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Caldera unrest at Campi Flegrei: a contribution to the magmatic vs. hydrothermal debate from inverse and numerical modelling

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We present results from the modeling of ground deformation and micro-gravimetric data recorded at Campi Flegrei in order to assess the causative phenomena of caldera unrest between 1981 and 2001. Via the inversion of gravimetric time series data for a single spheroidal body of dilatation, which was found to provide the best-fitting model for surface displacements presented in an earlier study, we find that residual gravity changes during ground uplift (1982–1984) are indicative of mass changes in a hybrid of magmatic and hydrothermal sources. For ground deflation between 1985 and 2001, the inversion of gravity residuals for a single source also does not provide convincing results. In order to quantify individual contributions of a hybrid body or bodies to the observed signals during inflation and to test source multiplicity for the subsequent ground deflation, we have then performed the joint inversion of gravity and vertical height change data for multiple spherical sources. Source parameters deduced from the inversion were then validated and refined by finite element modeling in order to account for limitations of the analytical solutions in particular regarding pressure changes. We find that the data recorded during inflation and rapid deflation between 1982 and 1987 may be best explained by mass and pressure changes in a deep magmatic source at about 5 km depth and a shallow (2 km deep) hydrothermal source. The shallow source is located ca. 800 m east of Pozzuoli, the deep source slightly offset to the north of the shallow source. Both sources contribute equally to the gravity changes observed between 1982 and 84, the contemporary uplift appears to be mainly caused by the shallow source. The subsequent deflation is dominated by a pressure de-

crease in the hydrothermal source, the magmatic source however contributes chiefly to the observed gravity changes. We also find that pressure and density variations within multiple shallow-seated hydrothermal sources provide acceptable fits to the deflation and accompanying gravity changes recorded since 1988. These shallow-level dynamics also appear to trigger spatially and temporarily random short-term reversals of the overall mode of ground subsidence since 1985. Our analysis does not support the idea of magmatic contributions to these short-lived periods of inflation.