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Identifying the locations of future eruptions within large calderas: Campi Flegrei, Southern Italy.

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Large calderas, with surface areas of 100 km2 or more, are among the most populated active volcanoes on Earth. New vents commonly open at locations across the caldera floor. An important goal for hazard mitigation, therefore, is to develop reliable methods for evaluating the most likely location for a future eruption. A preferred approach is to analyse statistically the distributions of previous vents. Using the Campi Flegrei caldera as a test case, we here examine the sensitivity of results to starting assumptions, notably the choice of data set for defining preferred vent locations.

Situated immediately west of Naples, in southern Italy, Campi Flegrei poses a direct threat to more than 300,000 people. It has been in episodic unrest since the late 1950s. The unrest is the first since the last eruption in Campi Flegrei in 1538 and suggests that the caldera may have re-entered a state with an increased probability of an eruption. Since the most recent episode of caldera collapse 15.5 ka BP, at least 60 intra-caldera eruptions have occurred across the 150 km2 that make up the modern onshore area of Campi Flegrei. The eruptions have been concentrated within three epochs: 15.5-9.5 ka BP (Epoch 1, c. 27 eruptions), 8.6-8.2 ka BP (Epoch 2; c. 6 eruptions) and 4.8-3.8 ka BP (Epoch 3; c. 27 eruptions).

Recent statistical studies of future vent locations have assumed that (1) only data from Epoch 3 are relevant to modern Campi Flegrei, and (2) repeated eruptions from the same vent can be incorporated, whether they are independent events or belong to a connected sequence of activity. We have relaxed these assumptions to investigate data from all epochs and to distinguish between independent and related eruptions from the same vent. Quadrat and nearest-neighbour statistics show that eruptions from Epochs 1 and 2 were distributed within an annulus 3-5 km around modern Pozzuoli, but that, in agreement with previous studies, eruptions occurred preferentially NE-ENE of Pozzuoli in Epoch 3. However, when related sequences of eruptions from the same vent are removed, the data show an even, annular distribution for all three epochs. The results suggest that, instead of a preference for the NE-ENE sector of Campi Flegrei, a new vent is expected to open within the established annular structure around Pozzuoli; that the probability of opening is similar in all locations within the annulus; and that, compared with Epochs 1 and 2, Epoch 3 was distinguished by a greater number of multiple eruptions from individual vents.