Geophysical Research Abstracts
Vol. 12, EGU2010-7715, 2010
EGU General Assembly 2010

InSAR Observations of the 2009 Harrat Lunayyir (western Saudi Arabia) Dyke Intrusion and Post-Diking Deformation

Sigurjón Jónsson (1), Zhong Lu (2), and Paul Lundgren (3)

(1) King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia (sigurjon.jonsson@kaust.edu.sa), (2) U.S. Geological Survey, Vancouver, USA, (3) JPL, Pasadena, USA

Interferometric Satellite Radar (InSAR) observations of one of the volcanic provinces in western Saudi Arabia, Harrat Lunayyir (also known as Harrat Al-Shaqah), provide rich information about the geometry and evolution of a dyke intrusion and surface faulting that occurred in the region in April-July 2009. The first sign of activity was the start of a seismic swarm on 24 April that steadily intensified until six magnitude 4.6-5.7 earthquakes struck on 17-20 May. More than 30000 people were evacuated from the area following the activity in mid-May and stayed in the neighboring cities of Yanbu and Medina for several weeks.

During the intensive activity in mid-May we sent a request for emergency satellite radar data acquisitions to the European Space Agency and later activated an International Charter to guarantee satellite data collection of the area. We have analyzed a number of Envisat, ALOS, and TerraSAR-X interferograms of the area and the results are outstanding, owing to the stable and vegetation-free surface conditions. Interferograms spanning the main seismic activity in mid-May exhibit strong deformation that extends across a large 40 km $\times$ 40 km area, with broad uplift and over a meter of WSW-ENE extension. In addition, the data show clear signs of surface faulting and graben-like subsidence in the middle of the deformed area with the graben subsidence exceeding 50 cm.

Modeling of deformation strongly suggests that a near-vertical dyke intruded with a WNW-ESE orientation, parallel to the Red Sea, and that the intruded volume is $\sim$0.13 km^3. The dyke intrusion appears to have triggered faulting on graben-bounding and inward-dipping normal faults. The shallowest part of the dyke seems to have reached within only 2 km of the surface, right below where the graben is the narrowest and under an area with a number of cinder cones from previous volcanic events.

While the day-to-day temporal evolution of the deformation cannot be derived from the InSAR data, the limited SAR acquisitions reveal an interesting story. No significant deformation is found before 8 May despite strong increase in seismic activity from the start of the earthquake swarm in April and until that time. The next SAR acquisition was on 27 May and the InSAR data show that 75% of the overall deformation was completed by that time, with further 20% occurring between 27 May and 17 June, and the remaining 5% in late June and July. This shows that significant part of the intruded magma was added to the dyke after the period of intensive seismicity in mid May.

The pattern of deformation in May, June, and July is very similar; only the amplitude is different. This indicates that the geometry of the intruding dyke did not change significantly when more magma was added to the system in June and July. It also shows that the numerous surface faults continued to move with increasing dyke volume, but that no new surface faults were activated after 27 May.