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Interplay Between Tectonics And Volcanic Processes Active In The Yellowstone Caldera Detected Via DInSAR And GPS Time-Series

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We discriminate and quantify the effects of different stress sources that are active in the Yellowstone volcanic region. In particular, the use of long-term deformation time series allows us to separate the spatial and temporal contributions of the regional tectonic field due to North American (NA) plate motion from the dynamic of magmatic/hydrothermal sources beneath the caldera area. Yellowstone volcano was formed by three major caldera forming eruptions that occurred around 2.0, 1.3 and 0.64 Ma, the most recent one responsible for the 60 km-wide and 40 km-long Yellowstone caldera. Two structural resurgent domes emerged after the last caldera forming eruption: the Mallard Lake (ML) resurgent dome in the southwestern region of Yellowstone caldera, and the Sour Creek (SC) resurgent dome in the northeast part of the caldera. In this work, we extensively exploit DInSAR and GPS measurements to investigate surface deformation at Yellowstone caldera over the last 18 years. We start by analyzing the 1992-2010 deformation time series retrieved by applying the Small BAseline Subset (SBAS) DInSAR technique. This allows us identifying three macro-areas: i) Norris Geyser Basin (NGB), ii) ML and SC resurgent domes and iii) Snake River Plain (SRP), characterized by unique deformation behaviors. In particular, SRP shows a signal related to tectonic deformation, while the other two regions are influenced by the caldera unrest. To isolate the deformation signals related to different stress sources in the Yellowstone caldera, we also remove from the retrieved mean deformation velocity maps the mean displacement rate associated to the northern sector of the Snake River Plain. This latter is the result of tectonic processes controlled by complex interactions between the NA plate, moving in the ENE – WSW direction with a rate of about 2 cm/yr, and the flow of the asthenosphere plume beneath the Yellowstone volcanic region. These de-trended data allow recognizing four major deformation episodes during the past 18 years: a general caldera subsidence phase from 1992 to 1995; the uplift of the NGB and the subsidence of the Resurgent Domes between 1996 and 2003; a switch in deformation from 2004 to 2008 and a general caldera subsidence since 2009. Finally, the performed data modeling confirm the existence of three active sources beneath the caldera floor but indicate a dissimilar behavior in time, space and stress distribution.