InSARによるフルネーズ火山の2007年4月の噴火イベントによる地殻変動

Ground Deformation associated with the Apr. 2007 Eruption of Piton de la Fournaise detected by PALSAR Interferometry

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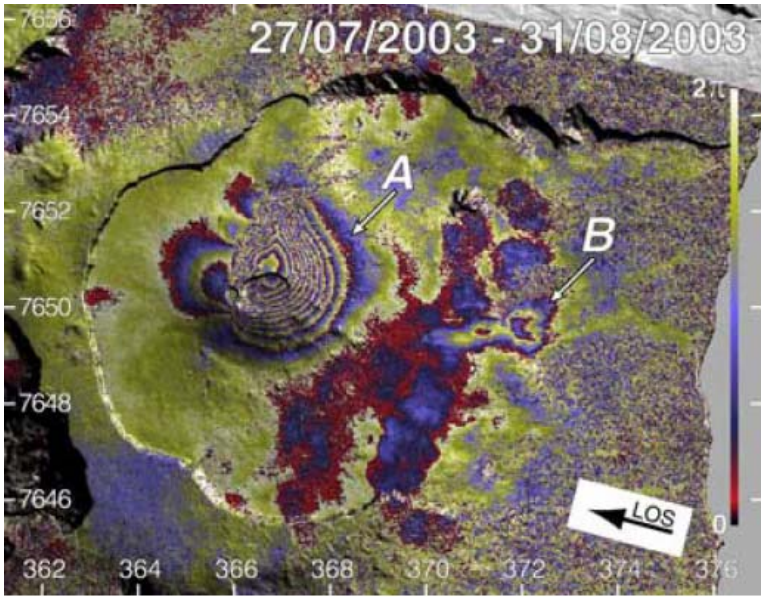
Introduction

Piton de la Fournaise
– One of the most active volcanoes in the world.

Recent Eruptions:
Jan. 2002, Nov. 2002
Jun. 2003, Aug. 2003, Dec. 2003
May 2004, Sep. 2004
Feb. 2005, Oct. 2005, Dec. 2005
Feb. 2007, Apr. 2007

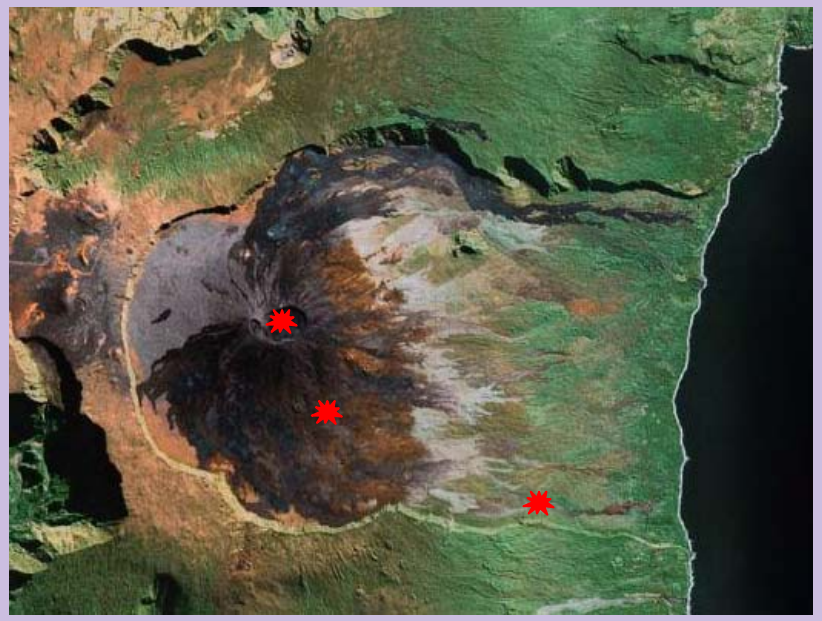


Deformation associated with 2003 Eruption (Froger et al. 2004)

Apr. 2007 Eruption

Mar. 30:
  Small eruption at SE of the summit
Apr. 2~:
  Large eruption at 7km SE from the summit
Apr. 5~10:
  Collapse of the summit crater
May 1:
  End of the eruption

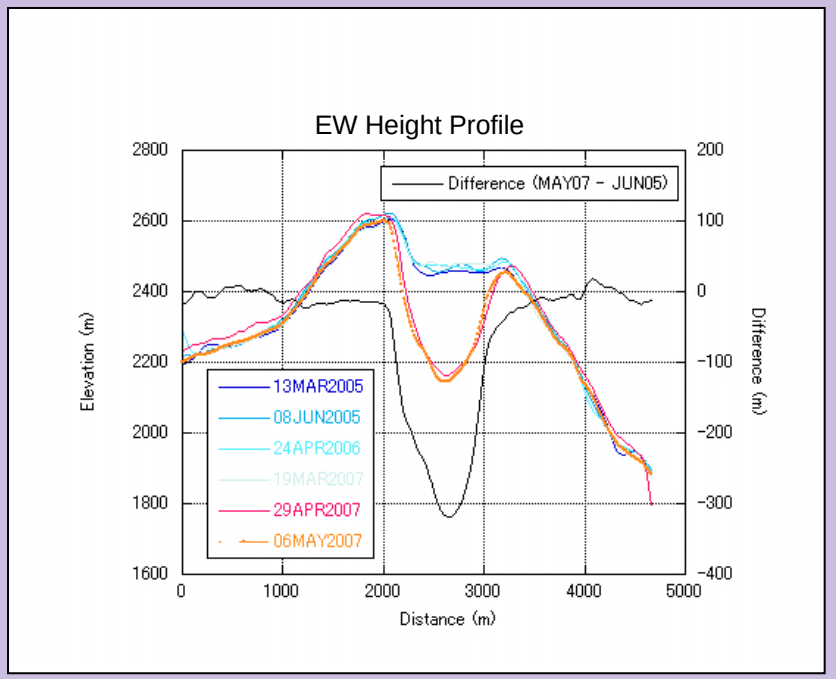
Total volume of the erupted lava: $1.4 \times 10^8 m^3$



http://www.fournaise.info/

Crater Collapse observed by ASTER (Urai, M., 2007)

Maximum Subsidence: 320m
Volume loss: $9.6 \times 10^7 m^3$



PALSAR Observations

Path/Row=539/676 (Ascending), Bperp= 39m, 46days

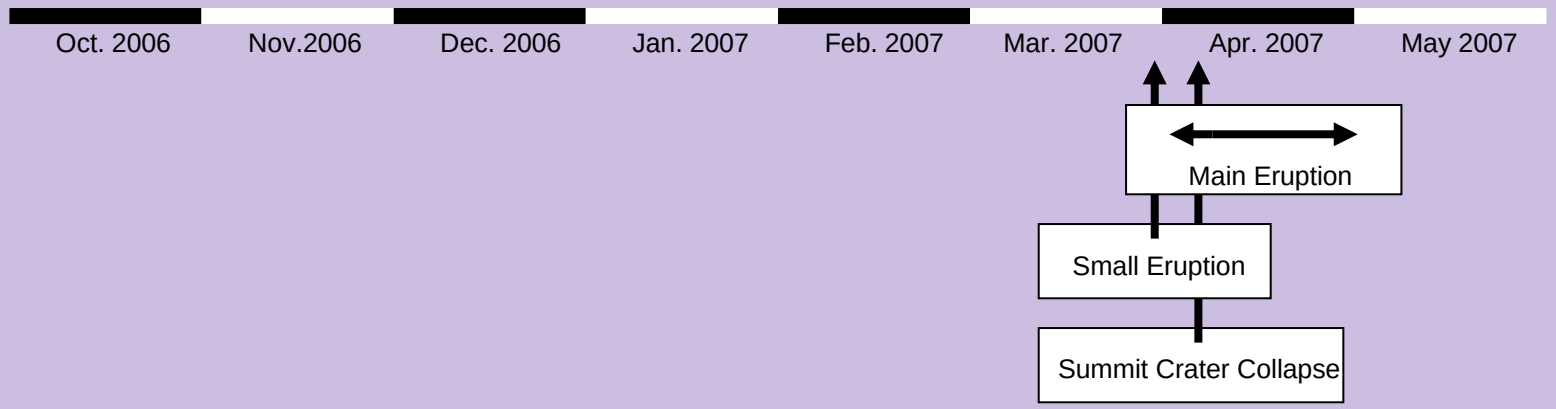
Mar.4, 2007 — Apr.19, 2007

Path/Row=541/675 (Ascending), Bperp= -806m, 92days

Feb.20, 2007 — Mar.23, 2007

Path/Row=541/675 (Ascending), Bperp= -1190m, 138days

Oct.5,2006 — Feb.20, 2007



Software: GAMMA

Topography: SRTM

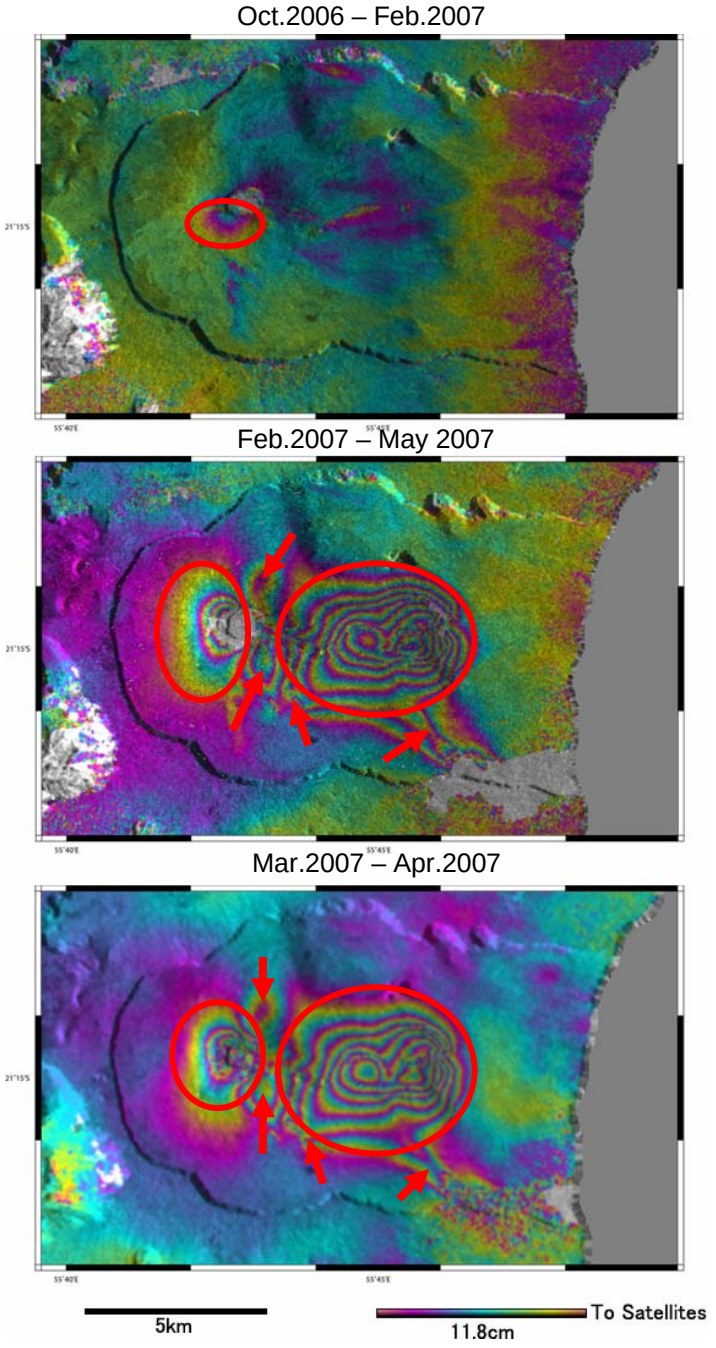
PALSAR Interferograms

Pre-Eruptive:

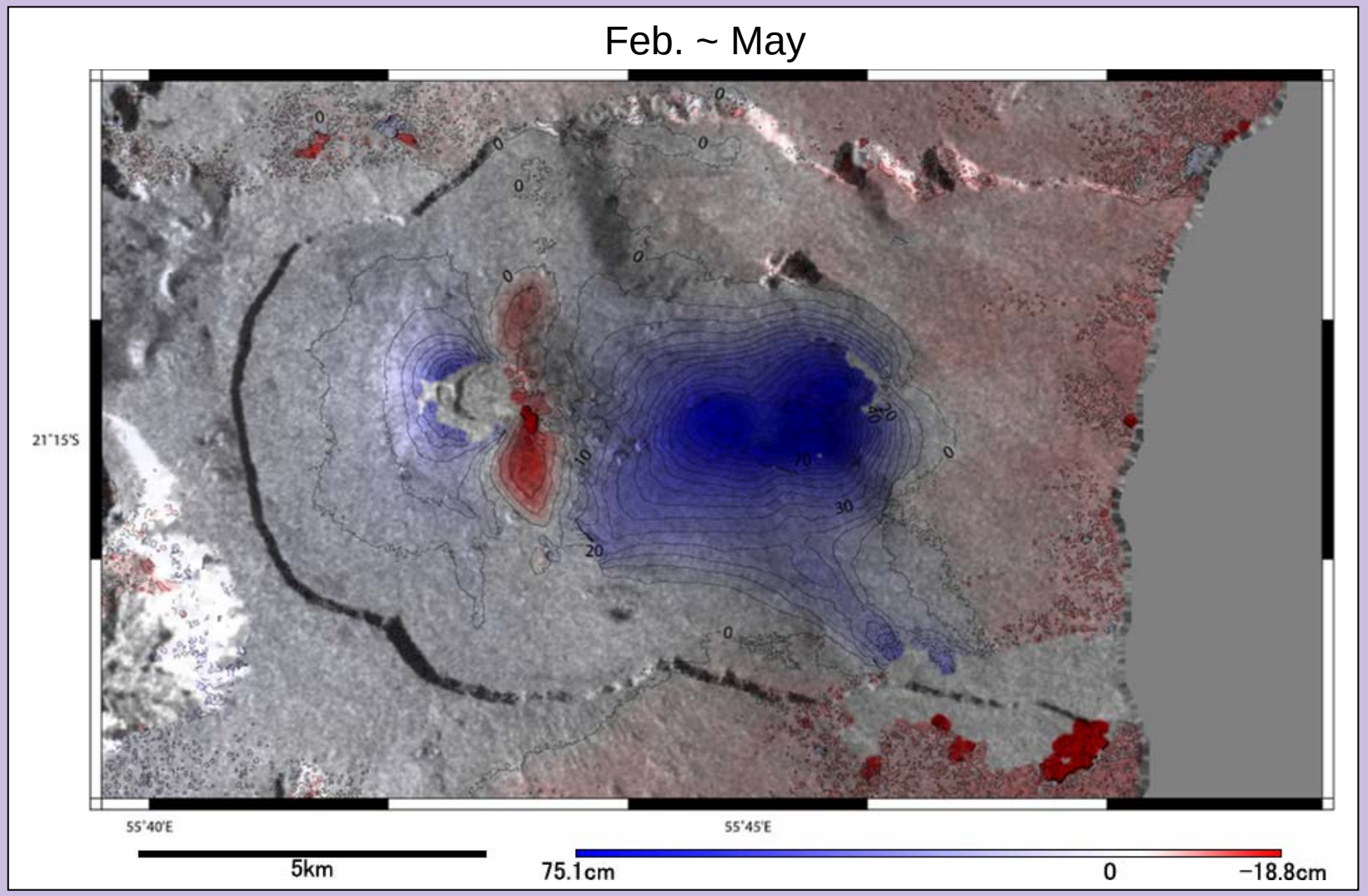
- LoS distance decrease at SW edge of the summit crater (~10cm)

Co-Eruptive:

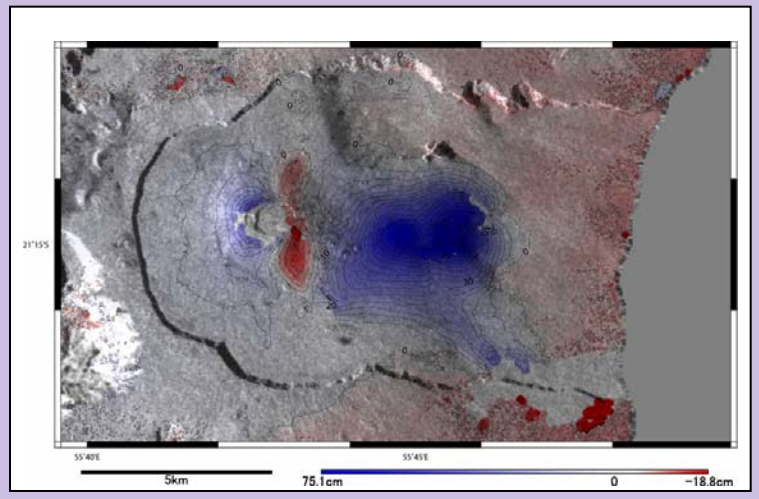
- LoS distance increase at east flank (Mar.~Apr.: ~72cm, Feb.~May: ~78cm)
- LoS distance increase between east flank and eruptive vents
- LoS distance increase at west of the summit crater (Mar.~Apr.: 36cm~, Feb.~May: 42cm~)
- LoS distance increase at NE/SE ridge of the summit crater (Mar. ~Apr.: ~18cm, Feb.~May: ~17cm)



PALSAR Interferograms



Interpretation



LoS distance increase between eruptive vents and big “blue” area at east flank

↓

This is caused by closing of the dyke which connects the magma reservoir and the vents

↓

1) The lave came from the big blue area
2) The dyke was filled at 1st observation, and the lave was gone at 2nd observation.

↓

The big blue area is subsiding due to deflation of the magma reservoir

There is no LoS distance decrease In Pre-Eruptive pair

↓

The dyke was already filled at Oct. 2006 (5 months before eruption)

Depth / Volume change estimation

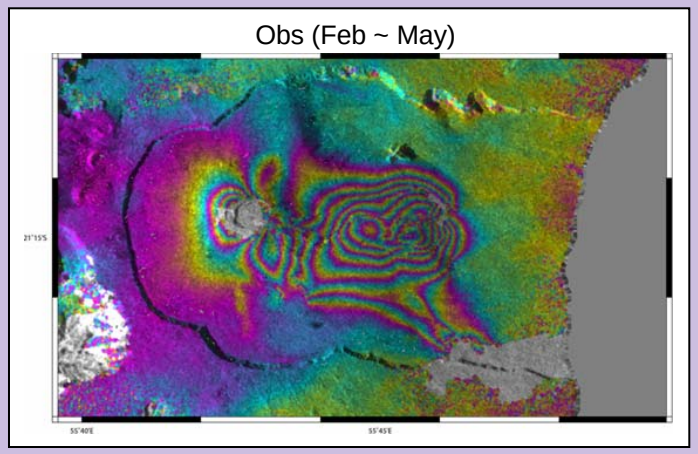
Assumed model: Sill (Okada, 1992)
size: 2km x 3km

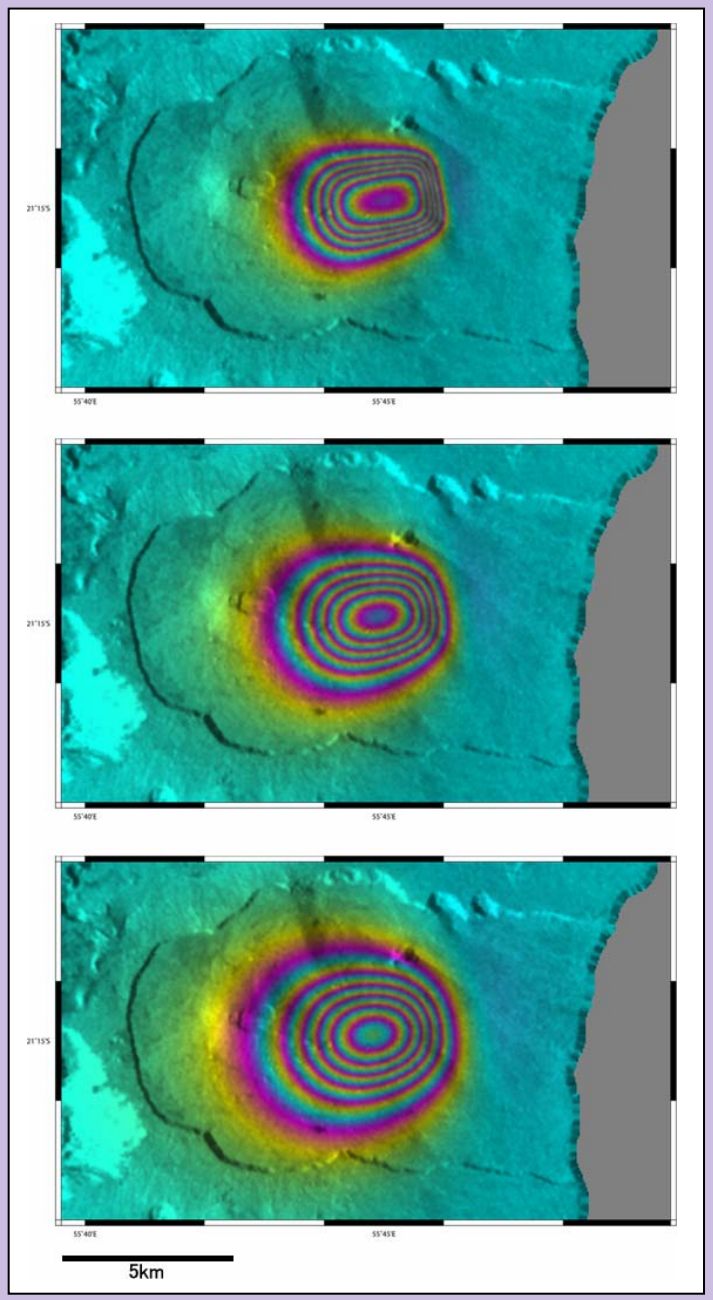
Top:
Depth: 500m, closing: 0.9m

Somewhere between these

Middle:
Depth: 1000m, closing: 1.2m

Bottom:
Depth: 1500m, closing: 1.7m

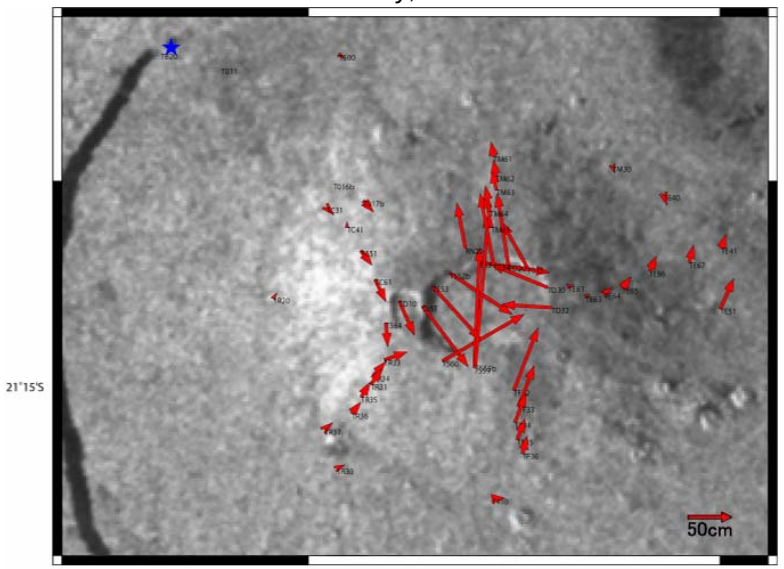




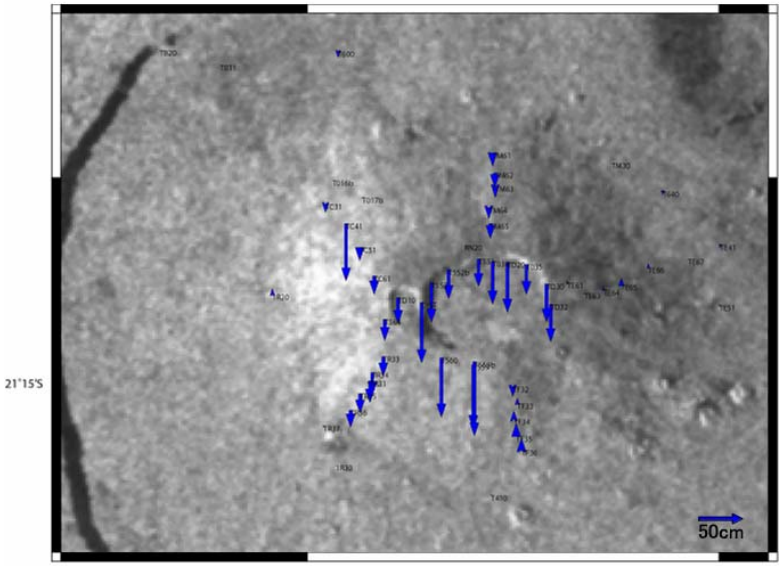
GPS observations

- Horizontal displacement towards the crater (except N/NE of the summit)
- Subsidence is dominant (except SE of the summit)

Mar. ~ May, Horizontal

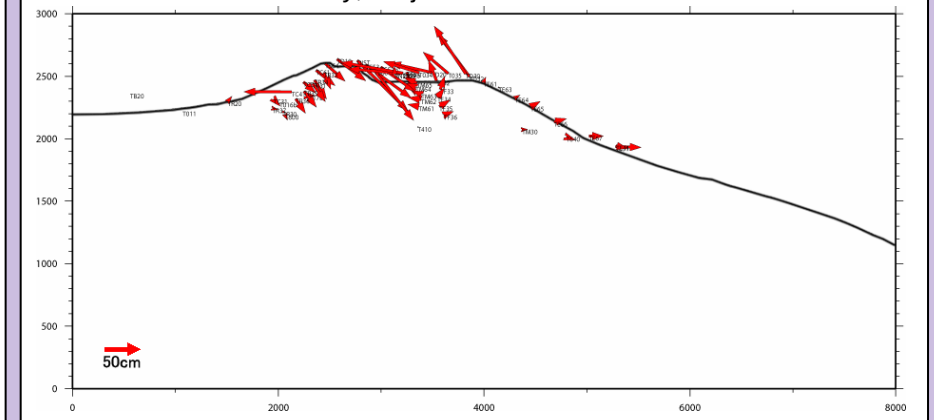


Mar. ~ May, Vertical



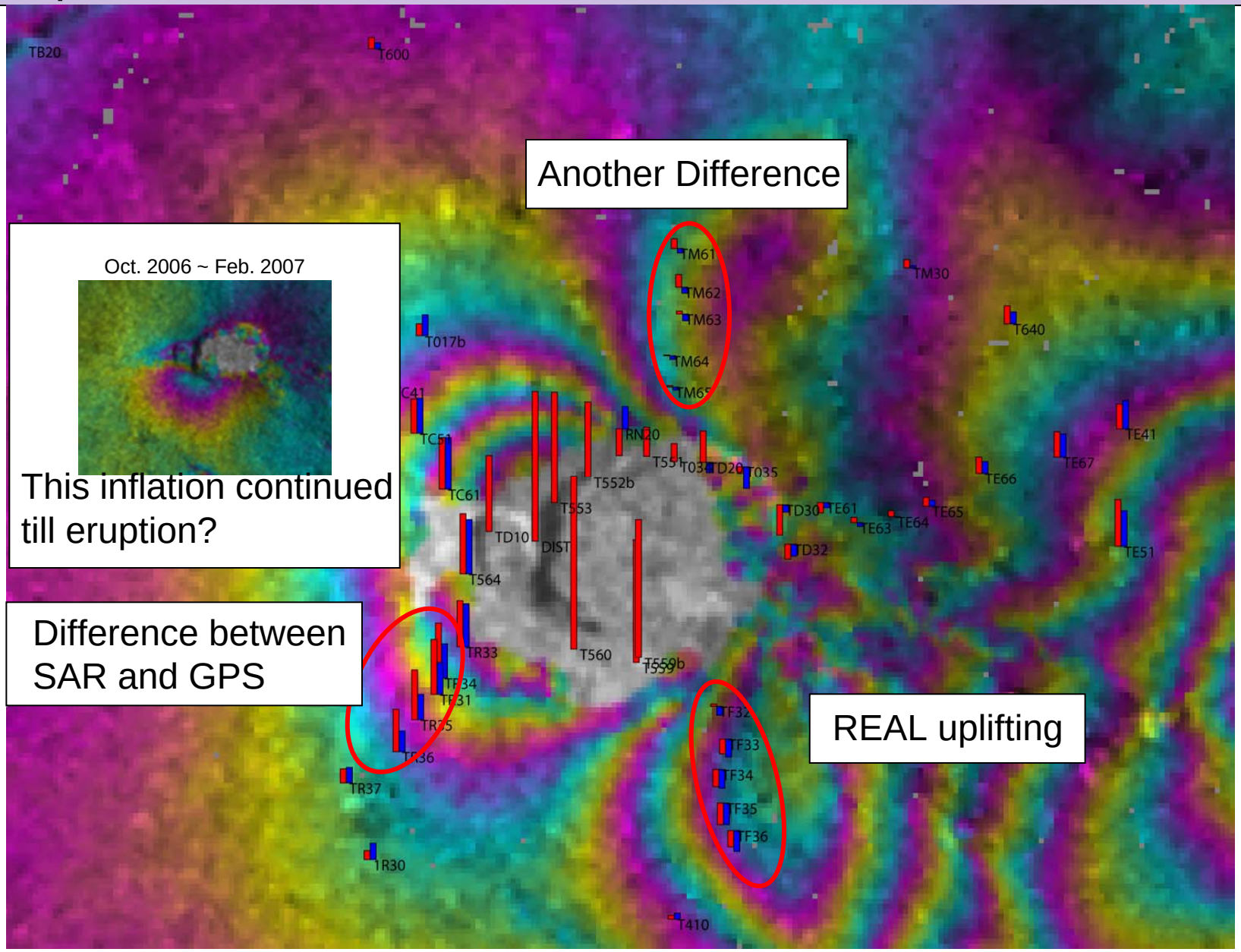
5km

Mar. ~ May, Projected to EW Vertical Plane

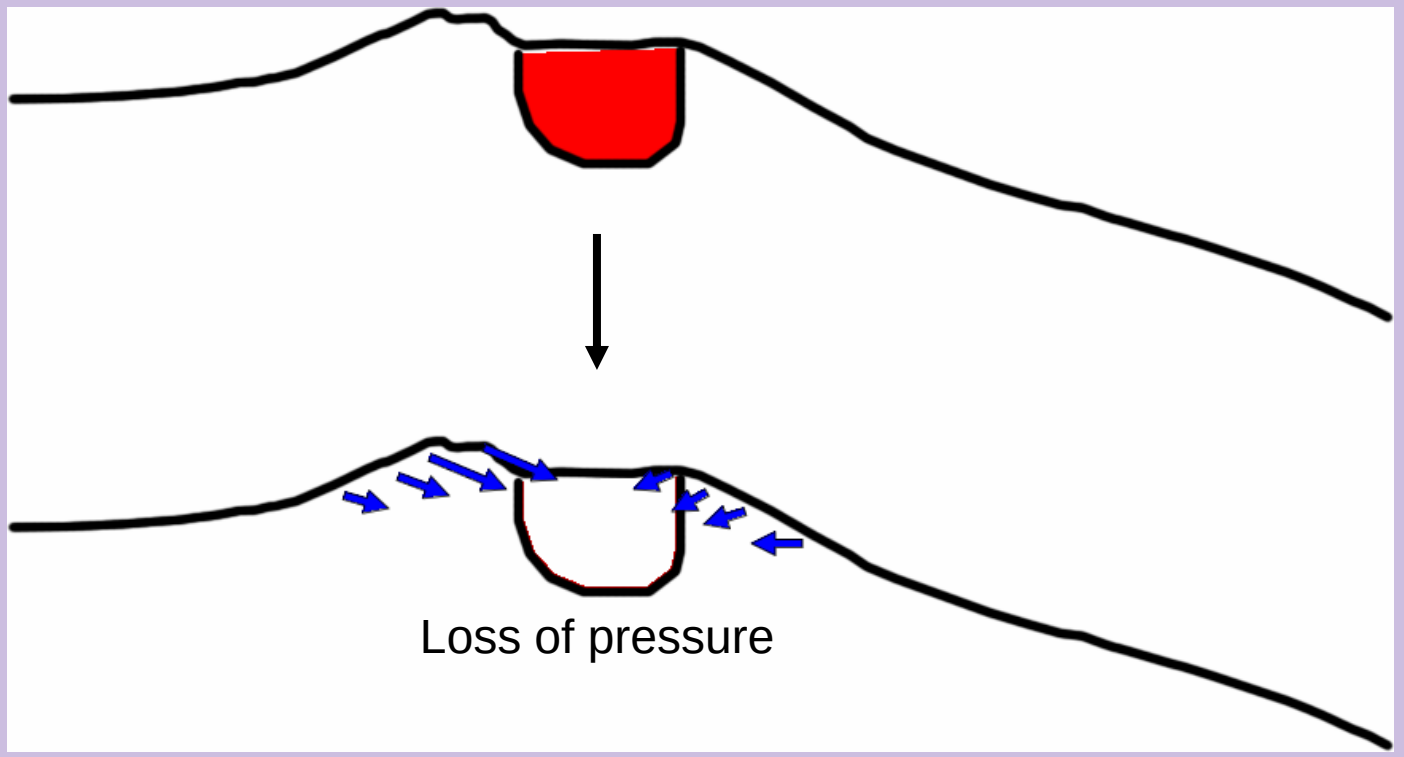


GPS data offered by T. Staudacher

Comparison between GPS and InSAR

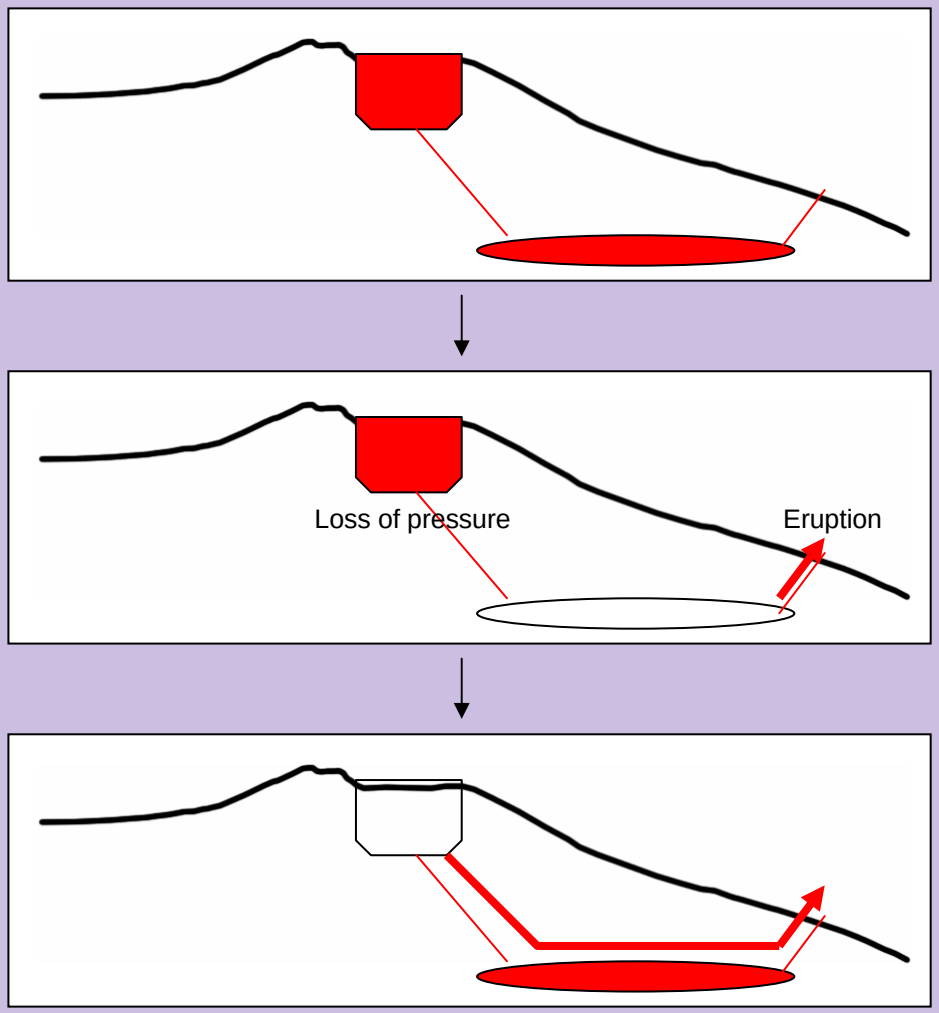


Mechanism of Deformation around the Summit



Problem: This model will not produce any uplifting

Possible mechanism of this Eruption



Stage 1:
Magma is stored in both reservoir and summit crater

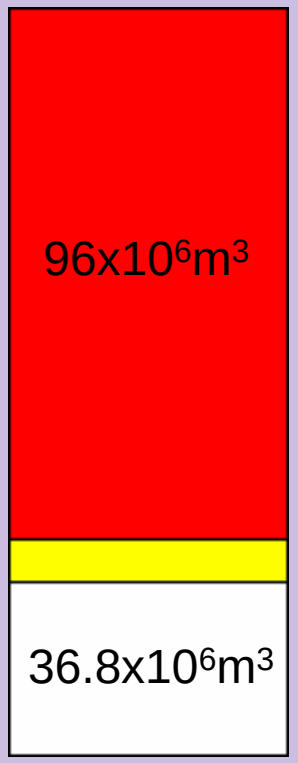
Stage 2:
Eruption causes pressure loss at the bottom of the summit crater

Stage 3:
As a result, summit crater collapses and the magma contained in the crater comes out, passing through the reservoir

Location of the Magma/Lava

Erupted Lava
Magma in crater
Magma in chamber
WHERE?

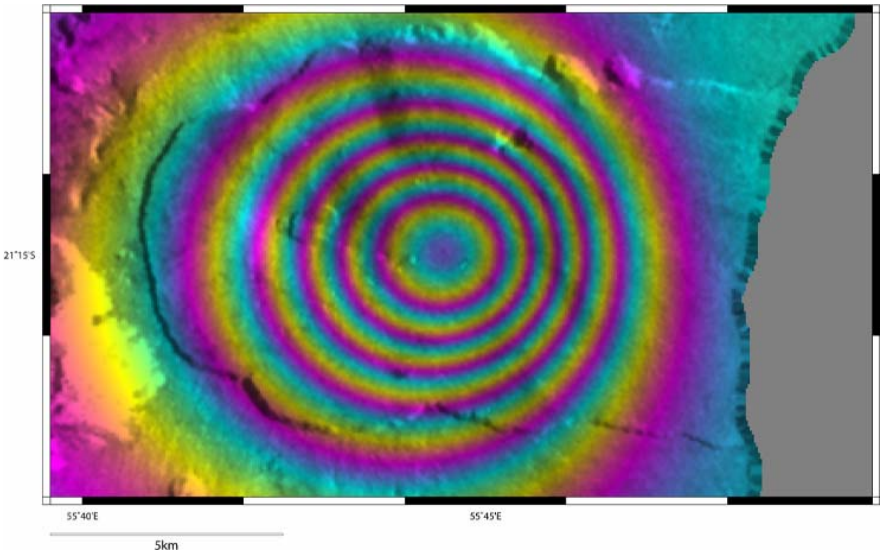
Befor



After

$2x10^3 \times 3x10^3 \times 1.2 = 7.2x10^6m^3$

If the depth estimate was terribly wrong and missing $36.8x10^6m^3$ was in the chamber…



Sill Size: 2km x 3km
Closing: 6.1m
Depth: 4200m

Summary

- The magma reservoir, which the erupted lava came from, was located at east flank, at the depth of 500 ~ 1000m
- The volume change of the reservoir due to the eruption is about $7 \times 10^6 m^3$
- Most part of the erupted lava was stored in the summit crater before the eruption

- The dyke which connects the reservoir and the vents was already filled by magma at 5 months before the eruption?
- The collapse of the summit crater is caused by the pressure loss, due to the movement of the magma from reservoir to the vent?

Questions:

- Where was the missing $36.8 \times 10^6 m^3$ of magma hiding before the eruption?
- How did SE (and NE?) of the summit crater uplift?