Crustal Deformation of 2005 Northern Pakistan Earthquake Detected by SAR (1) Outline and SAR Interferometry

Satoshi Fujiwara[1]; Hiroyuki Nakai[1]; Midori Fujiwara[1]; Mikio Tobita[1]; Hiroshi Yarai[1]

[1] GSI

http://vldb.gsi.go.jp/sokuchi/sar/pakistan/pakistan_happyo1111.html

We mapped the crustal deformation of the Northern Pakistan earthquake of 8 October 2005 occurred in the Kashmir region spatially with Synthetic Aperture Radar (SAR) data from the European Space Agency ENVISAT satellite, and found that the area with more than 1-m of observed deformation occupies a ~90-km long northwest-southwest trending strip-shaped area. The area north of Muzaffarabad, a heavily-damaged area, has the maximum deformation - ~5-m toward the satellite. There are known active faults stretching to the northwest and southeast near the epicenter, which reveal some uplift (on the northeast side) and dextral strike-slip activities. We found that the detected crustal deformation was along these active faults and all observations were consistent in the sense of fault offsets. The facts showed that these active faults had moved. Additionally, our model calculation showed that the faults slipped a maximum of ~9-m.

There are two important findings in this study. First, the earthquake occurred on the preexisting active faults. This means surveying existing faults should be important to estimate future earthquake hazard risk. Secondly, the satellite data show us the earthquake faults in detail and then we can simulate and estimate the seismically damaged areas for prompt rescue and relief operations.

In this presentation, we will show the outline of this study and SAR interferometry analysis.

The deformation has been transformed into images from the difference between two time-period SAR images that can measure the ground geometry and the distance between the satellite and the ground surface with radar waves. The ENVISAT data are from descending acquisitions that result in an east-southeast line-of-sight (LOS) direction from the ground target to the satellite and from ascending acquisitions. We combined the descending and the ascending acquisitions and synthesized the quasi-upward and the quasi-eastward displacements.

Synthetic aperture radar interferometry (InSAR) from space has become a powerful tool to monitor deformation of the Earth's surface. This technique has high measurement accuracy (a few cm). However, ENVISAT uses short wave length (C-band, 5.6-cm) radio wave and it is difficult to measure large deformation gradients or in heavy vegetated area.

We could not get the deformation on the upper side of the earthquake fault but succeeded to map the deformation just over the lower side of the fault. The deformation situated along the known preexisting fault and we found that the maximum downward displacement is ~30cm and the maximum eastward displacement is ~1m.

At present, the number of SAR satellites is limited, however, the Japan Aerospace Exploration Agency (JAXA) launched the Advanced Land Observing Satellite (ALOS) on 24 January 2006. ALOS has an L-band SAR sensor, which has better coherency than C-band.