D-INSAR MONITORING OF GROUND DEFORMATIONS IN A GEOTHERMAL AREA IN KYUSHU, JAPAN

Makoto Omura (1), Shigeki Kobayashi (2), Katsuaki Koike (3) and Nobuhiro Tomiyama (4)
(1) Department of Environmental Science, Kochi Women's Univ., Kochi 780-8515, Japan
Email: omura@cc.kochi-wu.ac.jp
(2) Department of Remote Sensing, Kyushu Tokai University, Kumamoto862-8652, Japan
Email: shigeki@ktmail.ktokai-u.ac.jp
(3) Faculty of Engineering, Kumamoto University, Kumamoto 860-8555, Japan
Email: koike@gpo.kumamoto-u.ac.jp
(4) Kumamoto University, Japan / Remote Sensing Technology Center of JAPAN
Email: tomiyama@restec.or.jp

Abstract: The D-InSAR (Deferential Interferometric Synthetic Aperture Radar) technique is one of the most effective tools for monitoring ground movement. We analyzed JERS-1 SAR data of the central part of Kyushu, Japan acquired between 1992 and 1998 in order to detect ground movements near the Mt. Aso and Kuju. L-band D-InSAR keeps relatively high coherence for more than 1 year even on vegetated area. We tried to distinguish timing of the occurrence of the ground subsidence in the Hatchobaru geothermal field. Poor accuracy of JERS-1 orbit data and sever atmospheric disturbance in D-InSAR images prevent us from obtaining enough number of interferograms. In the near future, ALOS 'Daichi' PALSAR with better accuracy of orbit data enable us to obtain D-InSAR image easier.

1. Introduction

There are some active volcanoes and geothermal fields in Kyushu, Japan (Fig.1). The Hatchobaru geothermal field is one of the active geothermal fields and has the largest (110 MW) geothermal power plant in Japan. It is situated near the Mt. Kuju. In 1995, a volcano (Mt. Hossho) in the area had erupted. We carried out JERS-1 D-InSAR monitoring of topographic changes around the volcano and observed clear crustal deformation [1].At the same time, ground subsidence in the geothermal filed were observed in a few D-InSAR images. Then, we will also try to apply D-InSAR in geothermal monitoring.

Figure 1: Mt. Kuju and Aso

2. Data and Software

We analysed JERS-1 L-band SAR data. The 13 scenes were used for the period between 1992 and 1998.The numbers of the scenes for each year are; 1 scene in 1992, 4 scenes in 1993, no scene in 1994, 2 scenes in 1995, 3 scenes in 1996, 1 scene in 1997 and 2 scenes in 1998 (ownership of the JERS-1 SAR data: METI/JAXA).

Two kind of software EarthView (Atlantis Scientific Inc.) and JAXA SIGMA-SAR software [2] were used for the present study.

3. Deformation by Volcanic Activity

At the first, we show an example of the deformation of the Mt. Hossho with the eruption on 11 October 1995 in Figure 2 and 3. The D-InSAR image indicates displacement in slant-range between 20 September 1995 and 14 March 1996, time interval is 176days.

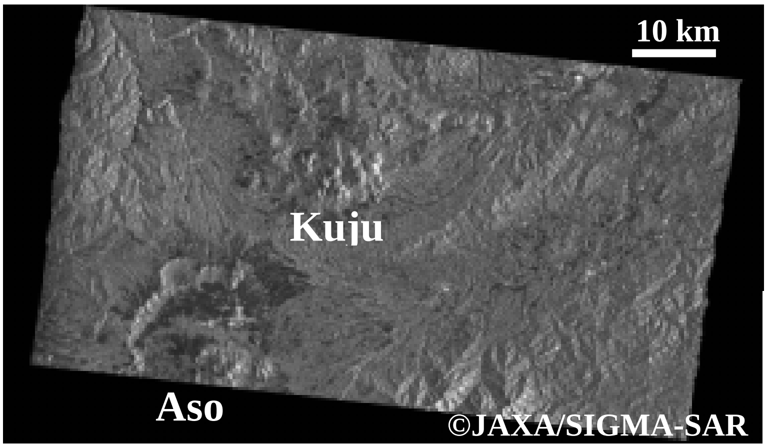


Figure 2: Power image (JERS-1 SAR: 14 March 1996)

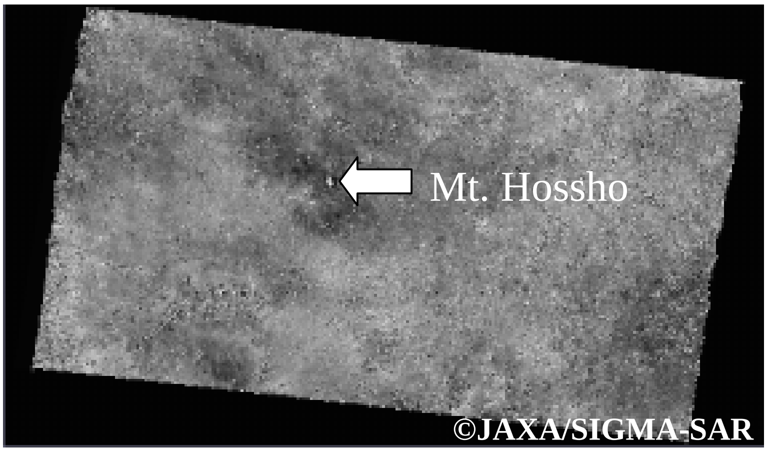


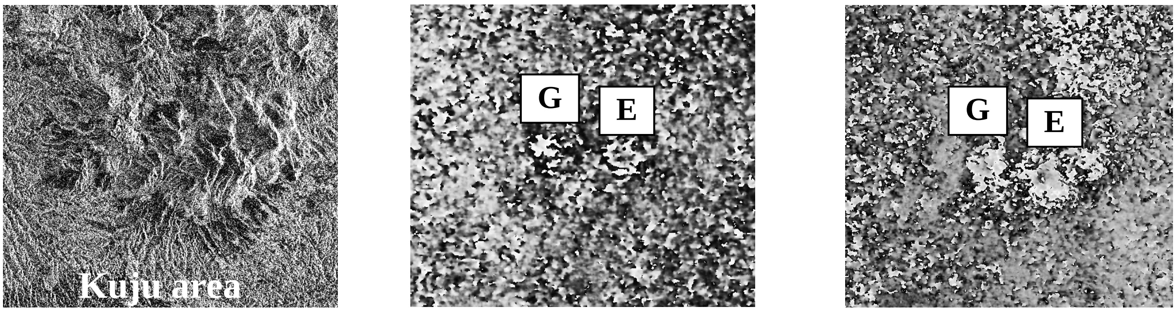
Figure 3: D-InSAR phase (JERS-1 SAR: 20 September 1995 and 14 March 1996)

Eruption of Mt. Hossho (11 October 1995) introduced distinct phase change.

4. Ground subsidence at the Hatchobaru geothermal field detected by D-InSAR

D-InSAR analysis for the Kuju area showed another site of displacement. It is the Hatchobaru geothermal field where the largest (110 MW) geothermal power plant in Japan is situated. The displacements were seen on the D-InSAR phase images for the long time interval and their sense is subsidence of the ground. Examples are shown in Figure 4.

(a) Power image **(b) 2 Sept. 93 – 16 Jan. 97** **(c) 3 Nov. 95 – 14 Mar. 96**



G: +7cm E:+15cm G: +8cm E:+18cm

Figure 4: Subsidence detected by JERS-1 D-InSAR

G: Geothermal field (Hatchobaru) E: Eruption on 11 Oct. 1995 (Mt. Hossho)

The both subsidence were also pointed out by other previous studies [1], [3]. We will carry out systematic re-analysis including new D-InSAR pairs to clarify the timing of the deformation in the geothermal field. Unfortunately, poor orbit data accuracy for JERS-1 and atmospheric disturbance prevent us to show the time series at this point.

5. Concluding remarks

JERS-1 L-band D-InSAR analysis provided ground movements in the Kuju area, near Mt. Aso in Kyushu, Japan. The D-InSAR analysis detected both expected and unexpected deformations before applying D-InSAR on the eruption site and geothermal field, respectively. This showed that D-InSAR is very powerful tool for verifying the deformation and is useful in the geotechnical purpose. However, orbit data accuracy and atmospheric disturbance are main issue on the analysis. We believe the new ALOS PALSAR will allow us to obtain better D-InSAR result.

Acknowledgment

We deeply thank for Dr. Masanobu Shimada of EORC/JAXA for the use of his SIGMA-SAR interferometry software [2] and giving suitable advices for use it.

References:

[1] Tomiyama N, K. Koike and M. Omura: Detection of topographic changes associated with volcanic activities of Mt. Hossho using D-InSAR, Advances in Space Research, vol. 33, pp.279-283, 2004.

[2] Shimada M: Verification processor for SAR calibration and interferometry, Advances in Space Research, vol.23, No.8, pp.1477-1486, 1999.

[3] Yarai H., M. Tobita, M. Murakami, H. Nakagawa, and S. Fujiwara: Crustal deformation of Kuju volcano detected by JERS-1 SAR interferometry –before and after the 1995 eruption-, Proceedings of 2001 ERI Workshop on ' Significance of L-band Interferometric SAR ', October 29-30, 2001, Earthquake Research Institute, Univ. of Tokyo, Tokyo, Japan (Workshop: 2001-W-04), c5, http://www.eri.u-tokyo.ac.jp/KOHO/KYODORIYO/report/2001_insar_ws/c5/, 2002.