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Analysis of the geodetic record of the 2009 eruption of Redoubt Volcano, Alaska

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Redoubt volcano, about 160 km to the SW of Anchorage, Alaska began its most recent eruption in March 2009. After an initial month of alternating explosive events and dome extrusions, dome growth continued at least for another two months into June 2008 and may still persist at small rates. No continuously recording GPS instrumentation existed within 25 km of Redoubt at the beginning of major precursory unrest in January 2009. The closest CGPS instrument at that time was the PBO backbone station AC17, about 27 km northeast of the volcano's summit. A small GPS campaign network, consisting of about 15 benchmarks, had been established at Redoubt in 2001 and had been partially reoccupied in 2008. In response to the precursory unrest, the Alaska Volcano Observatory deployed continuously recording GPS instruments at five of the campaign benchmarks, though only one of these was telemetered.

Several distinct signals appear in the GPS time series, suggesting an interplay of at least two magmatic sources ranging in depth from the lower crust to the upper most part of the volcanic edifice and possibly other, non-volcanic deformation sources. Following the first explosion on March 22, 2009, a clear deflation signal (down and towards the edifice) is measured on all sites; as far as 27 km away from the volcano at AC17. This clear trend terminates around the time of the last explosive event on April 4, 2009 which was followed by the emplacement of the large, still persisting lava dome.

Displacements within the campaign network between August of 2008 and June 2009 as well as the short record of the CGPS instruments deployed in response to the event suggest only minimal inflation prior to the explosive events. Sub-daily, kinematic solutions for the CGPS data show a complex deformation pattern which seems related to the growth of at least three domes during the eruption.

We invert the GPS time series for a variety of source models including magmatic sources and surface loads to infer a detailed interpretation of the volcanic system and its evolution during the 2009 event.
Doing this we take the first steps towards an automated deformation analysis system which will enable more sophisticated data analysis during volcanic crises.