Geophysical Research Abstracts
Vol. 16, EGU2014-14500, 2014
EGU General Assembly 2014

Insights into Seismic and Volcanic Processes around the Arabian Plate from InSAR Observations

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We use InSAR observations to study a variety of seismic and volcanic processes at the plate boundary surrounding the Arabian plate. The plate-boundary motion ranges from extension in the Red Sea and Gulf of Aden to the south, to compression in Turkey and Iran to the north, with transform motion to the west and to the east. Many large earthquakes have occurred during the past two decades in the region, some of which we are studying, including the 1995 magnitude 7.2 earthquake in the Gulf of Aqaba, the 2011 magnitude 7.1 Van earthquake in eastern Turkey, the 2012 Ahar earthquake duplet in northwestern Iran, as well as the 2013 magnitude 7.7 Baluchistan (Pakistan) earthquake. These earthquakes took place in tectonic settings ranging from a transtension in the Gulf of Aqaba, to transpression in Baluchistan, to almost pure compression in eastern Turkey. For the Aqaba earthquake we add previously unused InSAR data and use modern data processing methods to improve earlier fault-model estimations. In the case of the Baluchistan earthquake we find surprisingly uniform and simple fault slip along the over 200 km long rupture, with maximum slip of almost 10 m near the surface. In addition, for the Van earthquake we use SAR-image offset tracking in the near-field, as some of the interferograms are almost completely incoherent. By identifying point-like targets within the images, we are able to derive better pixel offsets between SAR sub-images than with standard offset-tracking methods. We use the azimuth- and range offsets to derive the 3D coseismic displacements, which help constraining the geometry and slip of the causative northward-dipping thrust fault. Further west, in the region near the triple junction between the Arabian, Eurasian, and Anatolian plates, we use large-scale InSAR data processing to map the interseismic deformation near the triple junction and find very shallow locking depth of the eastern part of the East Anatolian Fault, indicating limited strain accumulation and less-than-expected earthquake potential. In addition to the seismic processes, we are studying three volcanic eruptions that took place in the southern Red Sea during the past several years, on Jebel at Tair Island (2007-8) and within the Zubair archipelago (2011-12 and 2013). We use InSAR and optical data to study these eruptions and to constrain the feeder-dike geometry and the associated stress directions. On Jebel at Tair we find evidence for a temporarily varying stress field that is isolated from the regional Red Sea stress regime. The two eruptions in the Zubair archipelago were surtseyan and produced two small islands. The islands were formed entirely from explosive phreatomagmatic activity, as the eruptions did not last long enough to progress to an effusive eruption. The reawakened volcanic activity in the southern Red Sea comes after more than century-long quiescence and seems to be a part the recent increase in activity in the region near the Afar triple junction, following the onset of the Dabbahu (Afar) rifting episode in 2005.