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Discrimination between magmatic and hydrothermal nature of the sources responsible for the unrest phenomena at Yellowstone caldera via integrated model of InSAR time series, leveling and gravity measurements

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We studied the Yellowstone caldera geological unrest between 1977 and 2010 by investigating temporal changes in differential InSAR, precise spirit leveling and gravity measurements. In particular, we start by investigating the InSAR results obtained through the Small BAseline Subset (SBAS) differential InSAR technique, applied to a data set of ERS-1/2 and ENVISAT SAR images spanning 18 years, from 1992 to 2010. Moreover, we analyze the leveling data, which cover an additional time period of about 19 years from 1976 to 1995, and the gravity measurements that span the interval from 1977 to 1993. Inverting InSAR, leveling and gravity measurements infer parameters of the caldera best-fitting deformation sources by using the dMODELS software package. Compared to previous work on Yellowstone caldera, (i) we present long-term deformation time series derived from InSAR and their comparison to GPS results, (ii) we identify and remove the tectonic signal from the retrieved time-series, (iii) we jointly exploit InSAR, leveling and gravity measurements to investigate the deformation sources geometric characteristics and their densities; to do this we search for the best fit deformation source identified by inverting more than one source geometry and we use statistical analysis to discriminate among different geometries.
Our study indicates the existence of different distinct deformation sources within the caldera and we show that the detected sources have been intermittently active for the past three decades. We interpret the results of our inversions in view of the seismic tomography studies. This allows us to discriminate between the magmatic and the hydrothermal nature of the sources responsible for the unrest phenomena that affected the Sour Creek (SC) and Mallard (ML) Dome resurgent caldera domes during the last three decades. Our study indicates the existence of different distinct deformation sources within the caldera and we show that the detected sources have been intermittently active for the past three decades. We interpret the results of our inversions in view of the seismic tomography studies. This allows us to discriminate between the magmatic and the hydrothermal nature of the sources responsible for the unrest phenomena that affected the SC and ML resurgent caldera domes during the last three decades.