

InSARによる桜島火山・口永良部島火山の地盤変動

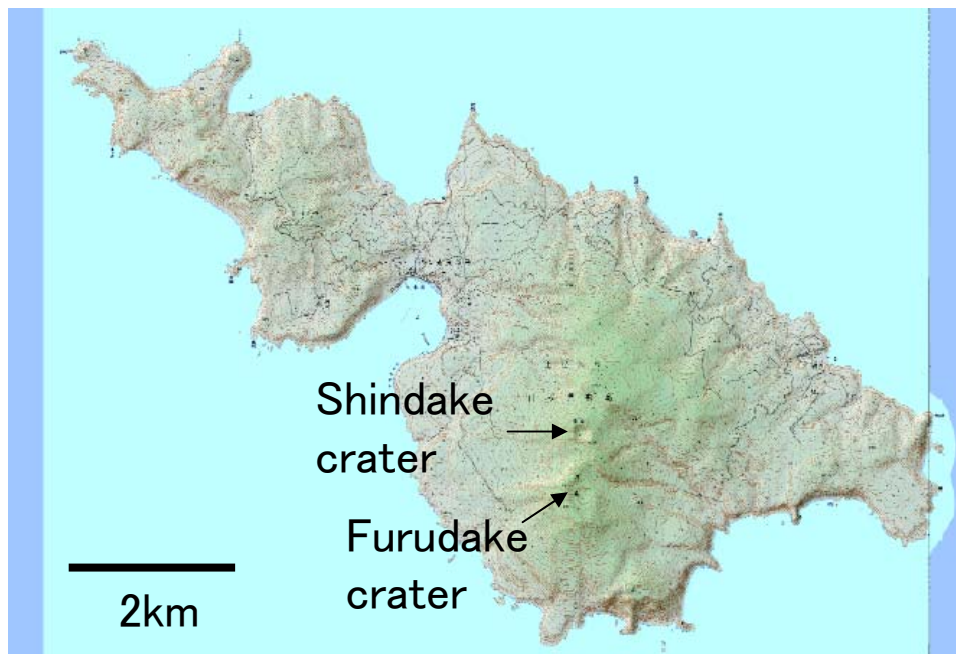
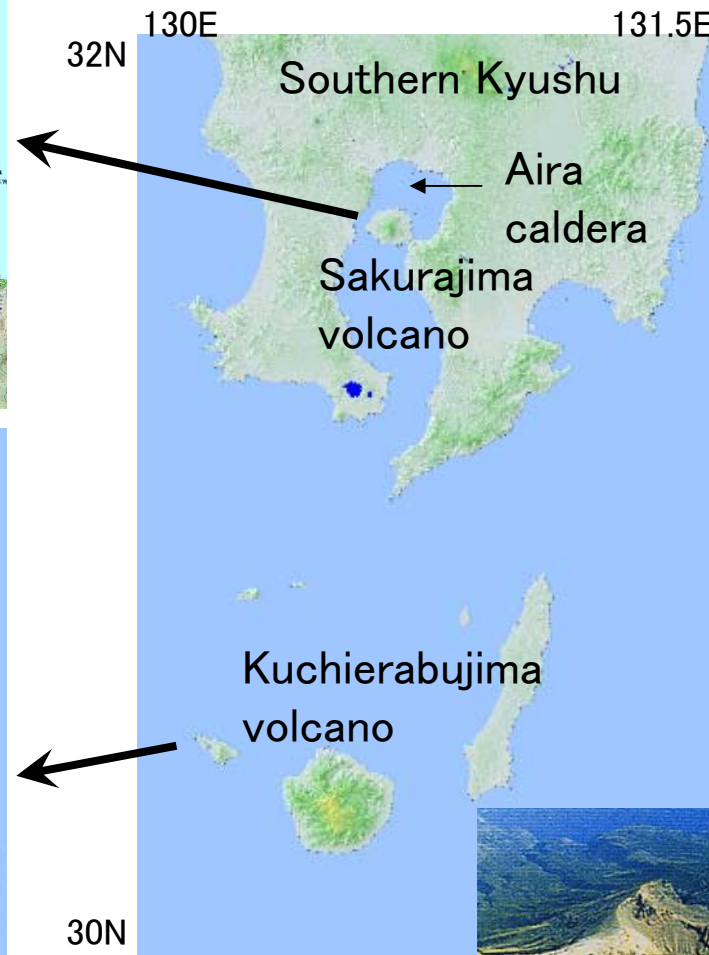
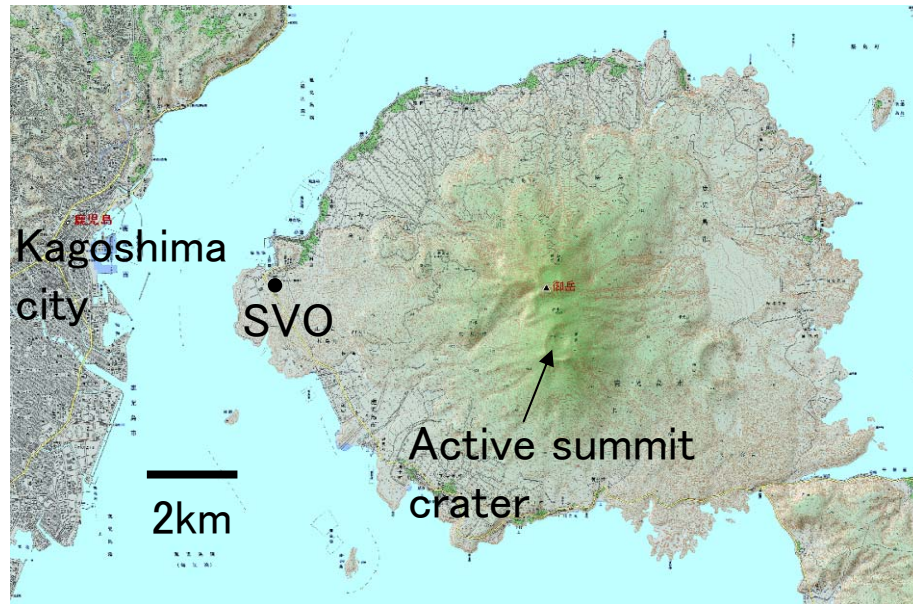
Ground deformation of Sakurajima and Kuchierabujima
volcanoes revealed by InSAR

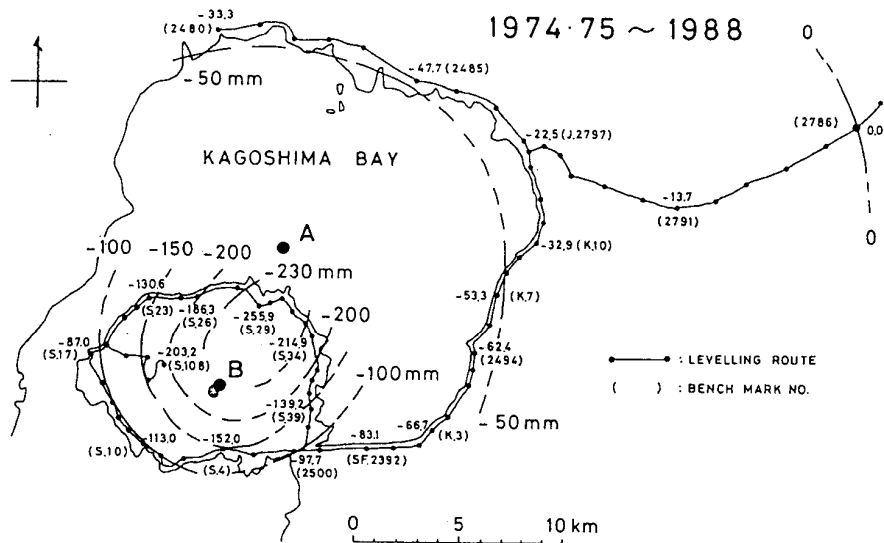
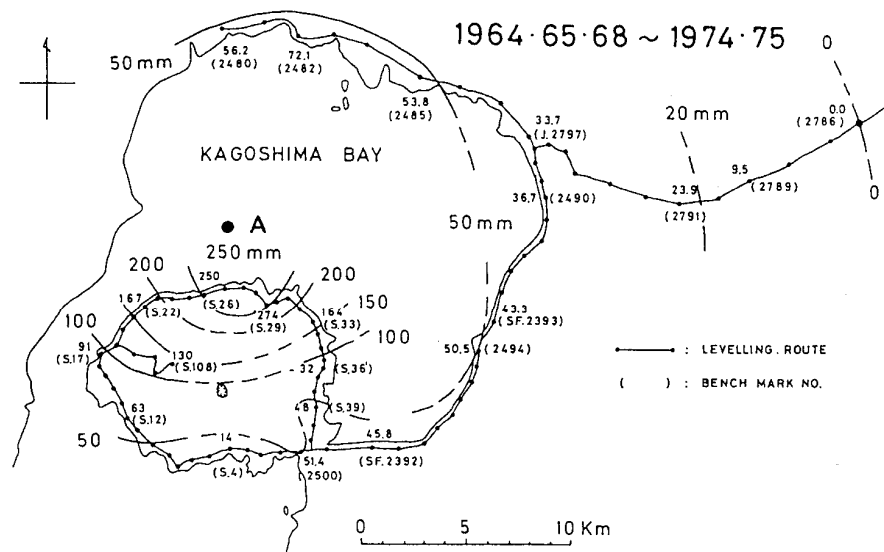
山本圭吾(京都大学防災研究所附属火山活動研究センター)

Keigo Yamamoto (Sakurajima Volcano Research Center, DPRI, Kyoto Univ.)

平成21年度京都大学防災研究所特別教育研究経費(拠点形成)研究集会
「高分解能レーダー・リモートセンシングによる災害観測の革新」

Sakurajima and Kuchierabujima volcanoes





Typical ground deformation patterns of Sakurajima volcano (leveling data)

Inactive stage of summit eruption: inflation beneath Aira caldera (about 25cm uplift around northern part of Sakurajima)

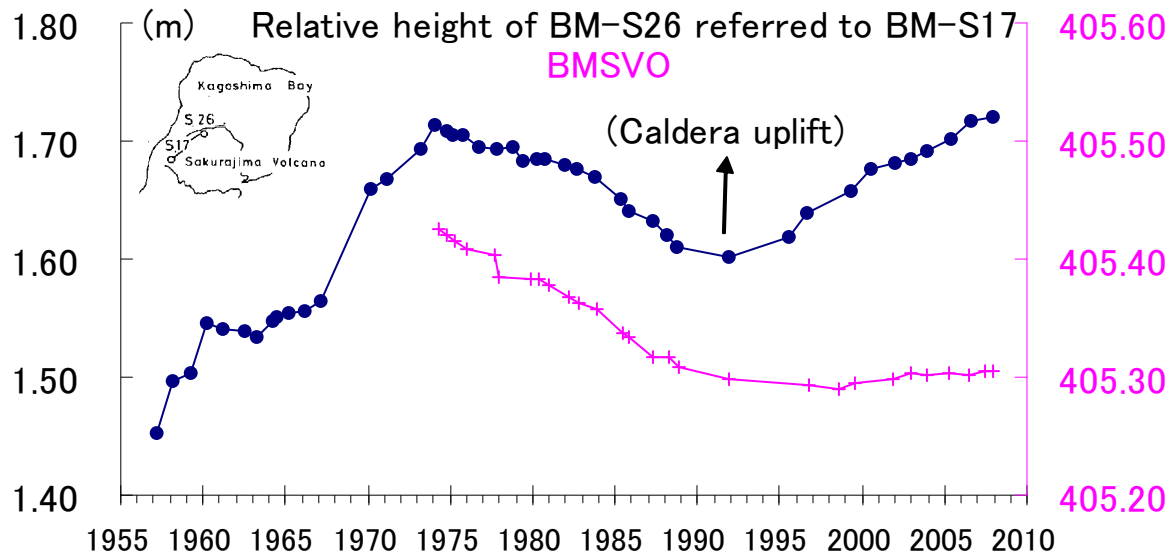
→ magma storage at the reservoir beneath Aira caldera

Active stage of summit eruption: deflation beneath Aira caldera and Sakurajima (about 23cm subsidence around northern and central part of Sakurajima)

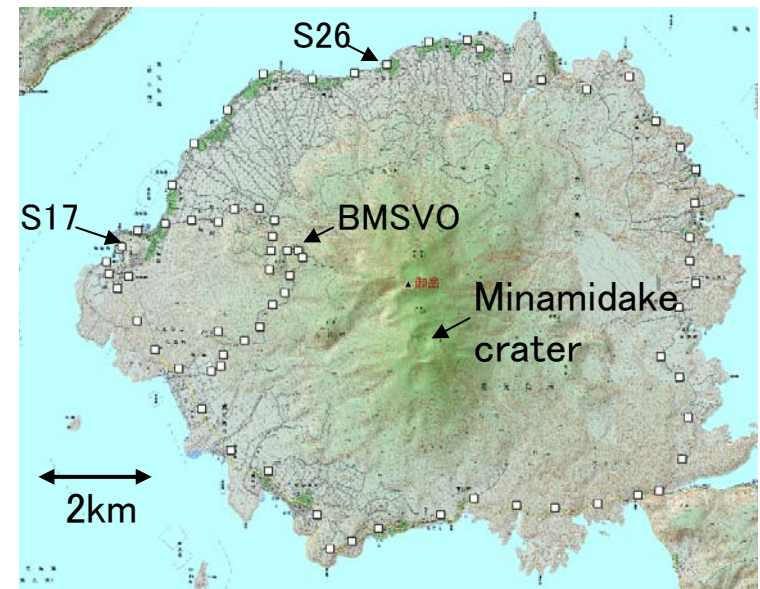
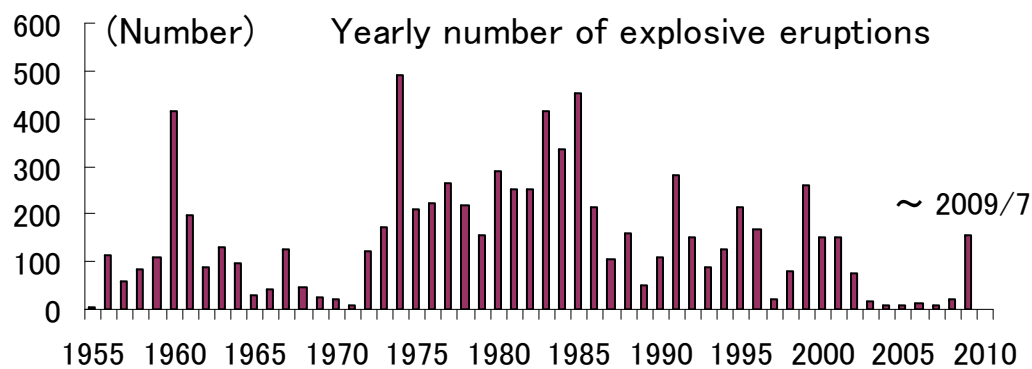
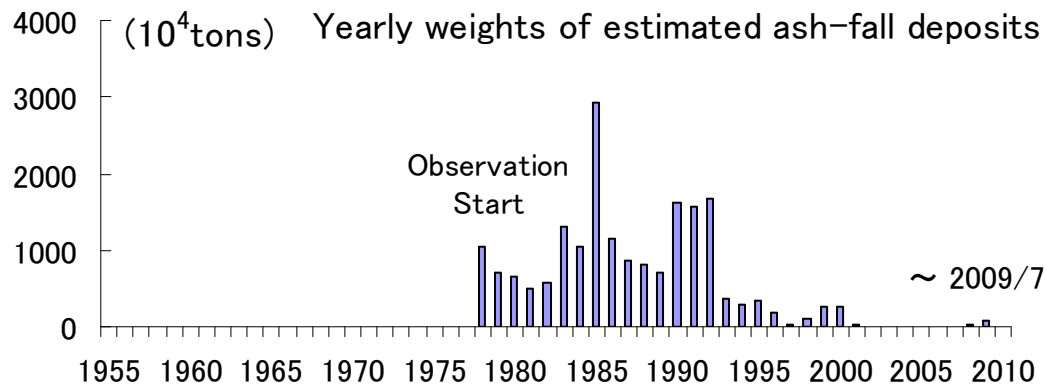
→ pressure decrease at the reservoirs beneath Aira caldera and Sakurajima due to excess magma ejection

Fig. 2 Distribution of vertical displacements referred to BM.2786 during the period from 1964·65·68 to 1974·75 (upper) and during the period from 1974·75 to 1988 (lower).

(after Eto et al., 1997)

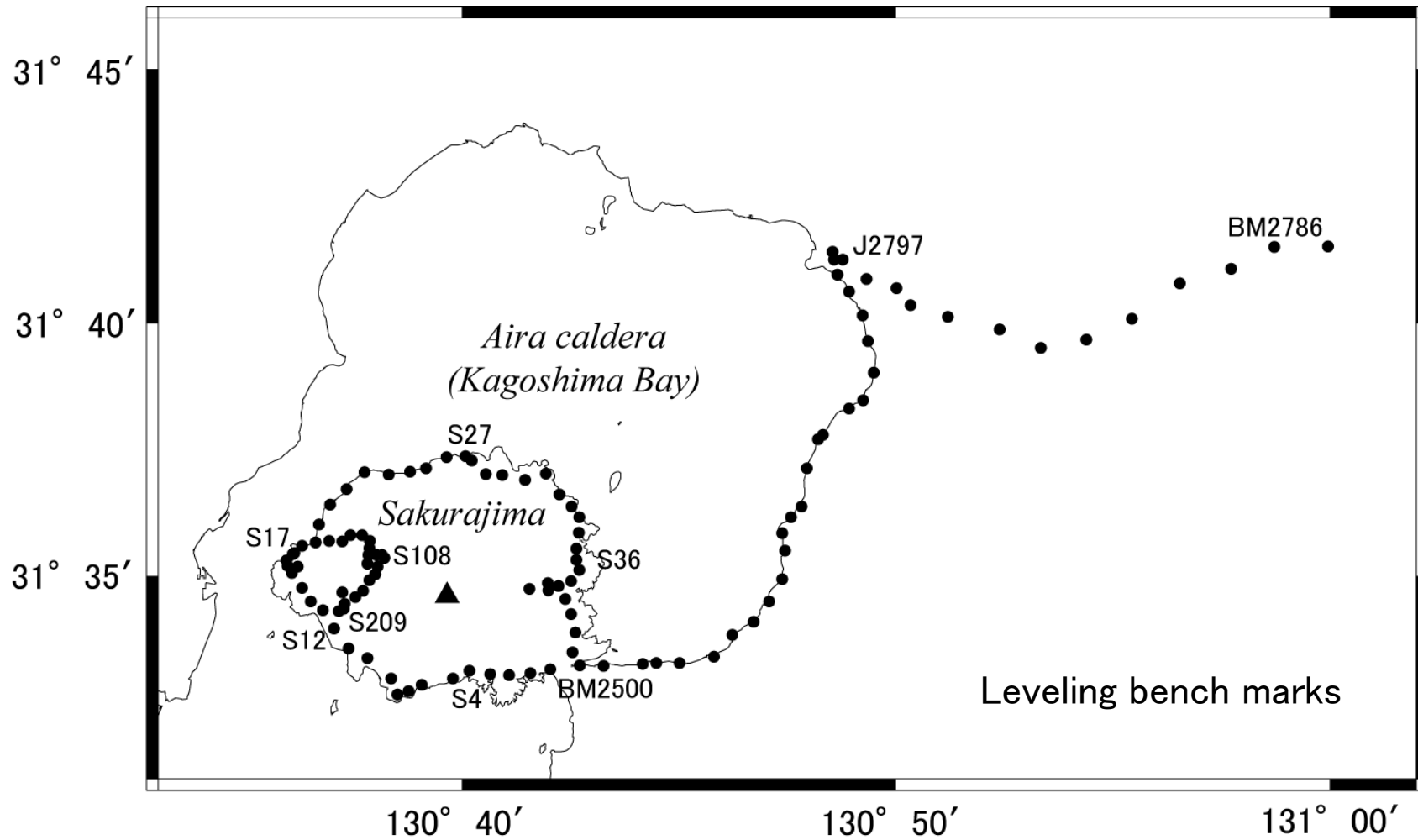


Relations among secular changes of relative heights of BMs and eruptive activities at the active crater of Sakurajima volcano

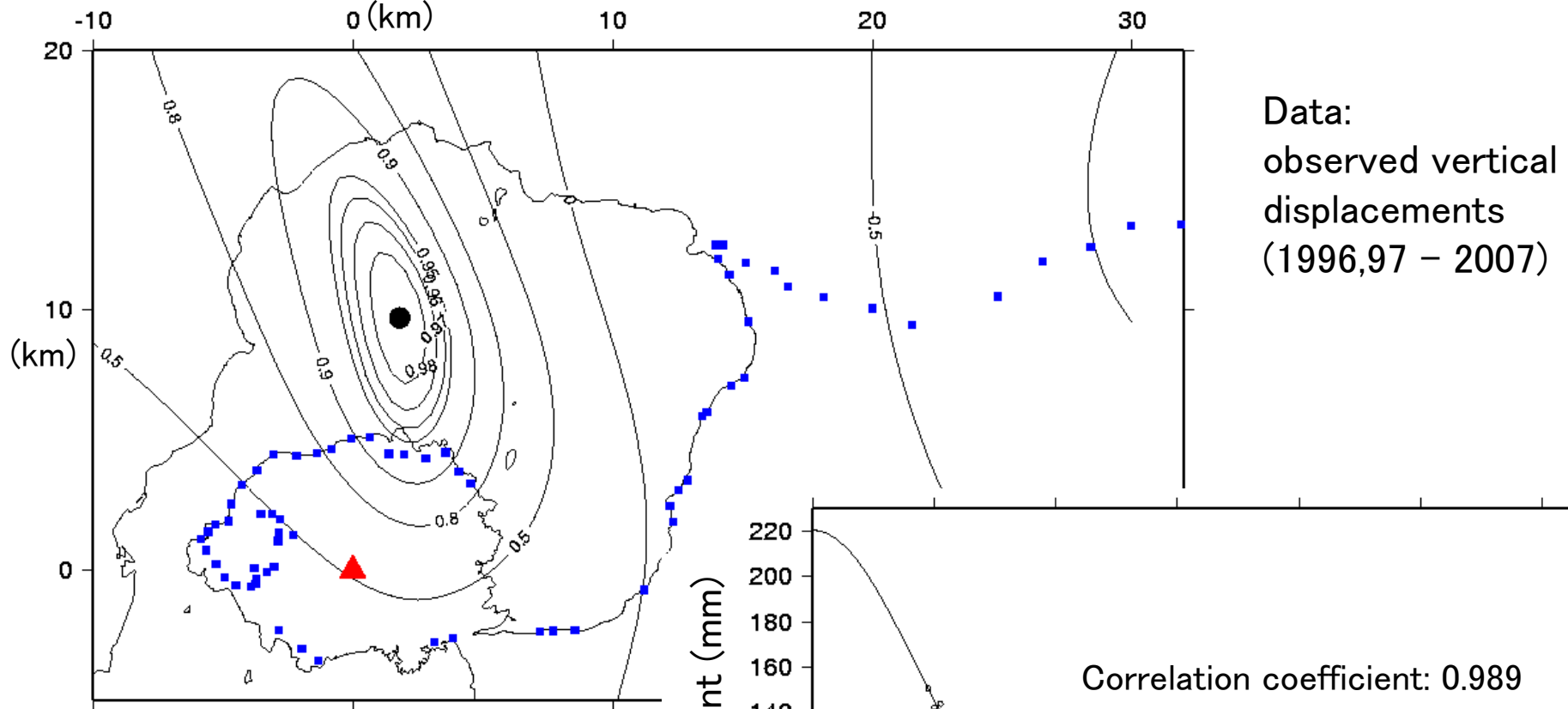


Leveling survey 2007

Observation period: 2007/10/01–11/06 (Geographical Survey Institute)
2007/12/03–12/11 (University group)

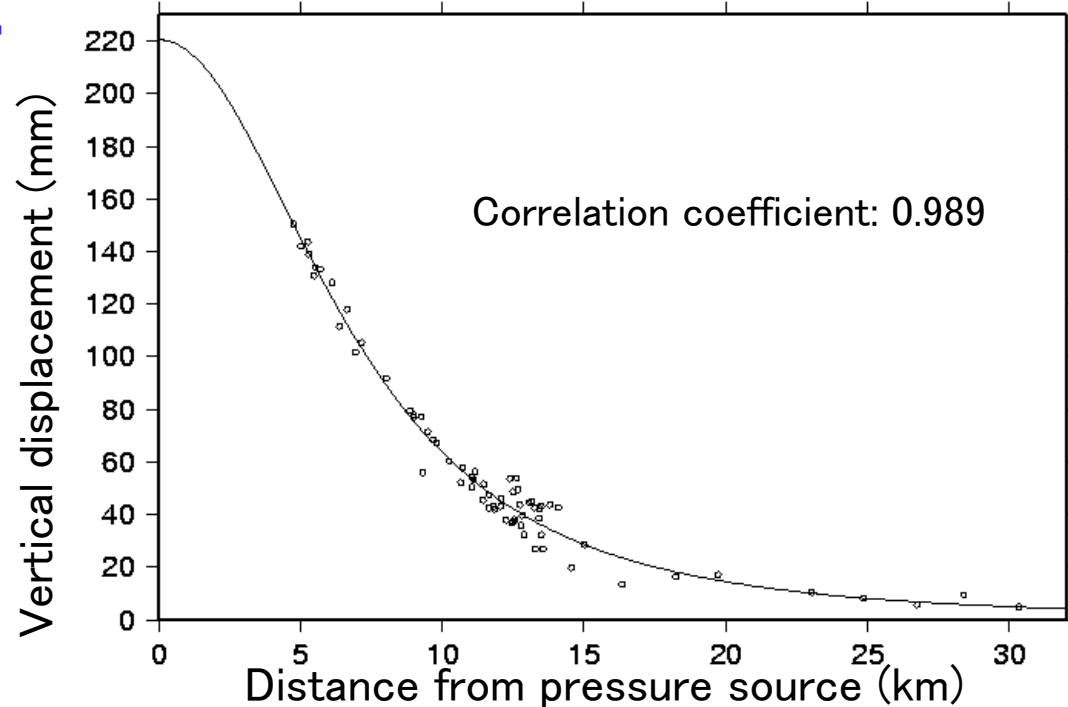


Pressure source (Mogi's model)

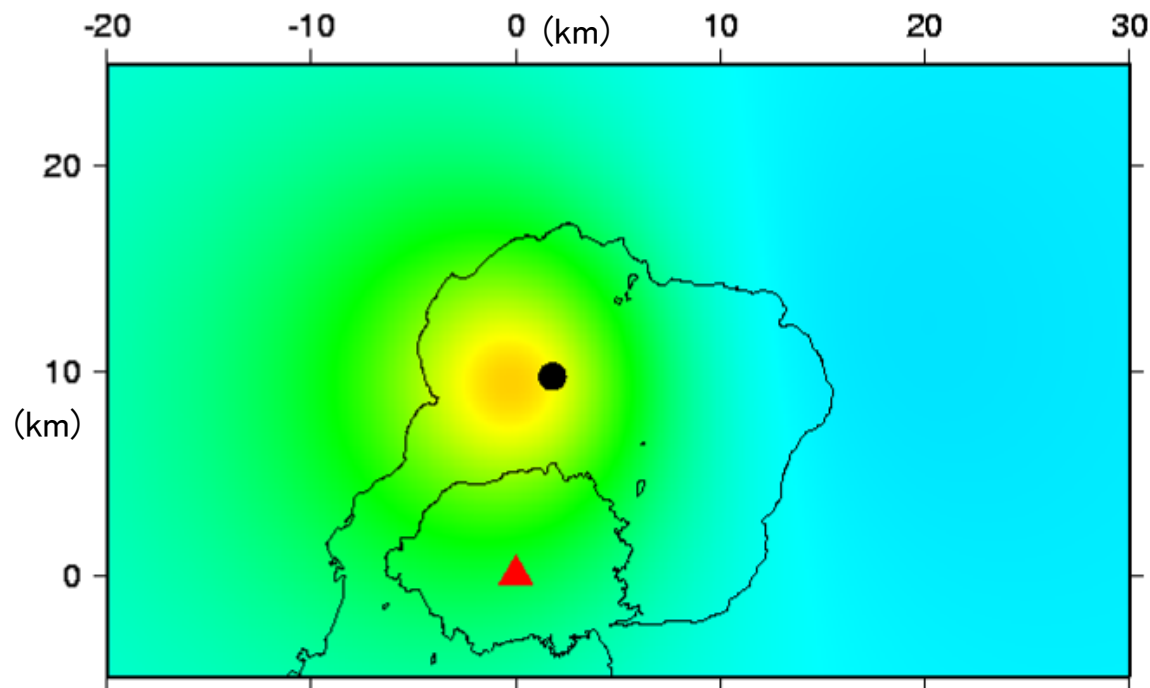
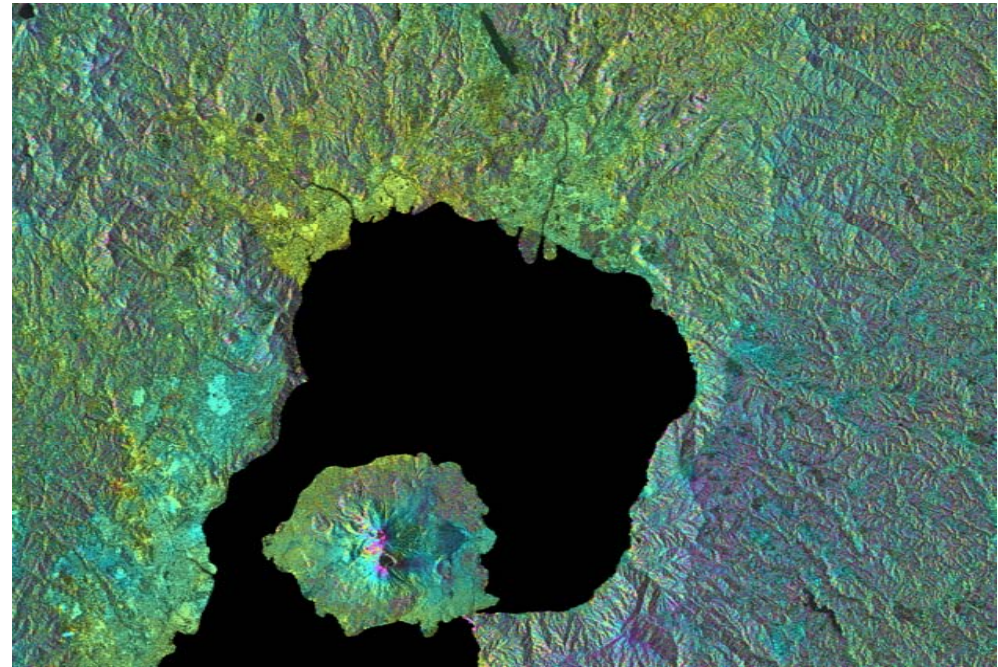
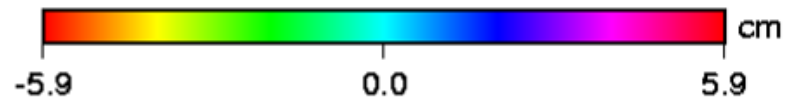


Pressure source location is shown by the solid circle. Contours are the correlation coefficients between data and theoretical curve at the depth of 8.8km.

Deformation volume at the pressure source: $+7.2 \times 10^7 \text{ m}^3$



Expected InSAR image calculated by using the pressure source from leveling data (deformation volume at the pressure source is assumed to be $+1.6 \times 10^7 \text{ m}^3$).

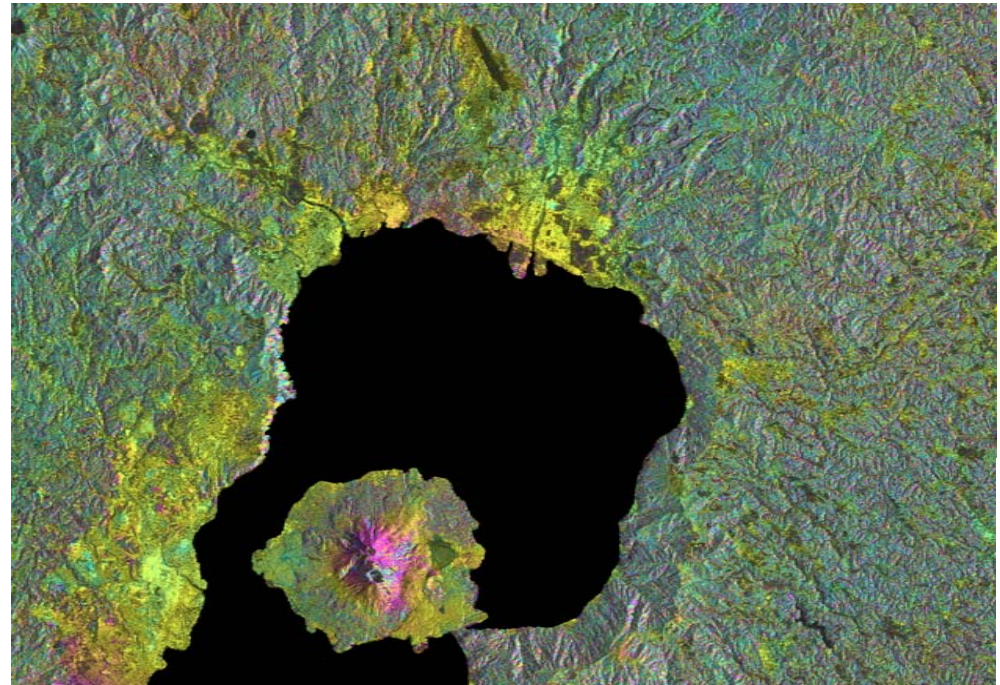
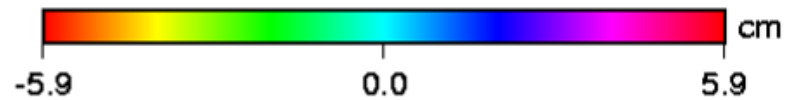


ALOS/PALSAR interferogram

2006/09/24 – 2009/02/14
(FBS) (FBS)

Ascending
Off nadir angle: 34.3 deg.
Bperp: -385 m

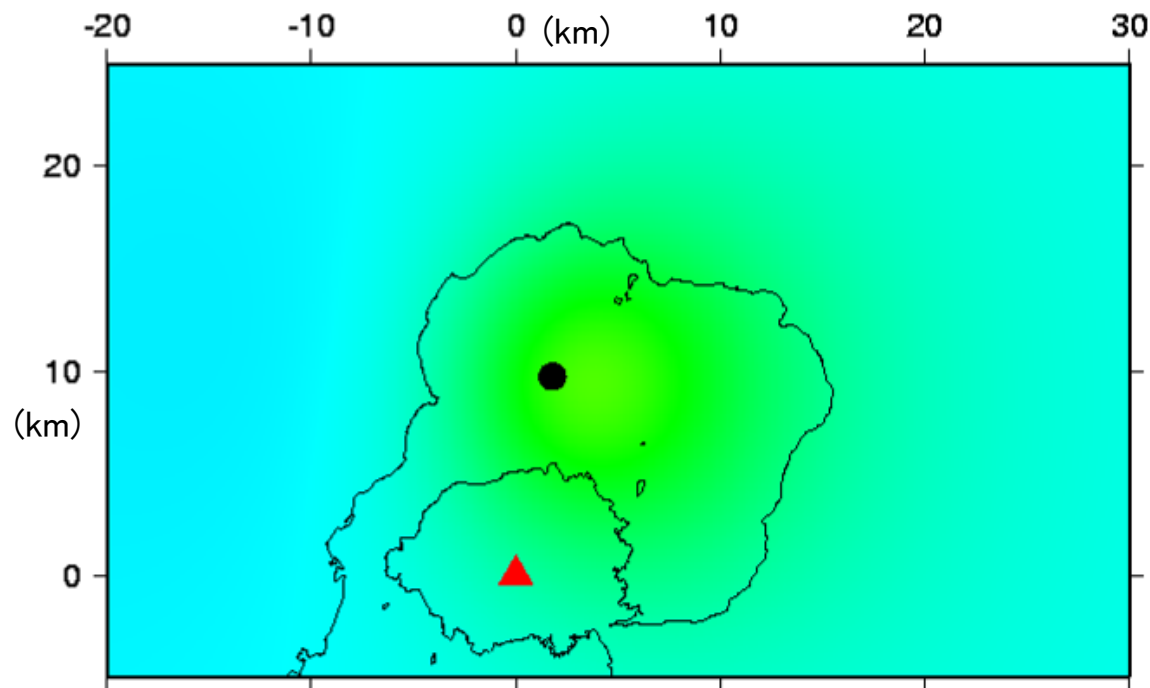
Expected InSAR image calculated by using the pressure source from leveling data (deformation volume at the pressure source is assumed to be $+9.8 \times 10^6 \text{ m}^3$).



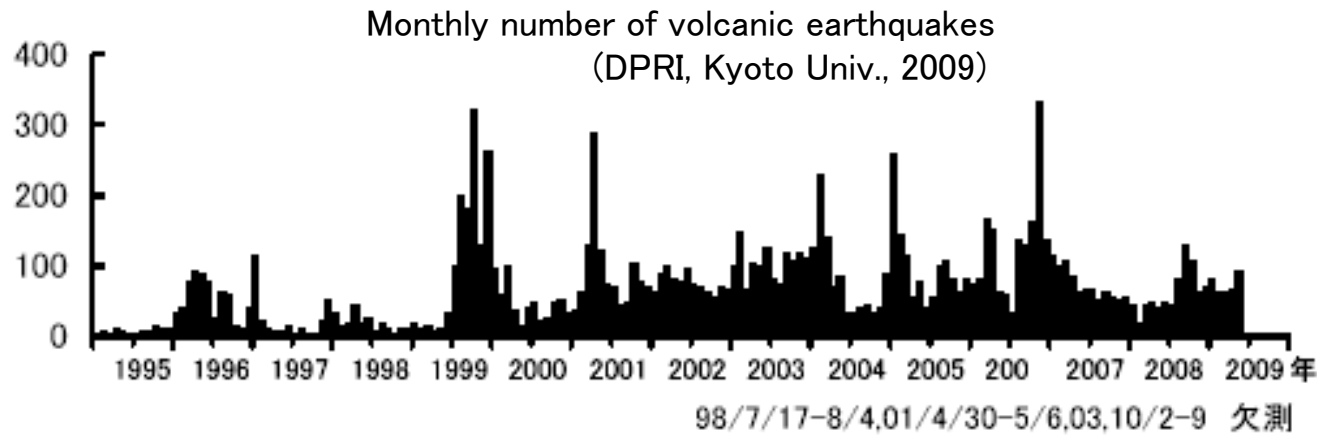
ALOS/PALSAR interferogram

2007/11/25 – 2009/05/30
(FBS) (FBS)

Descending
Off nadir angle: 34.3 deg.
Bperp: -1150 m



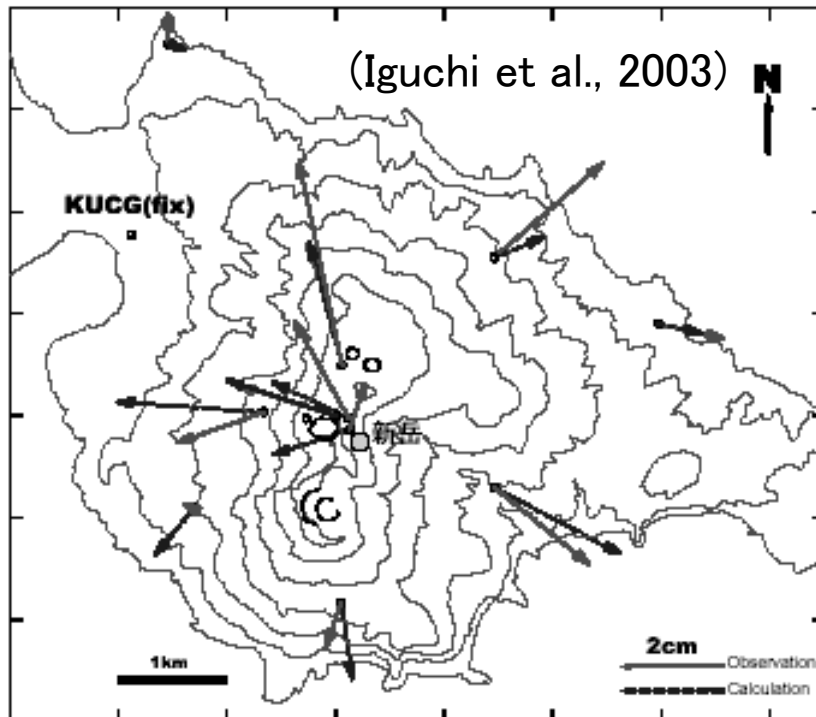
Kuchierabujima volcano



Recorded historic eruptions:
1841, 1933, 1966 and 1980.

↓
phreatic eruptions at a
summit crater or at a fissure
on the east of the crater

Increase of volcanic
earthquake activities has
been repeatedly observed.



← Repeated GPS surveys (1995/96 – 2000):
• Horizontal displacements: radial outward
pattern from the summit crater. 2–4 cm near
the crater and 1–3 cm at the flank.

Pressure source (Mogi's model):
• Located 500 m east of the crater at a depth
of 100 m below the sea level (shaded circle).
• Volume increase in the source is estimated
to be $1.7 \times 10^5 \text{m}^3$.

水平変位ベクトル(2005年2月～2006年1月)

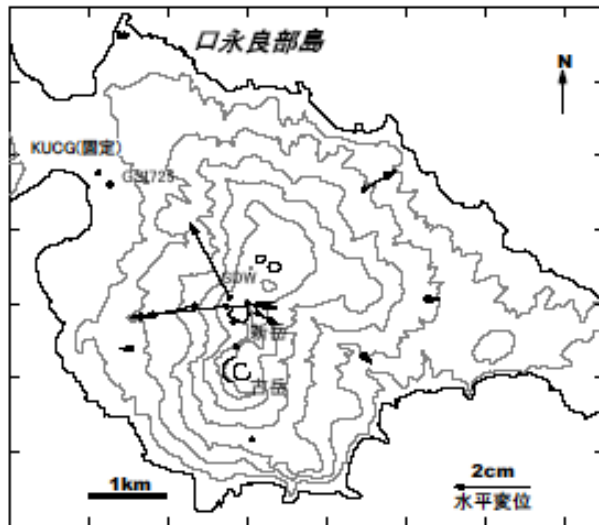


図 4. 2005年2月から2006年1月までの水平変位ベクトル.

水平変位ベクトル(2006年1月～2006年12月/2007年2月)

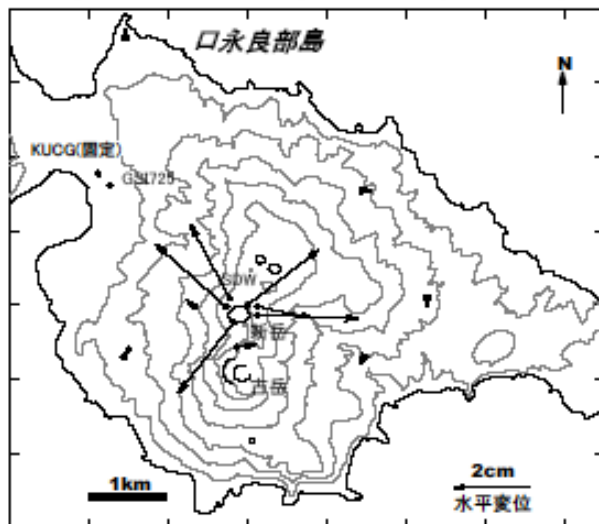


図 5. 2006年1月から2006年12月/2007年2月までの水平変位ベクトル.

Results of repeated GPS surveys

(Iguchi et al., 2007)

Feb. 2005 – Jan. 2006:

→ Horizontal displacements: radial outward pattern from the summit crater. Less than 1 cm at the flank.

Pressure source (Mogi's model) is located beneath the summit crater at a depth of 200 m above the sea level (300 m below the crater). Volume increase in the source is estimated to be $2.4 \times 10^4 \text{m}^3$.

Jan. 2006 – Dec. 2006:

→ Horizontal displacements: clear radial outward pattern from the summit crater (more than 2 cm). Rapid decrease of displacements away from the summit crater.

Pressure source (Mogi's model) is located beneath the summit crater at a depth of 130 m below the crater. Volume increase in the source is estimated to be $6.2 \times 10^3 \text{m}^3$.

Continuous GPS observation

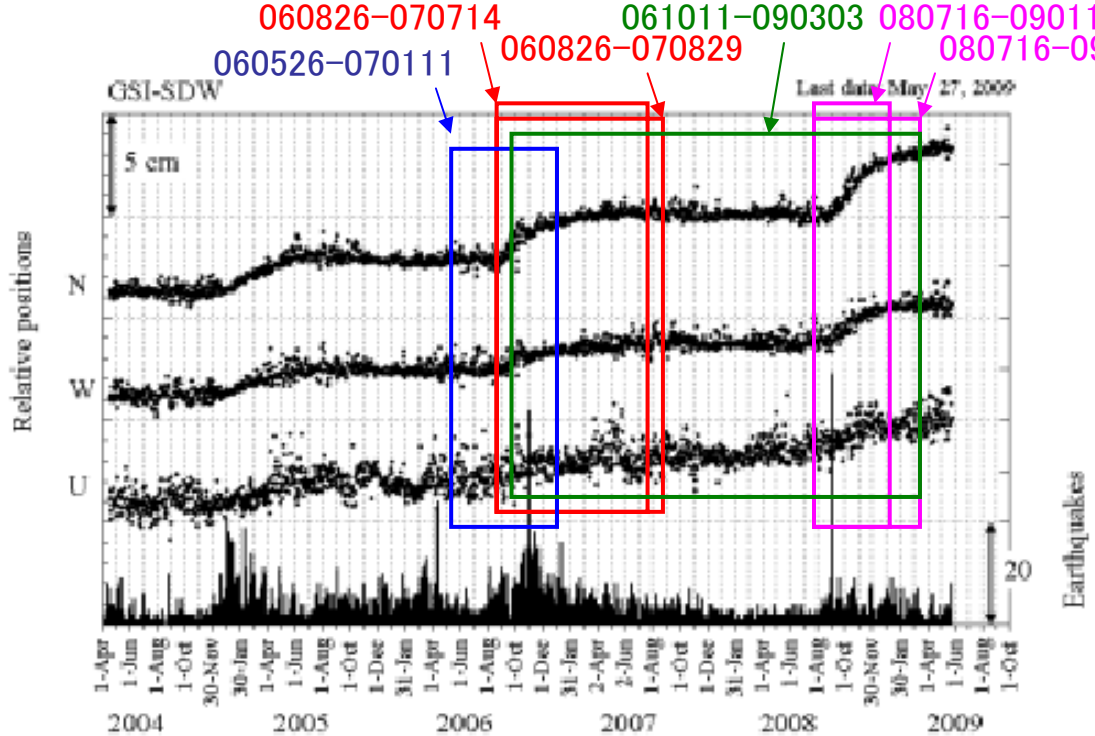
(Saito and Iguchi, 2007)

The continuous GPS observation is made at 4 stations since 2004.

The deformation indicating the inflation of summit region was observed at the observation site near the summit crater during the periods:

- Jan. 2005 – Jun. 2005,
 - Sep. 2006 – Jan. 2007,
 - Sep. 2008 – Jan. 2009,
- respectively.

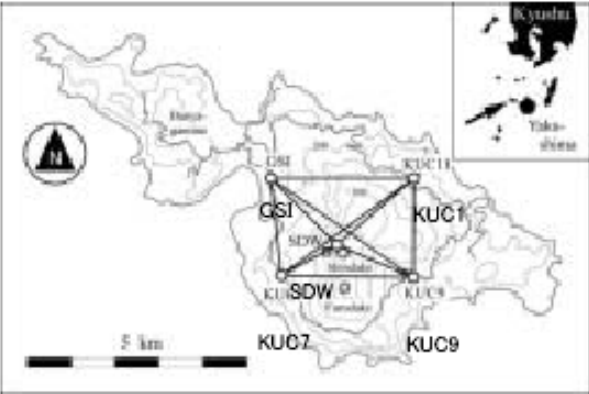
The ground deformation was accompanied by the increasing activity of volcanic earthquakes.



GPS 観測点SDW における変位. N:南北, E:東西, U:上下

2008年9月から始まった口永良部島新岳の北西200mの地点での北西方向の変位は、11月ごろから変位速度が低下しほぼ停止した。

(京大防災研究所・産業技術総合研究所, 第113回火山噴火予知連絡会)



観測点位置図の作成に当たっては国土地理院発行の2万5千分の1地形図(口永良部島)を使用した

Unwrapped interferograms

Software: GAMMA

PALSAR data

Orbit: Ascending

Off-nadir angle: 34.3 deg.

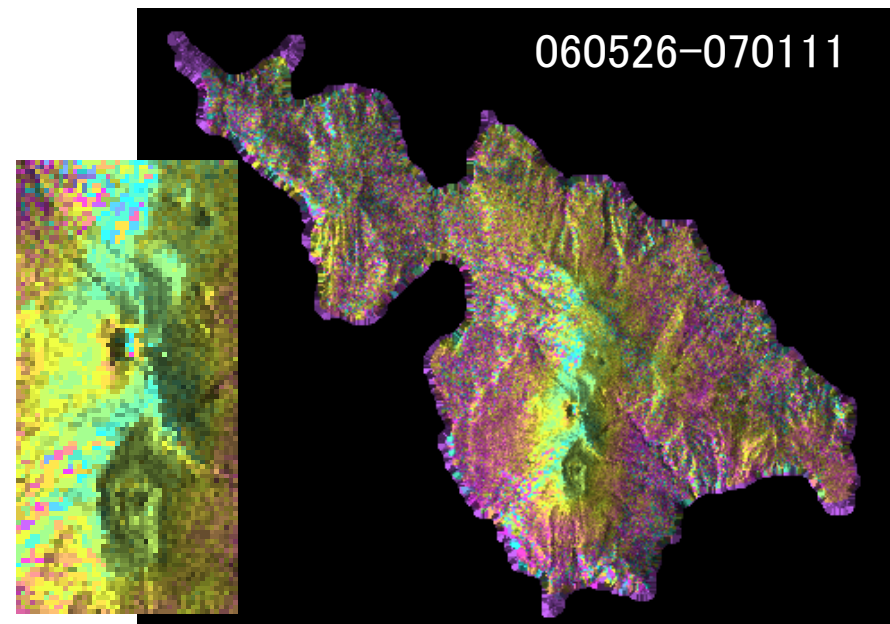
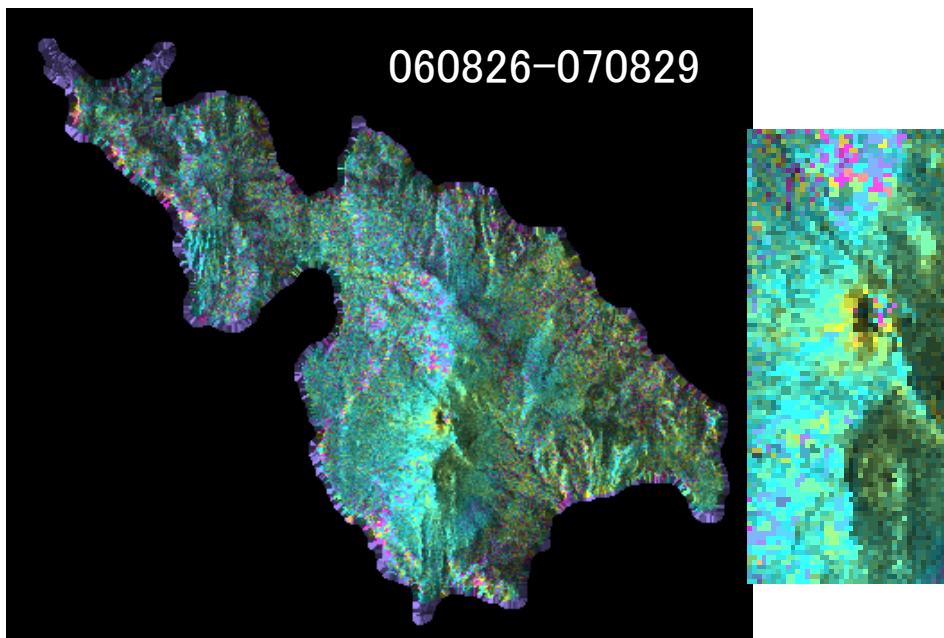
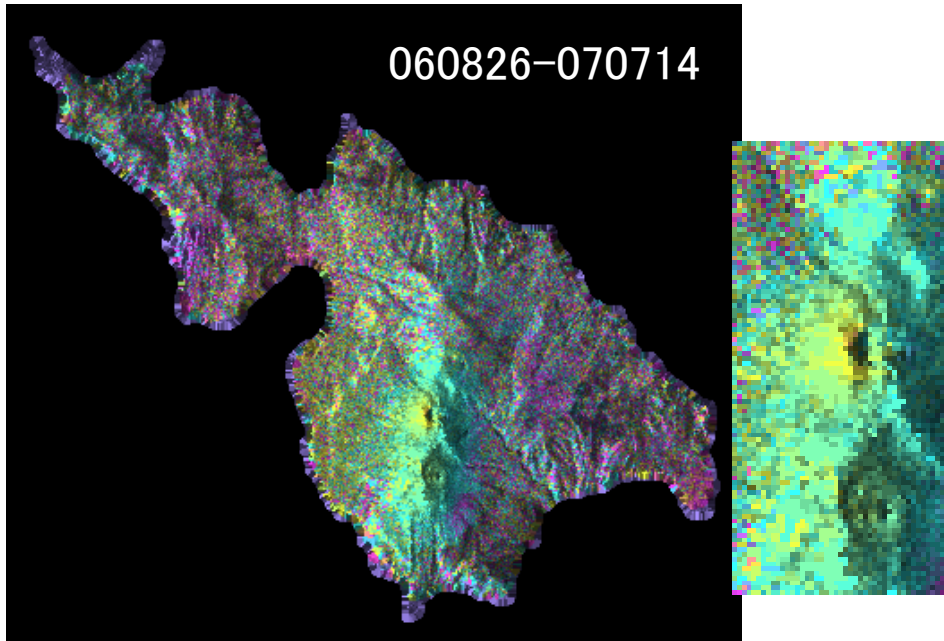
Bperp

2006/08/26(FBS) – 2007/07/14(FBD) 71m

2006/08/26(FBS) – 2007/08/29(FBD) 374m

2006/05/26(FBS) – 2007/01/11(FBS) 374m

Display: unwrapped phase and image intensity



Unwrapped interferograms

Software: GAMMA

PALSAR data

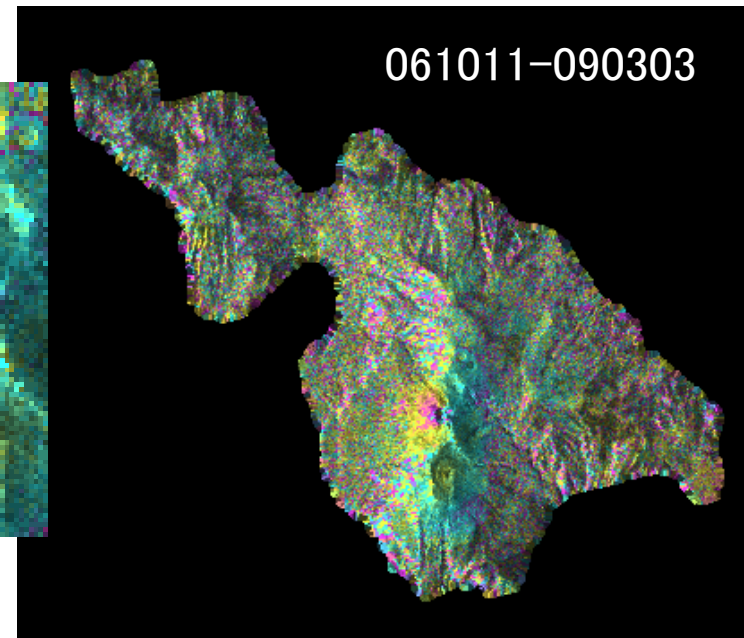
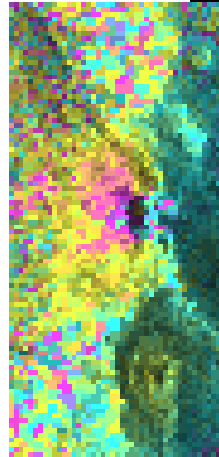
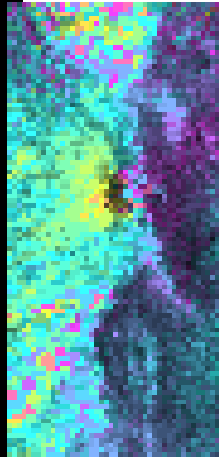
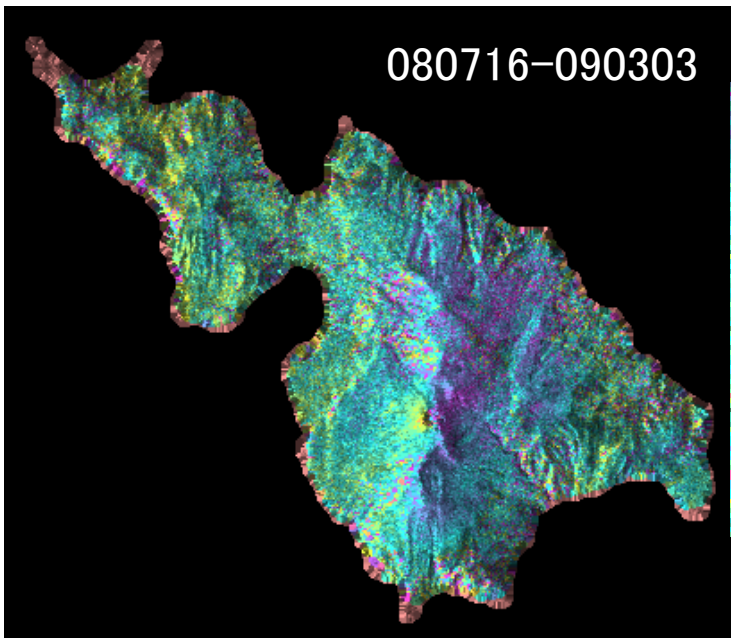
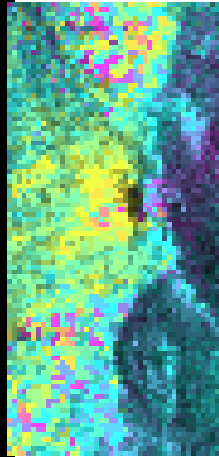
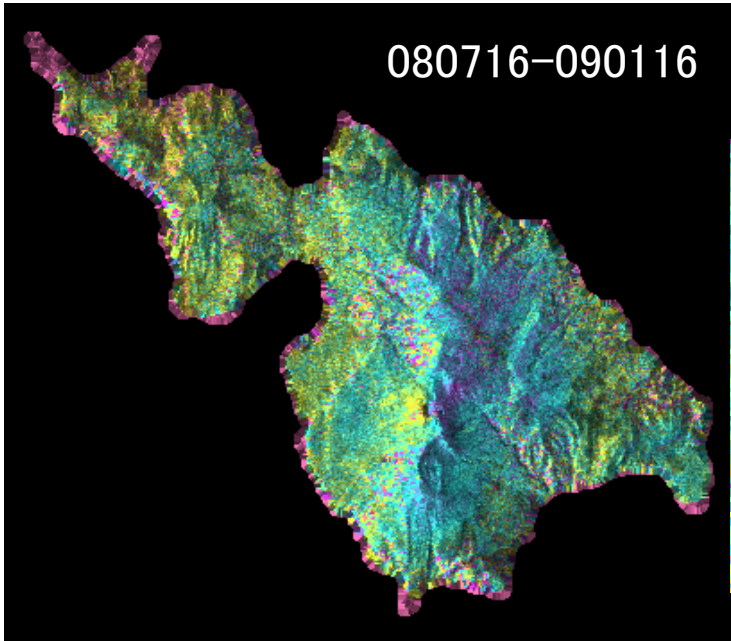
Orbit: Ascending

Off-nadir angle: 34.3 deg.

Bperp

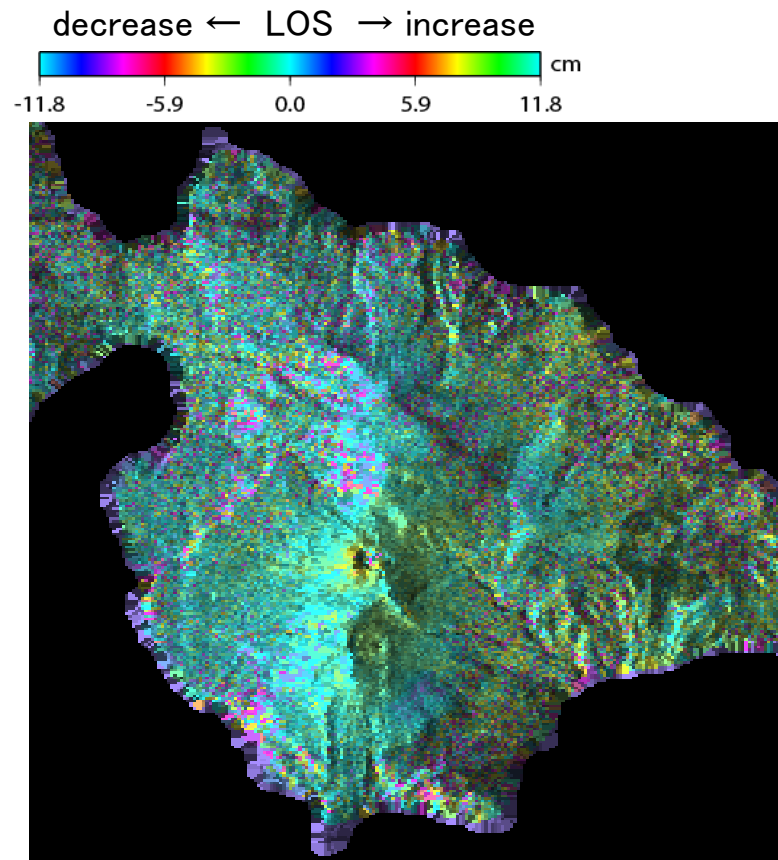
2008/07/16(FBD) – 2009/01/16(FBS)	558m
2008/07/16(FBD) – 2009/03/03(FBS)	-449m
2006/10/11(FBS) – 2009/03/03(FBS)	-589m

Display: unwrapped phase and image intensity



Comparison with the model calculation

Unwrapped interferogram:
2006/08/26 – 2007/08/29

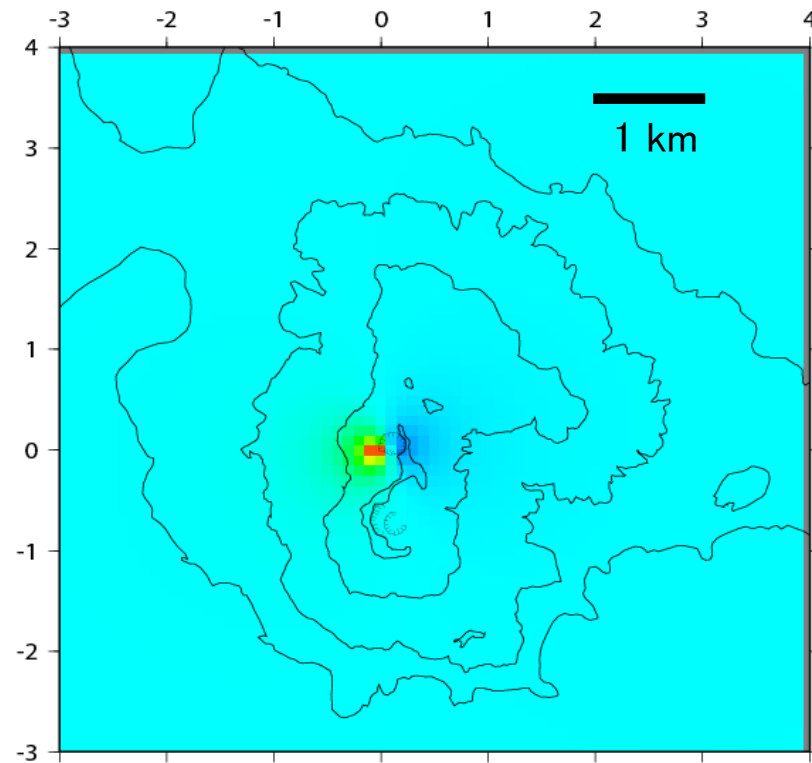


Pressure source inferred from GPS data
(Jan. 2006 – Dec. 2006):

- beneath the summit crater
- at a depth of 130m below the crater
- volume increase: $6.2 \times 10^3 \text{m}^3$



expected InSAR image



Summary

ALOS/PALSAR image pairs are analyzed in order to detect the recent ground deformation associated with the volcanic activity of Sakurajima and Kuchierabujima volcanoes, southwest Japan.

The resultant interferograms of Sakurajima volcano show a few centimeters of LOS distance decrease around the Aira caldera, being consistent with the results of the leveling surveys.

The interferograms of Kuchierabujima volcano show the LOS distance decrease in the small area near the summit crater during the periods of the inflation events observed by GPS.

The interferograms of these two volcanoes are in harmony with the simulated images in which the pressure sources inferred from the leveling or GPS data are assumed.

Acknowledgement:

PALSAR level 1.0 data are shared among PIXEL (PALSAR Interferometry Consortium to Study our Evolving Land surface), and provided from JAXA under a cooperative research contract with ERI, Univ, Tokyo. The ownership of PALSAR data belongs to METI (Ministry of Economy, Trade and Industry) and JAXA. This study was supported by the Earthquake Research Institute cooperative research program.