Processes and timescales of magma evolution prior to the Campanian Ignimbrite eruption (Campi Flegrei, Italy)

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The Campi Flegrei caldera collapsed 39 ka in the Neapolitan area (southern Italy) after the Campanian Ignimbrite eruption. This eruption, recognized as the largest and the most cataclysmic volcanic event in the Mediterranean area over the past 200 ka, extruded not less than 300 km^3 of trachytic magma. Controversy exists over the timescales required to assemble a such large volume of silicic melt and thus whether large magmatic reservoirs can actually persist below active volcanic systems over prolonged periods of time. Uranium-series analyses have been performed on Campanian Ignimbrite whole-rocks, glass matrixes and separated minerals. The compositionally most evolved sample which is most radiogenic with respect to Sr isotopes records a reference age of 71 ka. By contrast, U-Th internal isochrones of the three compositionally least evolved samples give identical initial Th isotope ratios and yield consistent ages predating the eruption by up to 6.4 ka. Therefore the time preceding this large caldera-forming eruption during which the large volume of Campanian Ignimbrite magma assembled and mixed is 6.4 ± 2.1 ka.

The highest Pb and Nd isotopic ratios and $^{230}Th/^{232}Th$ activity ratios together with the oldest reference age of the most evolved samples suggest the existence of a resident magma body possibly related to a magmatic system that is known to have fed earlier magmatic activity in the Campi Flegrei area. Conversely, the younger age of the least evolved and least radiogenic magma dates the crystallization/differentiation event of a chemically and isotopically new magma batch entering the reservoir of the resident magma some few thousand years before the cataclysmic eruption. The progress of crystallization yielded high-water contents (up to 6-7 wt%), thus producing an overpressurized gas cap. The onset of the eruption tapped this cap, with consequent depressurization and fast volume decrease that facilitated or even drove the caldera collapse, and allowed the water-rich magma to be discharged during the pyroclastic current phase.

Bahamian speleothems reveal increased aridity associated with Heinrich events

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During the last glacial period there is substantial evidence for global millennial scale variability in climate, dominated by Heinrich events and Dansgaard-Oeschger events. Heinrich events have been well documented in the ice core records, deep-sea sediment records and speleothems. These records document that Heinrich events are global and abrupt climate change events. Recent studies across Africa and Asia indicate that drying throughout the tropics of both hemispheres occurred during Heinrich event 1 [1]. Geochemical analysis of stalagmites from the Bahamas further support a more arid climate associated with Heinrich events in the subtropical Atlantic.

In this study, currently submerged speleothems have been collected at depths ranging from 10-40 meters below sea level. These stalagmites formed when sea level was lower than at present and the cave was subaerially exposed. The stalagmites were dated using U/Th methodologies and analyzed for stable carbon and oxygen isotopes at a resolution of 20 um (approximately one sample every 2 years). In the subtropics, it has been demonstrated that higher volume rainfall events generally leads to a depleted $\delta^{18}O$ and $\delta^{13}C$ signal, whereas heavier $\delta^{18}O$ and $\delta^{13}C$ values are attributed to lower amounts of rainfall. The geochemical results reveal a significant isotopic excursion associated with Heinrich events. The change across Heinrich events 1-4 averages about 4 ‰ for C and 2 ‰ for O. These changes were all from positive to more negative values. These results support a rapid shift from an arid to a much wetter climate in the Bahamas associated with Heinrich events. Based on our preliminary age analysis, these changes occurred over a period of approximately 50 years. These records provide a unique opportunity to study climate variations at a fine resolution and may better define the role of the sub-tropics in forcing climate change.

[1] Stager *et al.*, (2011) *Science*, **331**, 1299-1302.