5	3.84 ^b	817	427	0.184	0.103	1400	2.58	4.41	
Astroni 6	3.83 ^a	893	365	0.233	0.121	1300	3.03	4.48	7.4*10 ⁶
Astroni 7	3.82 ^a	110	50	0.116	0.065	1400	1.62	4.21	
Avemo 2	3.80 ^b	85	45	0.139	0.067	1200	1.67	4.22	3.2*10 ⁶
Fossa Lupara	3.75 ^b	24	11	0.041	0.016	1000	0.41	3.61	
Monte Nuovo	0.50	28	17	0.052	0.029	1400	0.73	3.86	2.0*10 ⁶

^a Measured and ^b inferred ages from Di Vito et al. (1999) and Orsi et al. (2004).



Explosive eruptions of the past 5 ka at Campi Flegrei and their measured physical parameters.

The distribution of products and physical parameters permitted to define 3 size classes for the explosive eruptions: small-, medium- and large explosive events (Orsi et al., 2009).

Relative proportions of conditional probability for all the events likely to occur (best guess values) at Campi Flegrei caldera.

Type of past eruptions occurred at Campi Flegrei and their physical parameters.



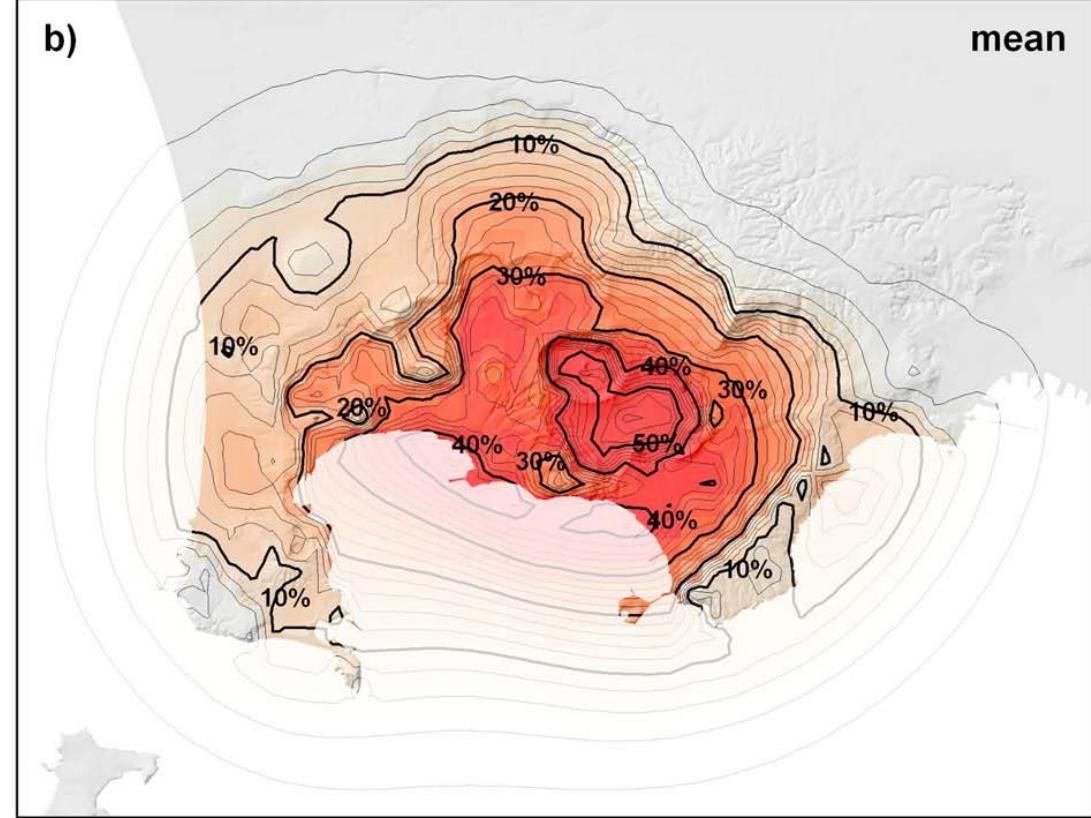
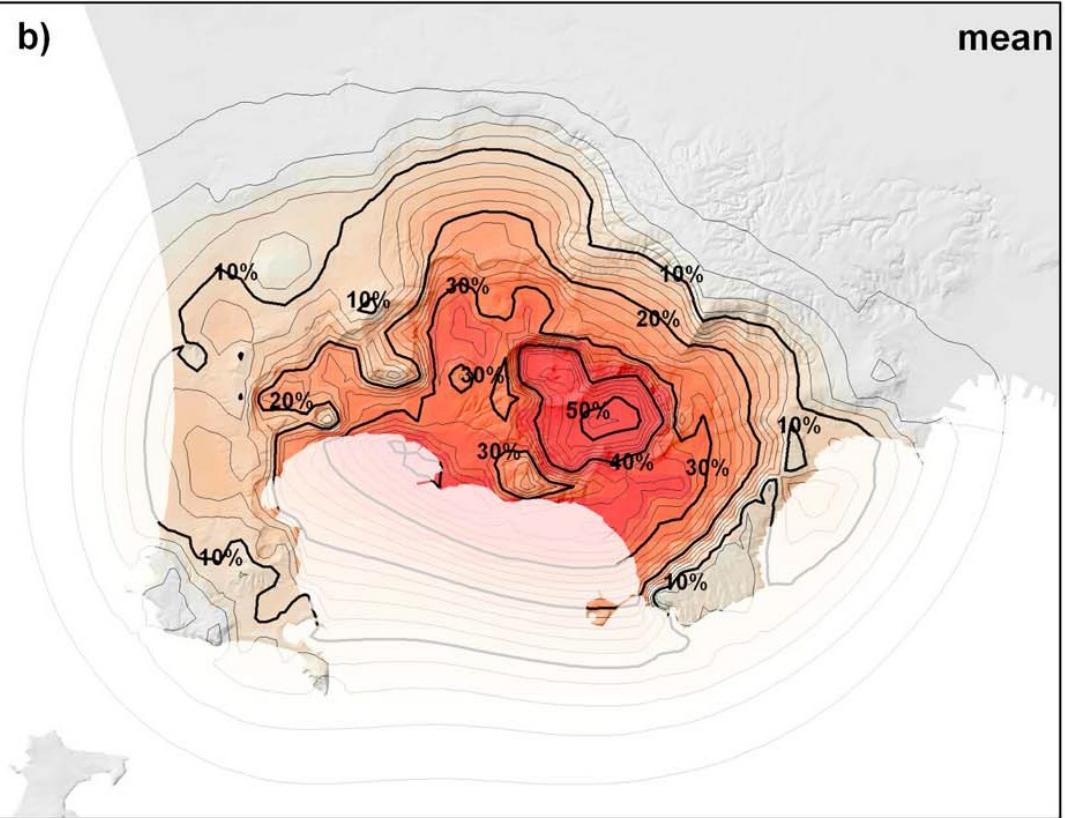
Ash loading probability maps (contours in excess of 300 kg/m²) for the high-, medium- and low-magnitude scenario. Left: eruption vent in the Averno-Monte Nuovo area. Right: eruption vent in the Agnano-San Vito area (after Costa et al., 2009).

High-magnitude

Medium-magnitude

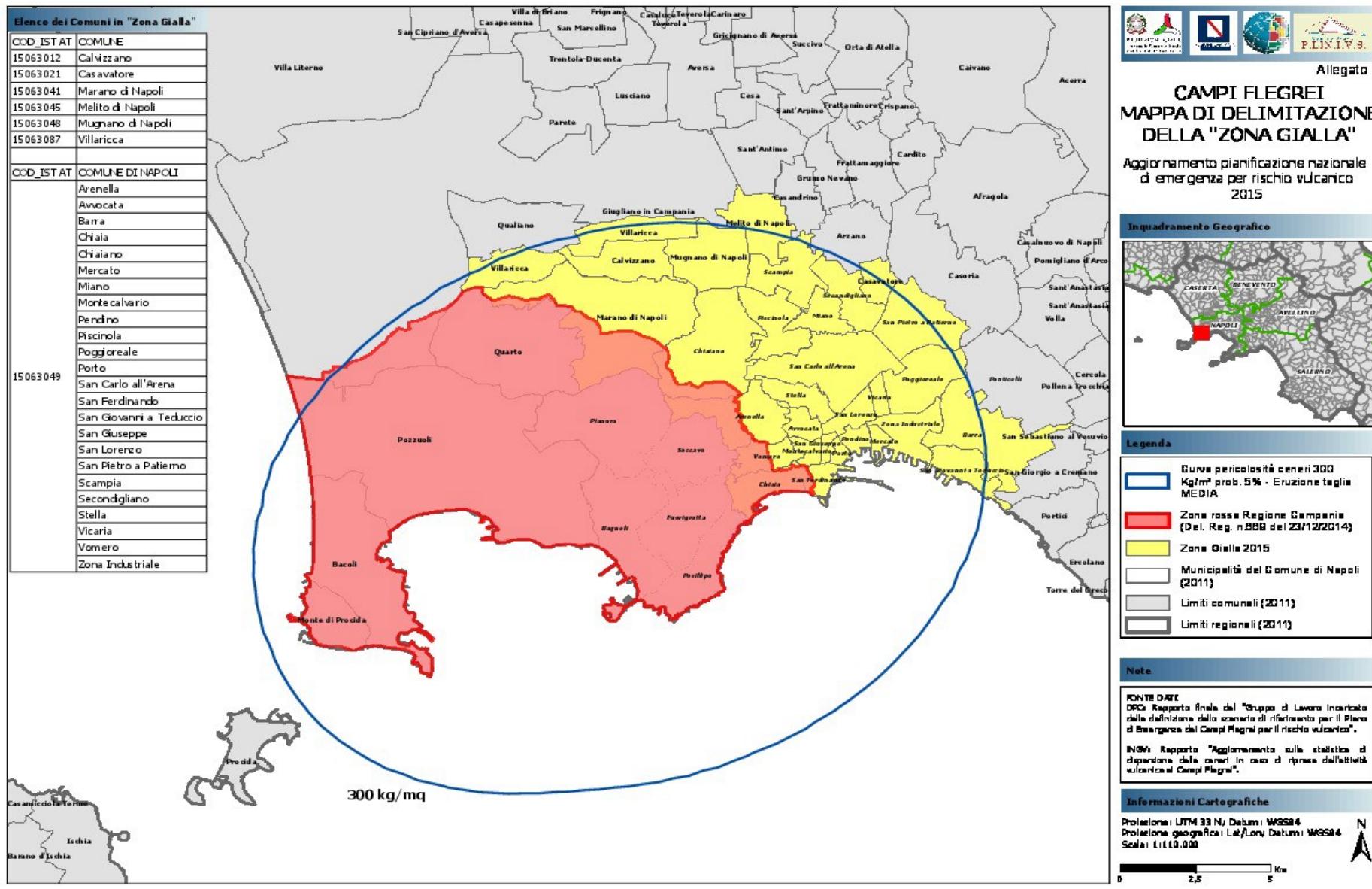
Low-magnitude

Pyroclastic Density Currents (PDC) invasion probability maps



PDC invasion probability maps computed by assuming the vent opening distribution described in Bevilacqua et al., 2015 and the spatial density distribution of invasion areas of the last 5 ka. Single vent located in the on-land. Contours and colors indicate the percentage probability of invasion conditional on the occurrence of an explosive eruption (Neri et al., 2015).

PDC invasion probability maps computed for PDCs that originate from two simultaneous vents in an eruptive event, with the vents located in the on-land part of the caldera. Condition like the map on the left (Neri et al., 2015)



Hazard map of the Campania adopted by Regione Campania in 2015 in case of an eruption in Campi Flegrei.

Red zone: area of possible invasion by PDC

Yellow zone: area of possible deposition of ash exceeding 300 kg/m² of load on the ground. All winds considered, probability 5%, medium eruption size.

Alert levels and present state of activity od Campi Flegrei



Campi Flegrei - Stato attuale
LIVELLO DI ALLERTA GIALLO

Il sistema di sorveglianza dell'Osservatorio Vesuviano evidenzia alcune variazioni
 nello stato di attività dei Campi Flegrei

The alert levels for the Campi Flegrei describe the state of activity of the volcano and mark the time before a possible resumption of the eruptive activity. The transition from one alert level to the next is established on the basis of changes in the monitored parameters and any ongoing phenomena. The alert levels are four:

green

	LIVELLO BASE
	STATO DI ATTENZIONE
	PRE ALLARME
	ALLARME

yellow

orange

Red

Every month the Civil Protection Department organizes a videoconference with the INGV-OV and the other Competence Centers responsible for monitoring, and the Campania Region to analyze the phenomena in progress and assess the volcanic hazard.

Alert level is declared at the outcome of the videoconferences.

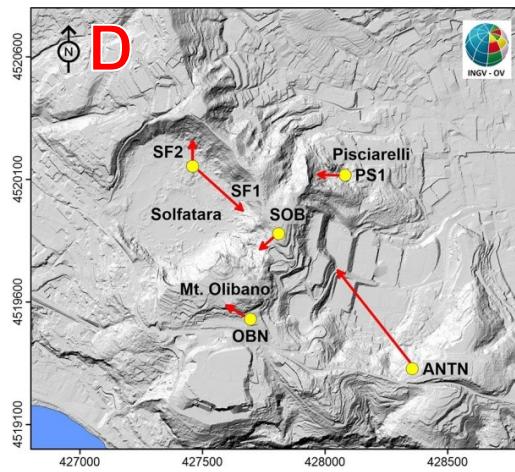
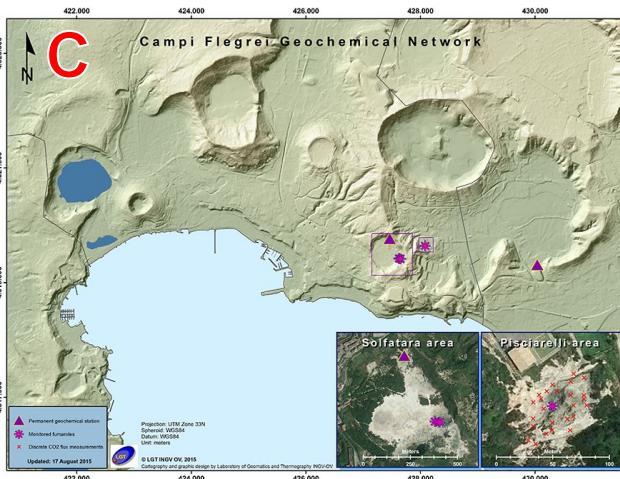
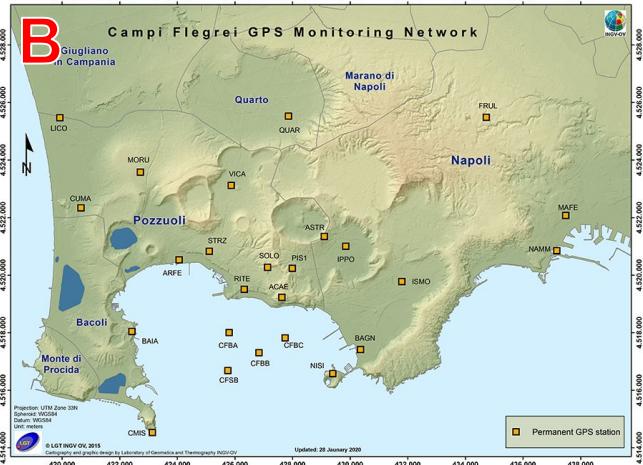
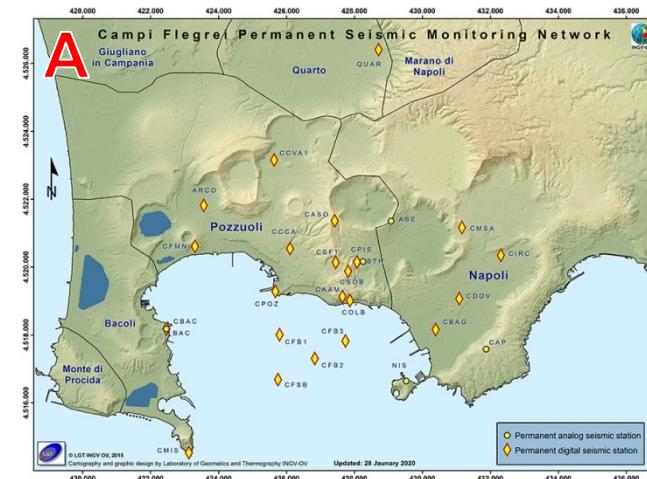
Every six months the Department for Civil Protection, having heard the opinion of the Commissione Grandi Rischi - Volcanic Risk Sector, decides whether to confirm the alert levels and the operational phases (attention, early warning and alarm) in close connection with the Civil Protection structure of the Campania Region. Currently, the alert level for Campi Flegrei is yellow and the operational phase adopted is "attention".

(<https://mappe.protezionecivile.gov.it/it/mappe-rischi/piano-nazionale-campi-flegrei>)

The INGV-Osservatorio Vesuviano surveillance system

The monitoring activities of the INGV-Osservatorio Vesuviano for Campi Flegrei are carried out through instrumental networks that produce data continuously, and through periodic measurement campaigns. The information collected in this way is analyzed by automatic and controlled systems and interpreted by the INGV staff in order to be constantly updated on the state of activity of the volcano. At present, instrumental networks are operating in the Campi Flegrei for:

- A.** Seismological monitoring (Permanent and mobile network),
 - B.** Geodetic monitoring (permanent GNSS, tiltmetric, mareometric networks and periodic gravimetric and SAR surveys),
 - C.** Geochemical monitoring,
 - D.** Volcanological monitoring (Permanent network of infrared thermal cameras and periodic survey with mobile thermal cameras and thermocouple).





Updated information on Campi Flegrei, monitoring networks and measured parameters are available on the new INGV-OV website and at the links of the Surveillance Bulletins (weekly, monthly and summaries)



OSSERVATORIO VESUVIANO
SEZIONE DI NAPOLI

SALA OPERATIVA INGV - OV

L'Osservatorio Vesuviano è una Sezione dell'Istituto Nazionale di Geofisica e Vulcanologia che si occupa di ricerca vulcanologica e geofisica e di monitoraggio dei vulcani attivi

Bollettini di sorveglianza

Localizzazioni Sismiche (GSSIP)
Localizzazioni Sismiche (SISMOLAB)

Segnali Sismici

MONITORAGGIO SISMICO: ULTIMO EVENTO REGISTRATO

Vesuvio (Automatico) | Temporale originale (UTC): 2021/10/05 06:44:36 | Magnitudo: 4.0 | Localizzazione sismica del vulcano Campania | Breve storia delle banche dati sismologiche | Dati sismici | Eventi Vesuvio

CAMPI FLEGREI | Ischia | Pozzuoli | Napoli | Baia | Capo Miseno | Ischia

I VULCANI DELLA CAMPANIA

Campi Flegrei | Vesuvio | Ischia

[New Web site of INGV-OSSERVATORIO VESUVIANO](#)

A cura della Sezione di Napoli | OSSERVATORIO VESUVIANO

CAMPI FLEGREI

Bollettino Settimanale
27/09/2021 – 03/10/2021
(Data emissione 05 ottobre 2021)

[Weekly Surveillance Bulletins](#)

Bollettino di Sorveglianza

CAMPI FLEGREI

AGOSTO 2021

A cura della Sezione di Napoli | OSSERVATORIO VESUVIANO

[Monthly Surveillance Bulletins](#)

CAMPI FLEGREI - Italia agosto 2021

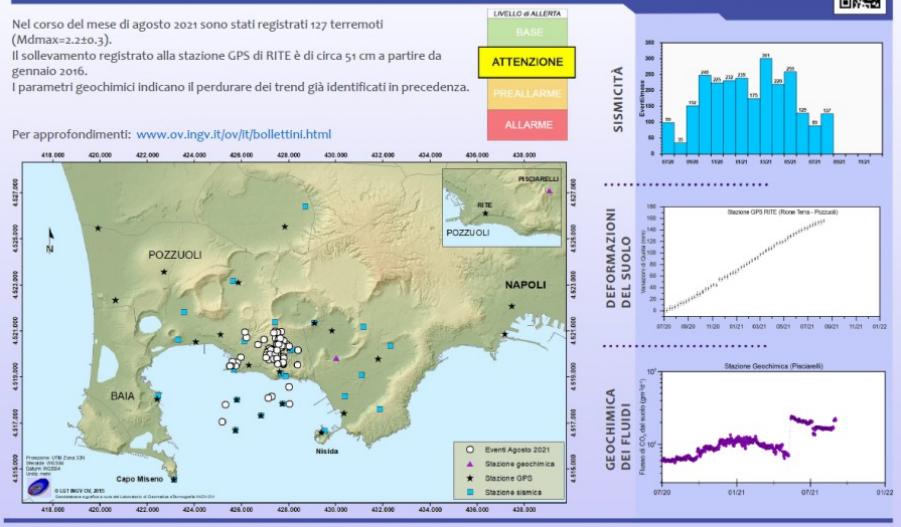
Comunicazione sullo stato attuale della caldera dei Campi Flegrei

Nel corso del mese di agosto 2021 sono stati registrati 127 terremoti (Mdmax=2.2±0.3).

Il sollevamento registrato alla stazione GPS di RITE è di circa 51 cm a partire da gennaio 2016.

I parametri geo chimici indicano il perdurare dei trend già identificati in precedenza.

Per approfondimenti: www.ov.ingv.it/ov/it/bollettini.html



[Summary Bullettins on Web](#)