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Increasing CO_2 at Campi Flegrei shows the reactivation of the deep caldera-forming magma reservoir

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Calderas present much more difficulties of forecasting unrest evolution than central volcanoes. Due to the extension of hydrothermal system, volcanic unrest at collapse calderas may display strong vertical ground deformation, which feeds continuous debates on whether the observed unrest is hydrothermal or magmatic. A major feature used to decipher the nature of unrest is CO_2 degassing. Nevertheless, variations in CO_2 degassing do not help much in constraining the depth and size of the magma chamber even when used to justify the models that fit measured ground displacements. At Campi Flegrei caldera (CFc), the study of hydrothermal degassing has largely contributed to a scientific debate yielding different assessments of the 1982-84 and current (post-2000) unrest. Here we show that the long-term increase of CO_2 degassing at Campi Flegrei caldera originates from the reactivation of the deep-seated magma body that in the past has been responsible of catastrophic caldera-forming eruptions. This appears as the only possibility that can satisfactory explain the heating of the caldera volume, the progressive drying of the hydrothermal system and the features of the current unrest. Based on a joint reprocessing of geochemical data and application of THOUGH2 thermo-fluid-mechanical computation constrained through the critical selection of the correct thermodynamic parameters, our study shows that geochemical assumptions typically developed for geothermal systems at andesitic (strato)volcanoes cannot be immediately transposed to CFc, otherwise major contradictions are generated. We suggest that the same limits apply to other large calderas that discharge relevant amounts of CO_2.