Accelerated Uplift of the Yellowstone Caldera, 2004-2006, from GPS and InSAR Observations

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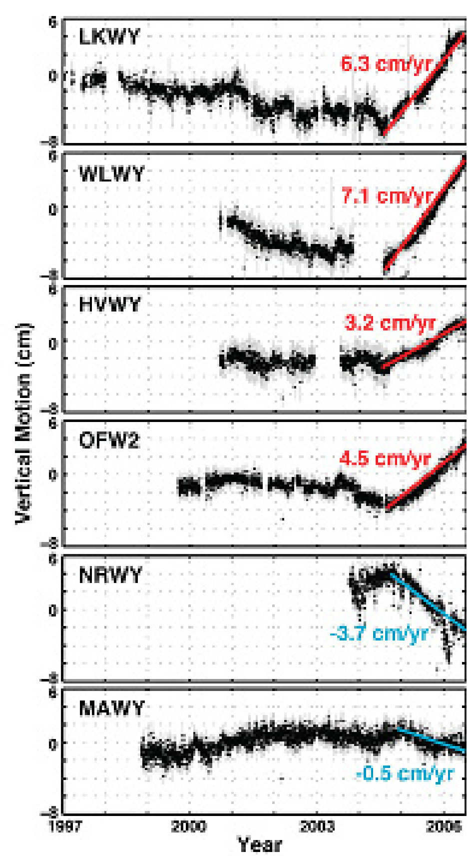
Geodetic techniques have been employed to monitor the crustal motion of Yellowstone beginning with the precise leveling of benchmarks installed in 1923. Since 1997, the University of Utah has installed six permanent GPS stations inside Yellowstone National Park for continuously monitoring the ground deformation associated with seismic, volcanic, and hydrothermal activities. Starting in mid-2004, the GPS network recorded an episode of unprecedented uplift of the Yellowstone caldera concomitant with subsidence of the northeast caldera area including Norris Geyser Basin. The deformation continues into 2007, with nearly constant inflation rates of ~6 cm/yr and 4 cm/yr at the Sour Creek and Mallard Lake resurgent domes, respectively (Figure 1). These rates are up to three times faster than preceding caldera uplift rate from 1923 and 1984. The horizontal velocities, in addition, are 7 to 21 mm/yr outward from both domes. Meanwhile, Norris Geyser Basin experienced subsidence at ~4 cm/yr that is two times higher than the 1996-2002 uplift rate. Incorporating GPS data from the University of Utah and five new PBO stations, we evaluated source models by inverting the GPS and InSAR data for the geometry and expansion (contraction) of dislocations in an elastic half-space [Chang et al., 2007]. The results indicate two horizontal sill-like structures ~8 km beneath the caldera with a total volumetric expansion rate of 0.11 km^3/yr, and a northwest-dipping tabular body 16 km beneath the Norris Geyser Basin with a volumetric contraction rate of 0.018 km^3/yr. Incorporating seismic, hydrothermal, and geochemical evidence, we propose that a new intrusion of magma into the mid-crustal or pressurization of a deep hydrothermal system likely caused the uplift within the Yellowstone caldera. The Norris subsidence, in contrast, may be induced by the crystallization and contraction of crustal magmatic bodies and the associated loss of dissolved fluid and gas to shallow fault and hydrothermal systems.

Figure 1. (a) Locations of measured uplift in the Yellowstone caldera. **(b)** Time series of vertical motion measured at six sites.



References

Chang, W., R.B. Smith, C. Wicks, C. Puskas, and J. Farrell, 2007, Accelerated uplift and source modeling of the Yellowstone caldera, 2004-2007, From GPS and InSAR observations, in preparation.

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