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The 1992-2010 Yellowstone Caldera surface deformation evolution investigated through Advanced Spaceborne Radar Interferometry

Riccardo Lanari, Pietro Tizzani, Giovanni Zeni, Antonio Pepe, Francesco Casu, and Michele Manunta
IREA, CNR, Napoli, Italy (lanari.r@irea.cnr.it, +39 081 570 5734)

The Yellowstone volcanic field, centered at the Yellowstone National Park, Wyoming, is one of the largest and most active silicic volcanic systems in the world; similar to other volcanic fields such as Long Valley, California, and Phlegrean Fields, Italy.
The youthful volcanic history of Yellowstone was dominated by three cataclysmic caldera-forming eruptions in the past two million years: the youngest of them occurred approximately 0.64 million-years-ago.
Over the years, many independent investigations about the deformation affecting the Yellowstone caldera has performed by using precise levelling, GPS (Global Positioning System), and small set of DInSAR (differential Interferometric Synthetic Aperture Radar) interferograms. The measurements revealed multiple episodes of caldera uplift and subsidence, with maximum average rates of about 1 to 2 cm/year in correspondence to its two resurgent domes: Sour Creek and Mallard Lake, respectively. In addition, in a northwest area of the caldera, phases of substantial ground deformation were also experienced. These spatial and temporal variations of the Yellowstone unrest also correlated with pronounced changes in seismic and hydrothermal activity.
In this work, we analyze the overall temporal evolution of the surface deformation at Yellowstone Caldera by applying advanced DInSAR techniques to a set of ERS and ENVISAT SAR images acquired over the last 18 years.
The retrieved DInSAR time-series reveal a complex scenario characterizing the detected deformation fields. In particular, four main deformation trends characterize the displacement dynamic of the Caldera region and its surrounding area. From 1992 to 1995 a broad subsidence pattern affects the caldera roof with maximum displacement located along its major axis (Mallard lake dome and Sour Creek dome). After, the ground deformation detected from 1995 -1998 reveals an uplift phenomenon focused at west of Sour Creek dome (Mud volcano). Moreover, in the 1995 -2003 time interval the previous uplift event grows significantly, extending to the outside caldera rim.
Finally, the 2003 -2009 time interval is characterized by a spectacular inversion of the caldera floor deformation. More specifically, Mallard lake dome and Sour Creek dome areas, which were affected by a subsidence phenomenon during the 1992–1995 period, are now subject to an uplift event. At the same time, from 2003 to 2009 the area outside caldera rim shows an inversion of the ground deformation.
At our knowledge, this work represents the first attempt at retrieving a such long deformation time series over the Yellowstone Caldera via advanced DInSAR analyses.