A geochemical and geophysical reappraisal to the significance of the recent unrest at Campi Flegrei caldera (Southern Italy)

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Volcanic unrest at calderas involves complex interaction between magma and geothermal fluids. Campi Flegrei caldera (CFc), located in the Neapolitan area and characterised by the highest volcanic risk on Earth for the extreme urbanisation, undergoes unrest phenomena involving several meters of uplift and intense shallow seismicity since several decades. Despite the presently on-going unrest displays moderate ground deformation and seismicity, geochemical variations point to a highly pressurized hydrothermal system. We show that at CFc, for which an exceptional 35 years long geochemical and geophysical dataset exists, the usual assumption about vapour-liquid coexistence in the fumarolic fluidplume leads to inevitably estimate high hydrothermal pressures, which conditions unrest interpretation. By relaxing the unconstrained 'a priori' assumptions generally made for geochemical interpretations, we get a likely agreement between geophysical and geochemical observations, and enlighten the discrepancies between what observed 1) for two decades since the 1982-84 bradyseism, when shallow magma was supplying heat and fluids to the hydrothermal system, and 2) in the last decade. The post-2005 unrest is marked by much lower aquifer overpressure and magmatic involvement, with respect to the one occurred in the '80s, just as indicated by geophysical data and despite large changes in geochemical indicators. Our interpretation points to a model in which shallow sill intrusions, occurred during 1970-1984, have quickly cooled, so that fumarole emissions are affected now by deeper gases released from a 8 km-deep magma. Our results have important implications on the short term risk in the area and the monitoring of hydrothermal pressure build-up.