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Interactions between repeated Trapdoor Faulting and 5 m of Uplift prior to the 2005 Eruption at Sierra Negra Volcano, Galapagos

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Sierra Negra volcano on Isabela Island, Galapagos, erupted in October 2005 for the first time since 1979. InSAR and GPS data document a remarkable story of pre-eruption uplift and multiple trapdoor faulting events on an intra-caldera fault system. The limited InSAR data that exist from before 2000 indicate that 2.7 m of uplift occurred at Sierra Negra during 1992-1999. Campaign GPS observations (2000-2002) and continuous GPS measurements (from 2002) initially showed decreasing uplift rate and then a change to subsidence until inflation resumed in April 2003. From that time the uplift accelerated until the start of the eruption, and included more than 2 m of inflation during these 2.5 years, resulting in a total uplift of nearly 5 m since 1992. This extraordinary uplift was accommodated in part by at least two trapdoor faulting events, one in 1997-1998 and another on 16 April 2005.

We use elastic dislocation models to infer about the uplift, faulting, and stress changes on Sierra Negra during the years before the eruption. The pattern of observed uplift from different time periods during 1992-2005 is consistent with filling and pressurization of a 2 km deep sill under the caldera. Previously, we suggested that strong uplift had triggered trapdoor faulting on the intra-caldera fault system in 1997-1998. The continuous GPS data of the similar April 2005 faulting event confirm this interpretation and provide stronger constraints on the amount and style of faulting, as well as showing it took place within 10 seconds. The results of our modeling suggest that the inflation triggered slip on a small ($\sim 3 \times 5$ km^2) inward dipping thrust fault

that reached the surface. The large mean slip ($\sim$1 m) results in an abnormally large stress drop, which probably implies that the caldera floor is unusually weak. Stress change calculations show that the trapdoor faulting events relieved pressure within the inflating sill and therefore provide a mechanism to postpone eruptions.