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Constraining the Long Valley caldera (California) deformation source using SBAS-DInSAR, two colors EDM and gravity measurements

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We study the Long Valley caldera deformation source by a joint analysis of ground deformation and gravity measurements. Given the constraints on the available geodetic and gravity data sets (leveling data are available from 1975, gravity data from 1982, two colors EDM data from 1985, and SAR acquisitions from 1992), and the need to have the largest possible signal-to-noise ratio, our modeling strategy follows a two-step approach: first we invert EDM and InSAR deformation data from 1992 to 1999 to bound the geometry of the source; then we use uplift and gravity changes between 1982 to 1999 to determine its density. We apply the SBAS-DInSAR technique to generate displacement time series and mean velocity maps from ERS1/2 SAR acquisition (descending orbits). The DInSAR results clearly show that the displacement phenomena affecting the Long Valley caldera have a maximum in correspondence of the resurgent dome. We invert the geodetic data set using a spheroid pressure sources in an elastic, homogeneous and isotropic half-space. The minimum of the inversion penalty function is determined using the Levenberg- Marquardt least-square algorithm. The inflation source is a tilted prolate ellipsoid with a dip angle between 62° and 82°, a vertical ellipsoid dip angle is 90°, at a depth of 5.7 to 7.0 km beneath the resurgent dome with an aspect ratio between 0.41 and 0.56, a volume change from 0.083 to 0.121 km^3 and a density of 1572-2906 kg/m^3. Our results do not support hydrothermal fluid intrusion as the primary cause of unrest and suggest the intrusion of magma beneath Long Valley caldera.