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A multidisciplinary study of DPRK nuclear tests

Valerio Materni, Christian Bignami, Alessandra Giuntini, Stefano Chiappini, Roberto Carluccio, Francesca D'Ajello Caracciolo, Alessandro Pignatelli, Salvatore Stramondo, Rodolfo Console, and Massimo Chiappini
Istituto Nazionale di Geofisica e Vulcanologia, Sezione Roma 1, Rome, Italy (console@ingv.it)

The Democratic People Republic of Korea announced two underground nuclear tests carried out in their territory respectively on October 9th, 2006 and May 25th, 2009. The scarce information on the precise location and the size of those explosions has stimulated various kinds of studies, mostly based on seismological observations, by several National Agencies concerned with the Nuclear Test Ban Treaty verification.
We analysed the available seismological data collected through a global high quality network for the two tests. After picking up the arrival times at the various stations, a standard location program has been applied to the observed data. If we use all the available data for each single event, due to the different magnitude and different number of available stations, the locations appear quite different. On the contrary, if we use only the common stations, they happen to be only few km apart from each other and within their respective error ellipses.
A more accurate relative location has been carried out by the application of algorithms such as Double Difference Joint Hypocenter Determination (DDJHD) and waveform alignment. The epicentral distance between the two events obtained by these methods is 2 km, with the 2006 event shifted to the ESE with respect to that of 2009.
We then used a dataset of VHR TerraSAR-X satellite images to detect possible surface effects of the underground tests. This is the first ever case where these highly performing SAR data have been used to such aim. We applied InSAR processing technique to fully exploit the capabilities of SAR data to measure very short displacements over large areas. Two interferograms have been computed, one co-event and one post-event, to remove possible residual topographic signals. A clear displacement pattern has been highlighted over a mountainous area within the investigated region, measuring a maximum displacement of about 45 mm overall the relief.
Hypothesizing that the 2009 nuclear test had been carried out close to the area where the displacement has been observed through the DInSAR technique, its relation with the epicenter location obtained through seismological processing has been discussed as a possible alternative hypothesis with respect to the preferred solutions reported by the Nuclear Explosion Database (NEDB). The distance of about 10 km between the two places can be considered acceptable in light of the possible systematic location shifts commonly observed in the seismological practice over a global scale.