JERS-1 D-InSARによる九重山の時系列的な地殻変動解析

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Time Series Analysis of Crustal Movements observed by JERS-1 D-InSAR

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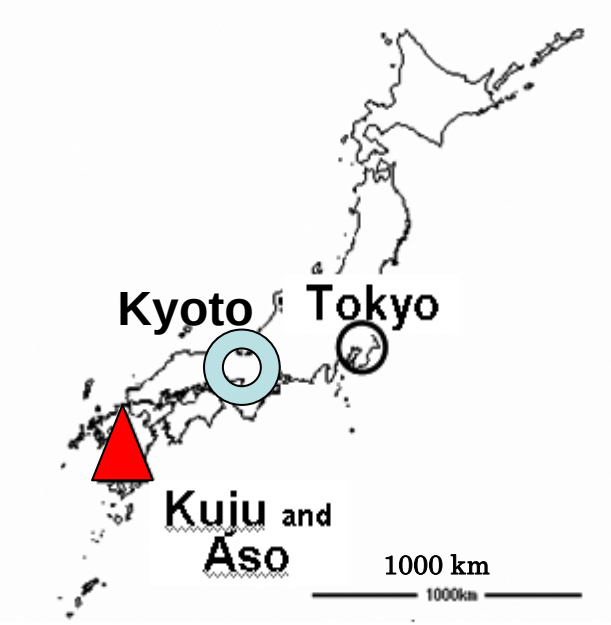
D-InSAR Observation of Kuju Volcano in the middle Kyushu, Japan

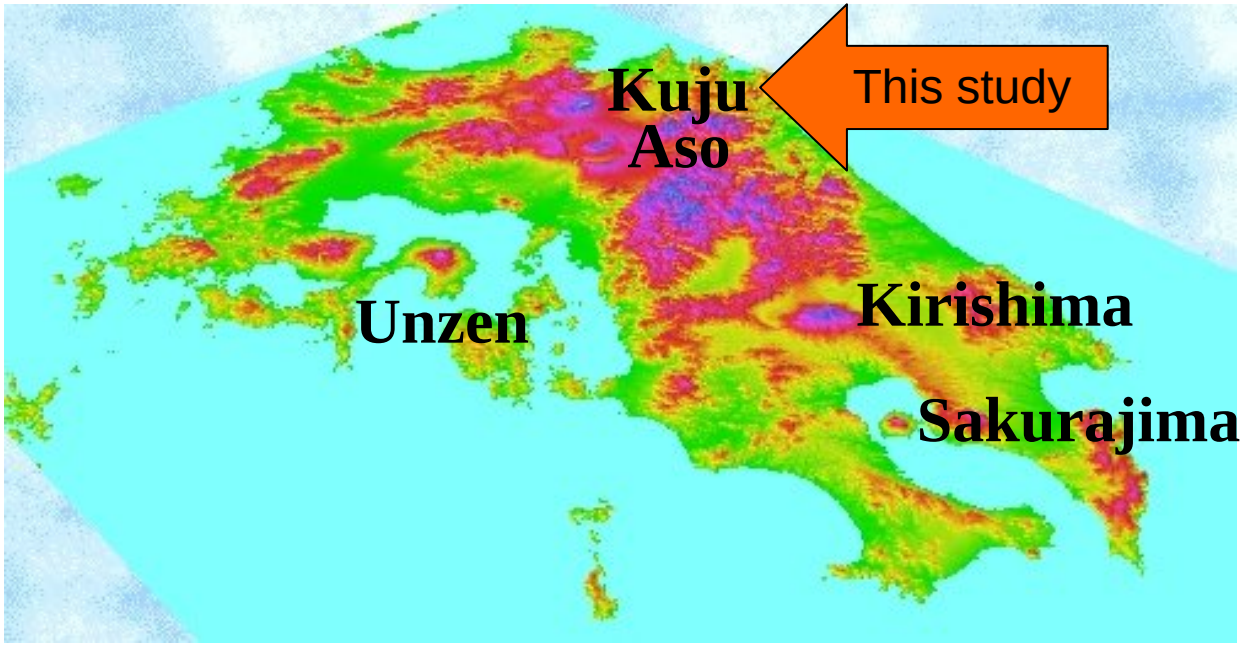


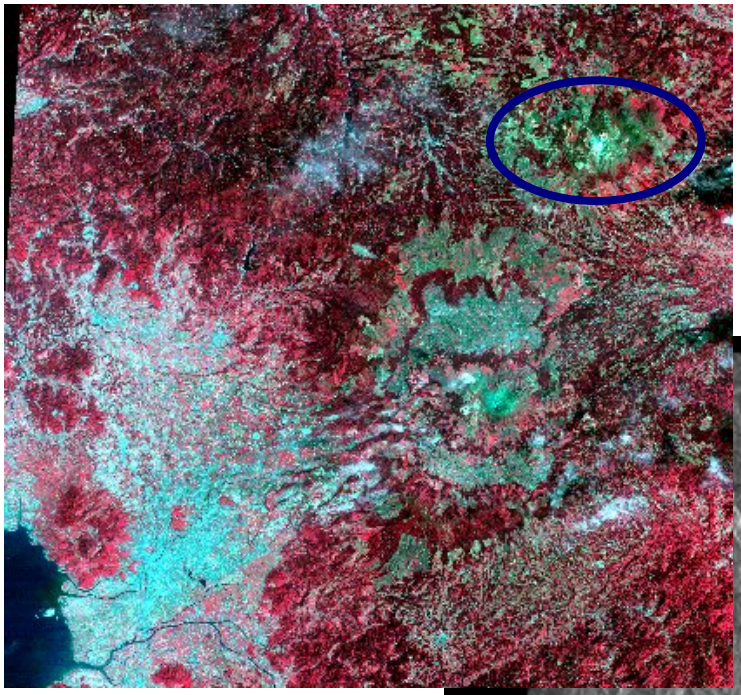
1. Introduction
2. Data and Software
3. Preliminary D-InSAR analyses for the Kuju volcanic area
4. Discussion
5. Concluding remarks

1. Introduction

There are some active volcanoes and geothermal fields in Kyushu, Japan .

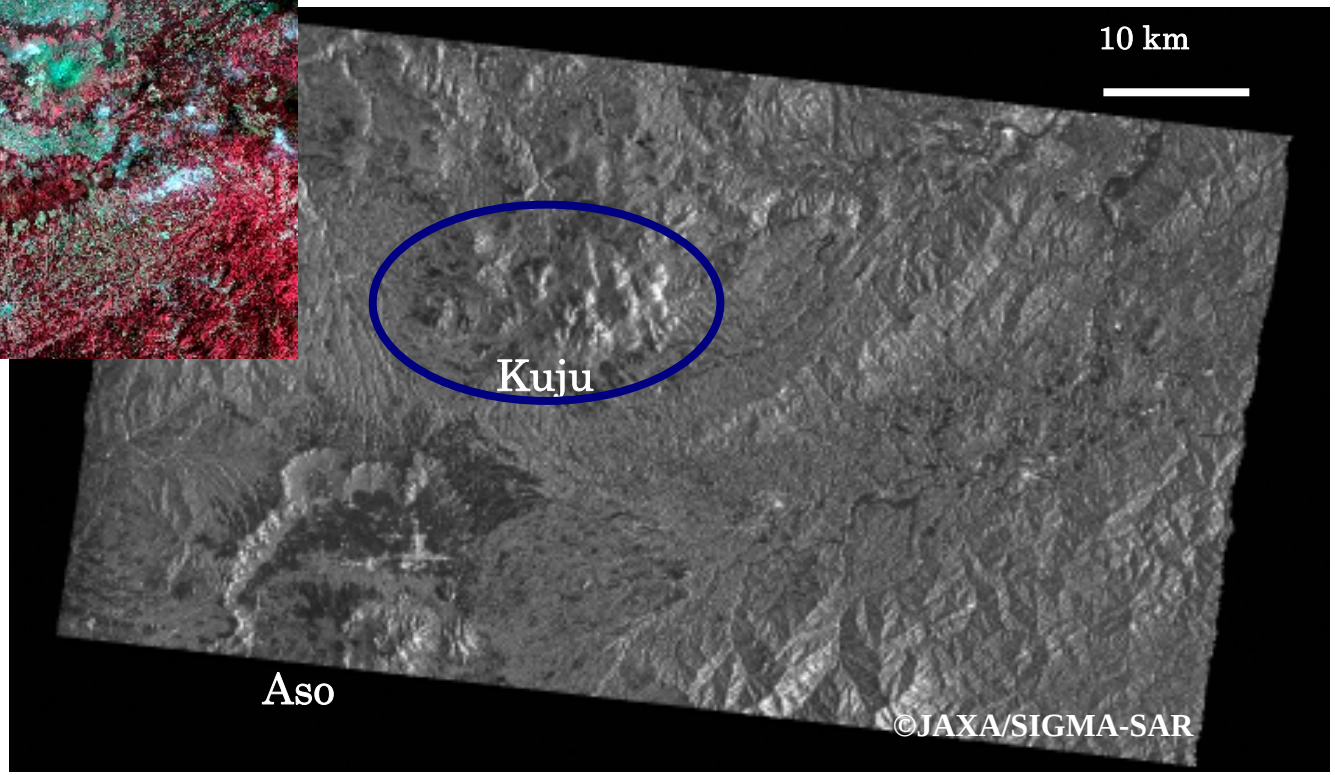
This study concerns on **Kuju** volcanic area.





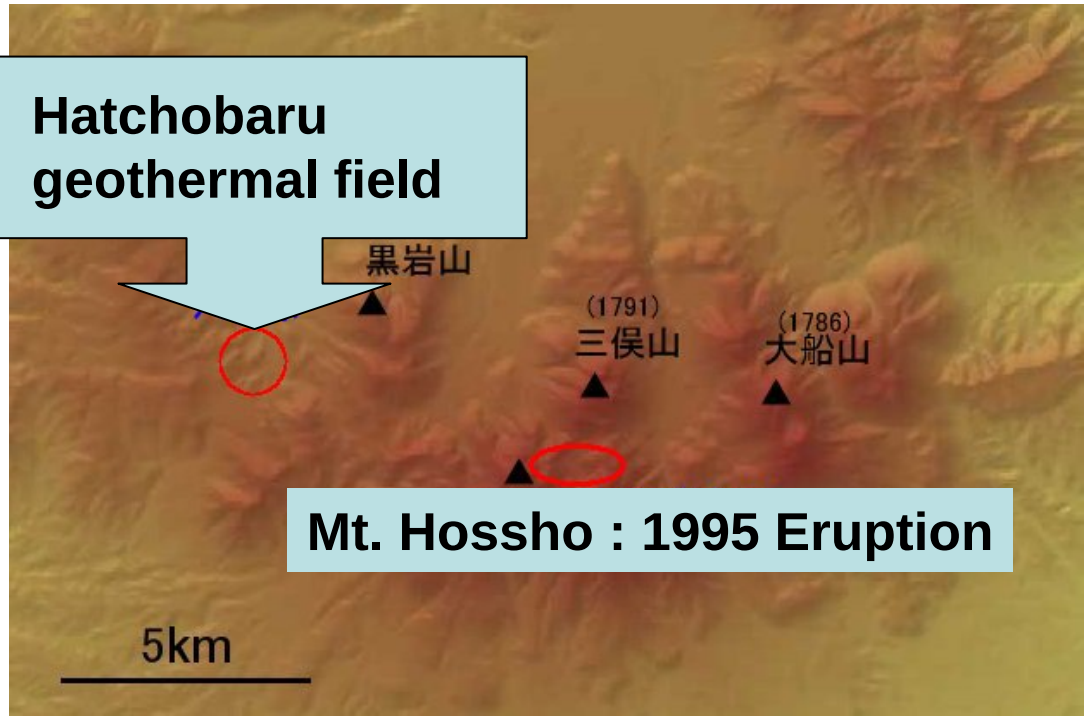
LANDSAT TM
(RGB=432)
25 Apr. 1998

Kuju volcanic area is located to NE of Aso volcano.



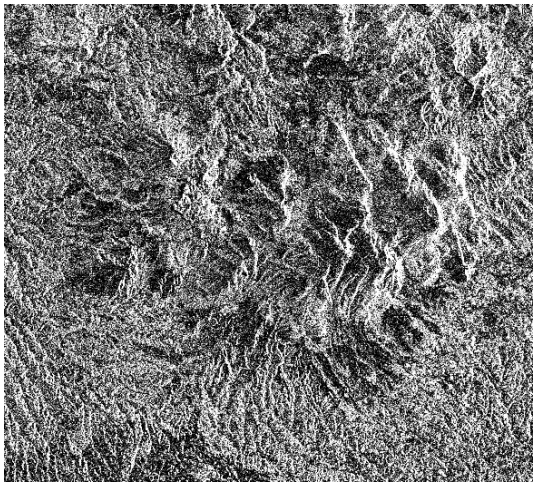
JERS-1 SAR: 14 March 1996

On 11 October 1995, Mt. Hossho erupted.
We carried out JERS-1 D-InSAR monitoring of ground deformations associated with the volcanic activity.
Ground deformations in the Hatchobaru geothermal field were also detected. There is the largest geothermal power plant (110MW) in Japan.

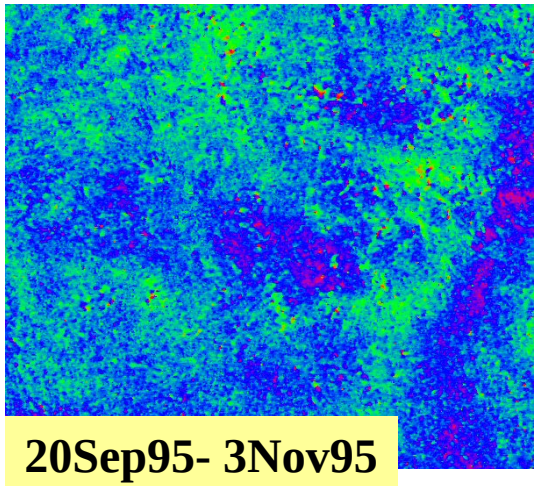


Fumarolic activity at Kuju Volcano
(Photo by Makoto Nakaboh)

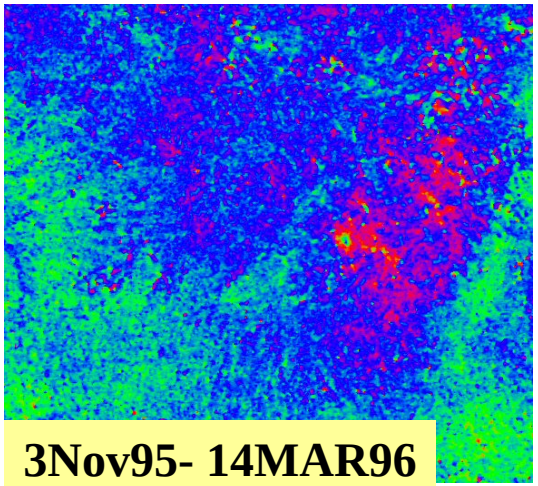
JERS-1 D-InSAR



Power image

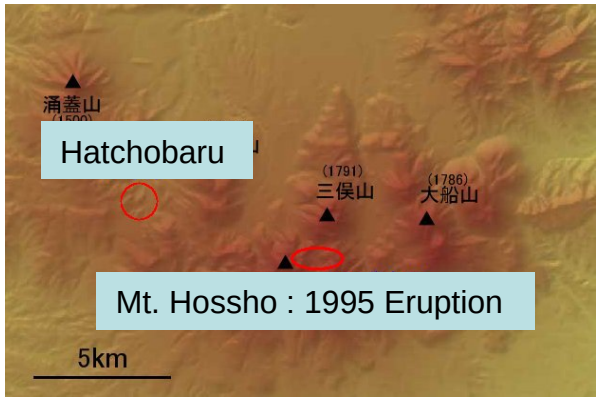


20Sep95- 3Nov95

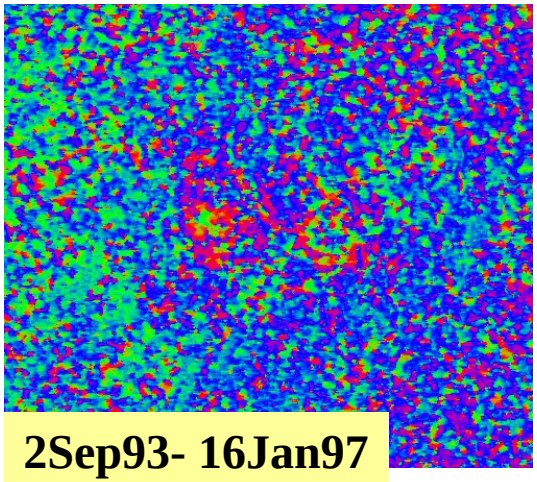


3Nov95- 14MAR96

(+10cm / 4months)

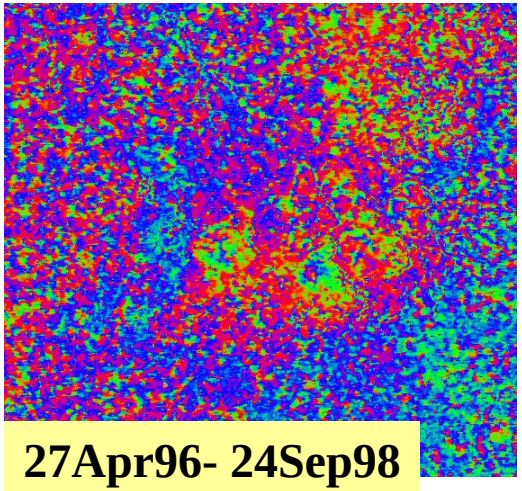


-5.8cm　　+5.8cm



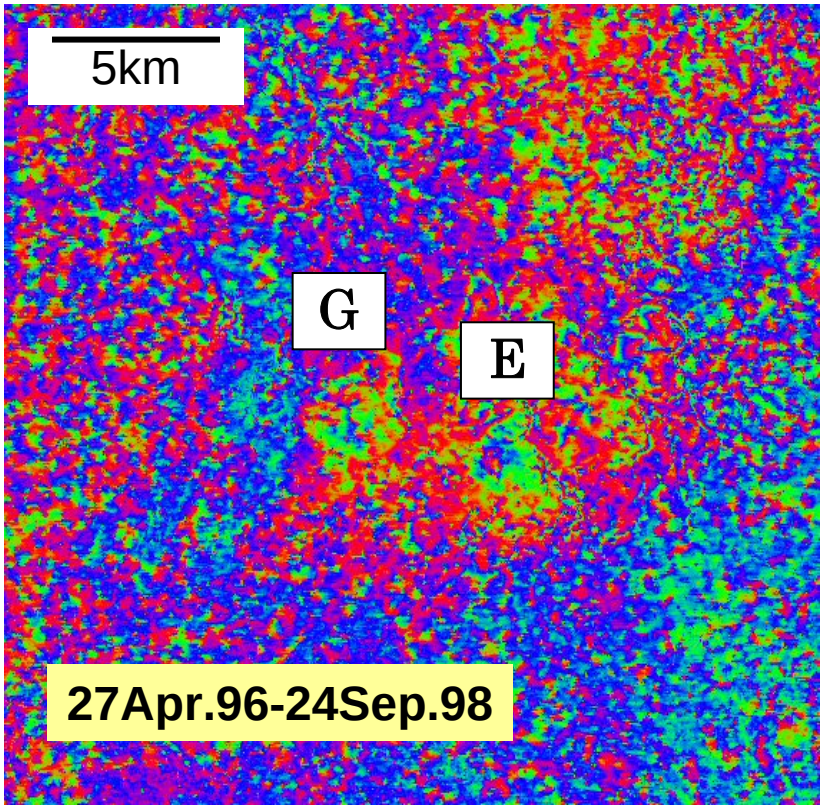
2Sep93- 16Jan97

（＋7,＋15cm / 15months）



27Apr96- 24Sep98

(+8, +18cm / 29months)



The figure shows a typical case of subsidence in the Kuju volcanic area.

27Apr.96-24Sep.98 :　2years 5 months

G: Geothermal area　　+8cm in LOS

E: Eruption of Mt. Hossho　+18cm in LOS

2. Data and Software

We analysed 28 scenes JERS-1 L-band SAR data for the period between 1992 and 1998.

Year	Number of scenes
1992	1
1993	6
1994	2
1995	2
1996	7
1997	4
1998	6

78-245(+4)

About 50 pairs were tried so far.

(ownership of the JERS-1 SAR data: METI/JAXA)

We applied the SIGMA-SAR software of Linux version under the corroborative study with ERI and JAXA.

SIGMA-SAR software (Shimada,1999)

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

GSI 50m mesh DEMs were applied for D-InSAR processing.

3. Preliminary D-InSAR analyses for the Kuju volcanic area

We carried out preliminary D-InSAR analyses for about 50 pars of JERS-1 SAR archived data for the region .

All the pairs formed by the successive observed scenes and some pairs for the longer time intervals were processed.

Detailed analyses will be continued.

Time interval: 44 days (1 cycle) - 1584 days (36 cycles)

Perpendicular Baseline: 82 m - 3000 m (or more)

The pairs formed by the successive observed scenes

Coherence: good ○, rather good △, poor ×

No.	1	2	3	4	5	6	7
	92/09/15	93/01/25	93/03/10	93/04/23	93/09/02	93/10/16	93/11/29
	93/01/25	93/03/10	93/04/23	93/09/02	93/10/16	93/11/29	94/01/12
Bprep(m)	6684	1202	222		2087	2994	2147
	×	○	○	Error	○	×	○

No.	8	9	10	11	12	13	14
	94/01/12	94/05/24	95/09/20	95/11/03	96/01/30	96/03/14	96/04/27
	94/05/24	95/09/20	95/11/03	96/01/30	96/03/14	96/04/27	96/06/10
Bprep(m)	1160		538		3554	466	912
	○	Error	○	Error	△	○	○

No.	15	16	17	18	19	20	21
	96/06/10	96/07/24	96/10/20	96/12/03	97/01/16	97/07/11	97/08/24
	96/07/24	96/10/20	96/12/03	97/01/16	97/07/11	97/08/24	97/11/20
Bprep(m)	905	82	1086	932		116	1819
	○	○	○	○	Error	○	○

No.	22	23	24	25	26	27
	97/11/20	98/01/03	98/02/16	98/05/15	98/06/28	98/08/11
	98/01/03	98/02/16	98/05/15	98/06/28	98/08/11	98/09/24
Bprep(m)	1649	861	1049	780		209
	○	○	○	○	Error	○

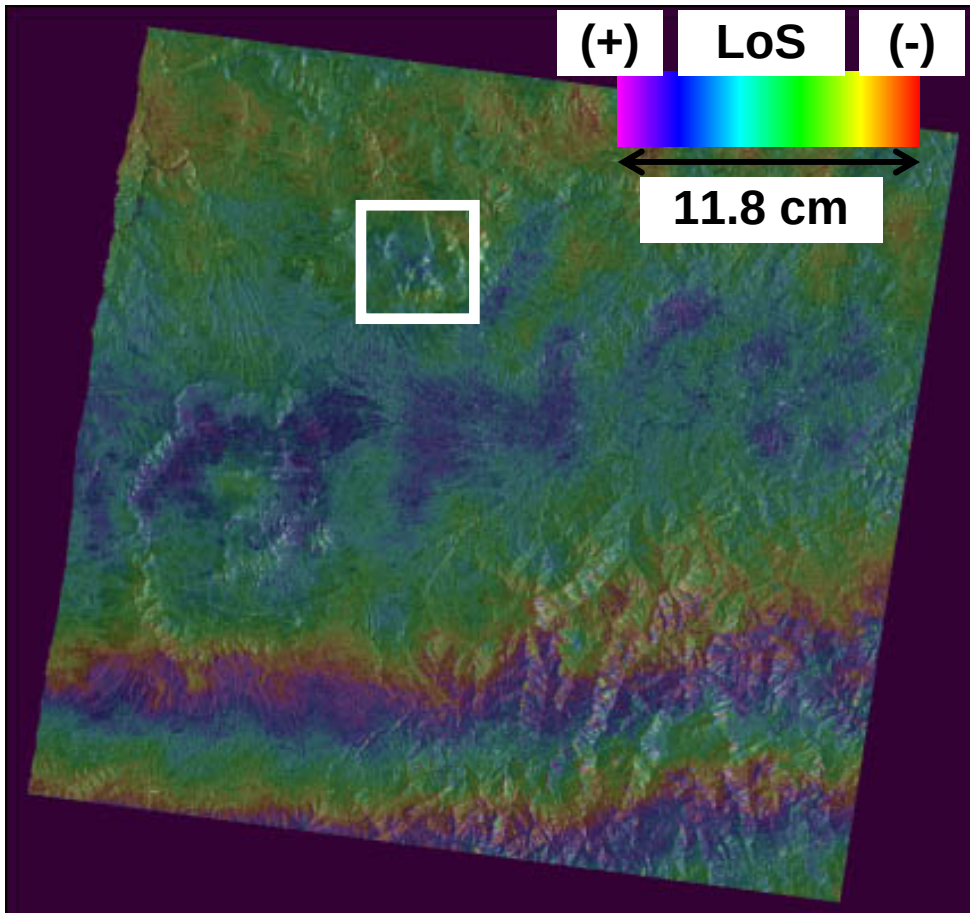
Eruption
95/10/11

Crustal movements detected for the pairs based on scene of 20 Sept. 1995 (just before the eruption on 11 Oct. 1995).

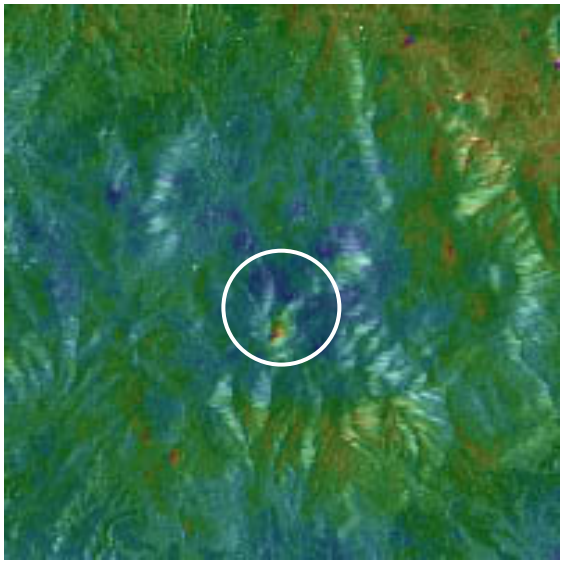
No.	10	35	36	51	47	48	50	49
	95/09/20	95/09/20	95/09/20	95/09/20	95/09/20	95/09/20	95/09/20	95/09/20
	95/11/03	96/01/30	96/03/14	96/04/27	98/01/03	98/02/16	98/05/15	98/06/28
Bprep(m)	538	3528	322	788	1187	335	1389	2155
	○	×	○	○	○	○	○	×

Sorry, other pairs for those acquired in 1996-98 will be processed in the near future.

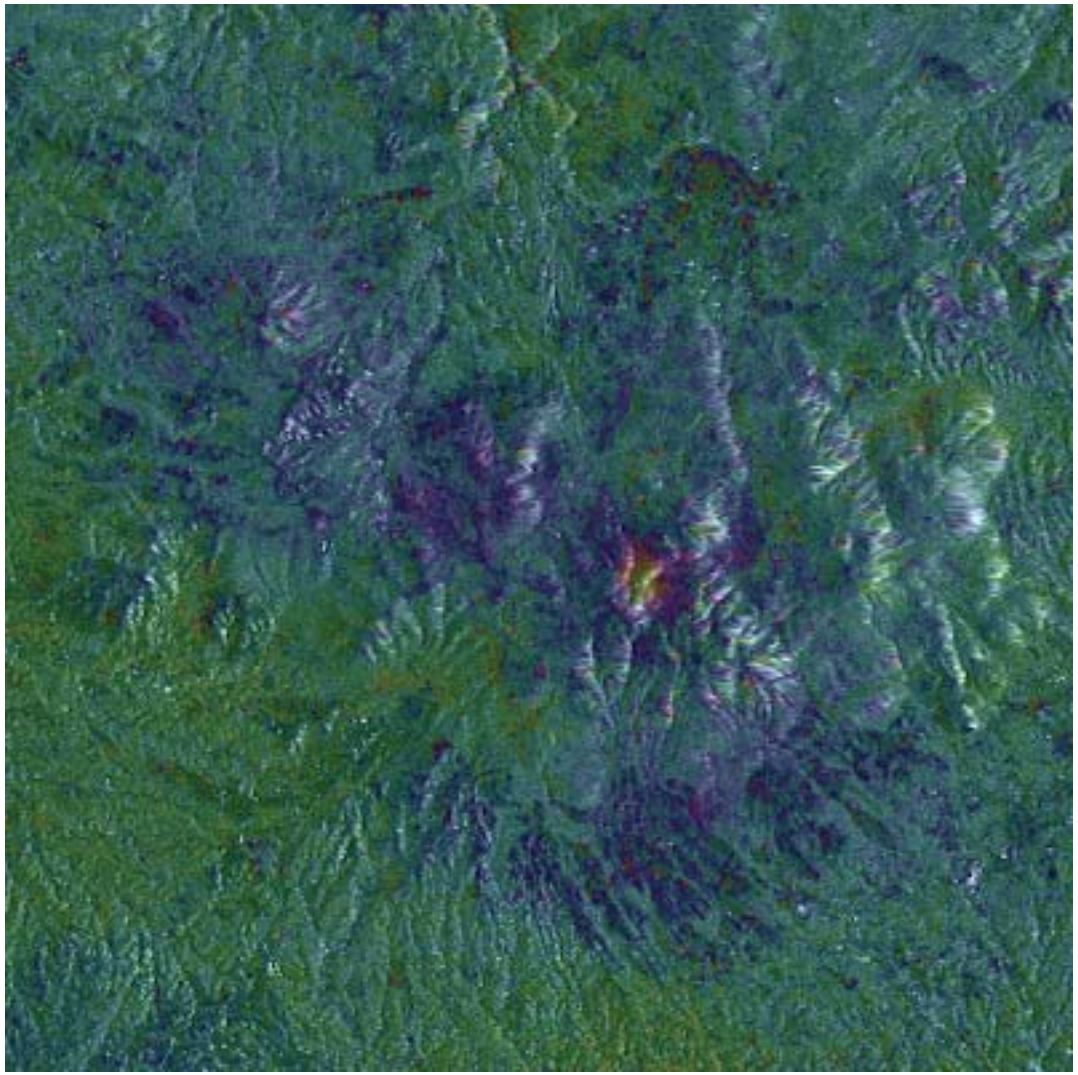
Time Series Analysis of Crustal Movements based on scene of 20 Sept. 1995



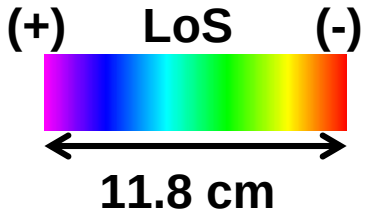
20 Sept. 1995
3 Nov. 1995



Eruption
11 Oct. 1995

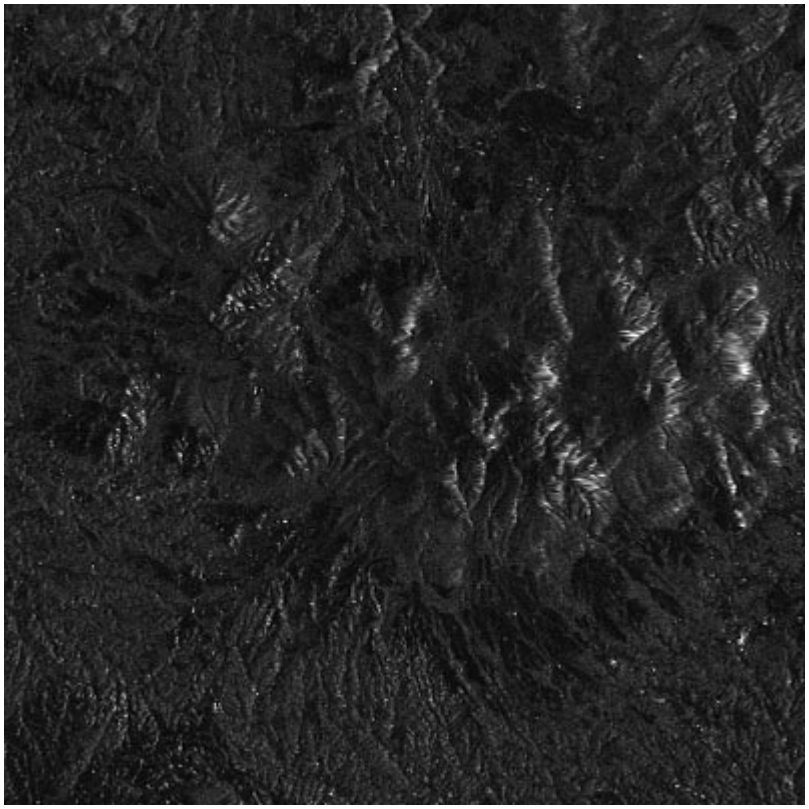


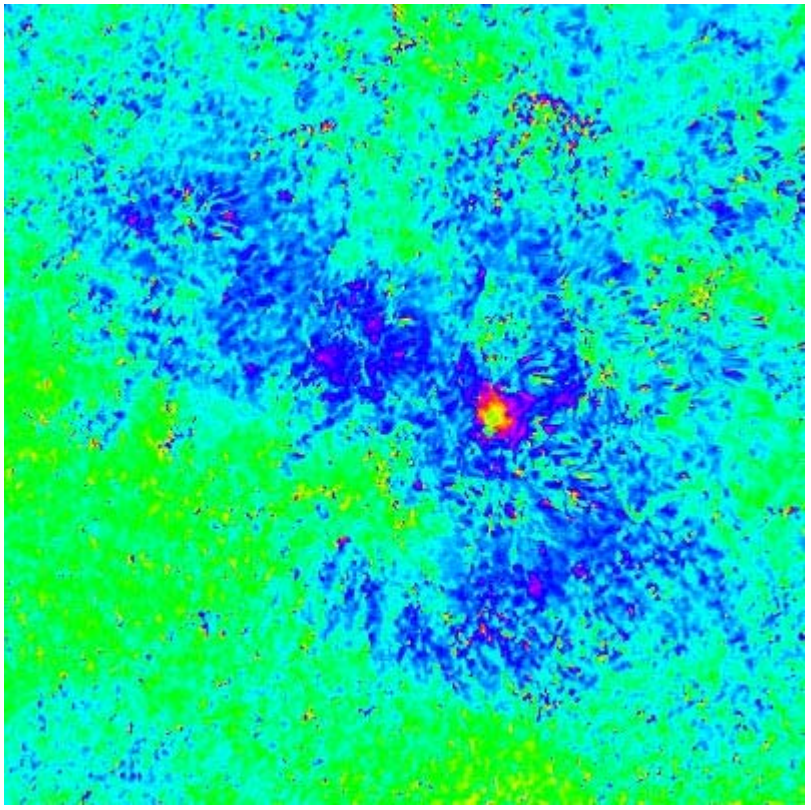
Remarkable subsidence is detected at the eruption site for the 176 days.



20km X 20km

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

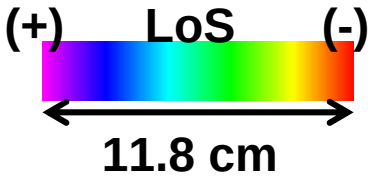




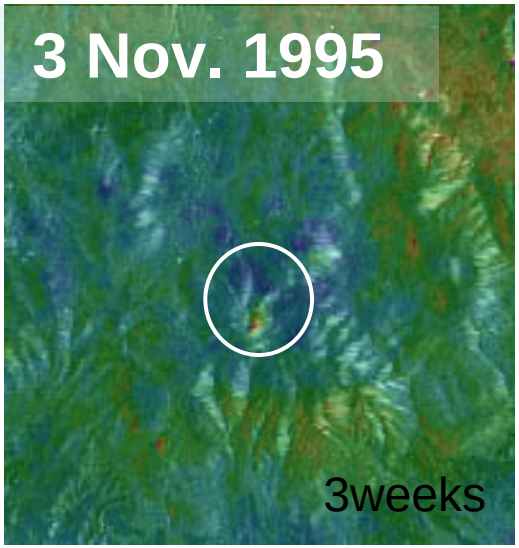
20km X 20km

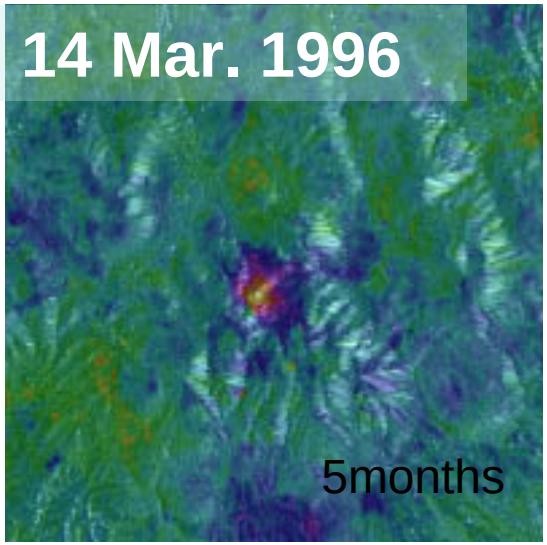
Power and D-InSAR phase image
(JERS-1 SAR: **20 September 1995 - 14 March 1996**)

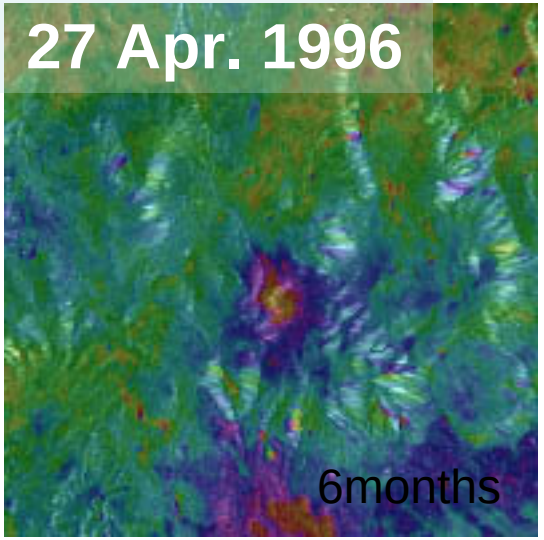
based on 20 Sept. 1995

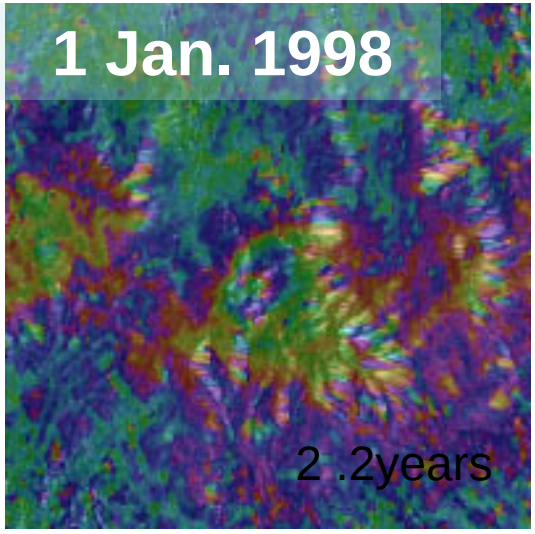


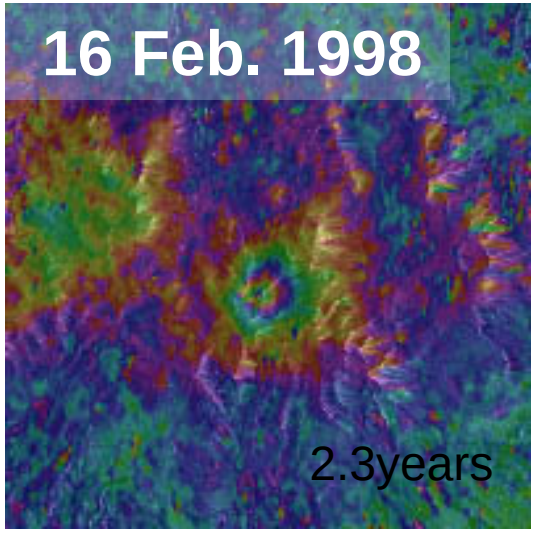
Eruption

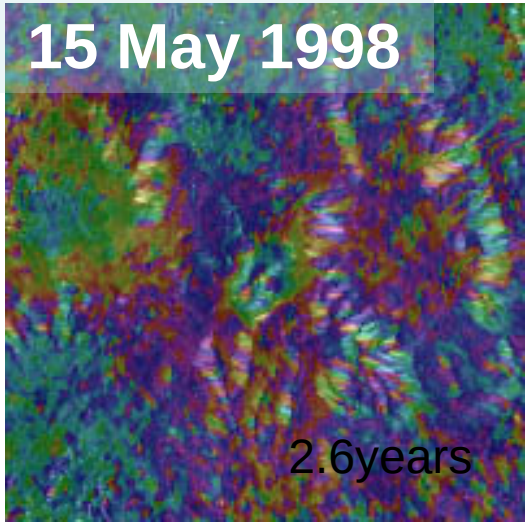






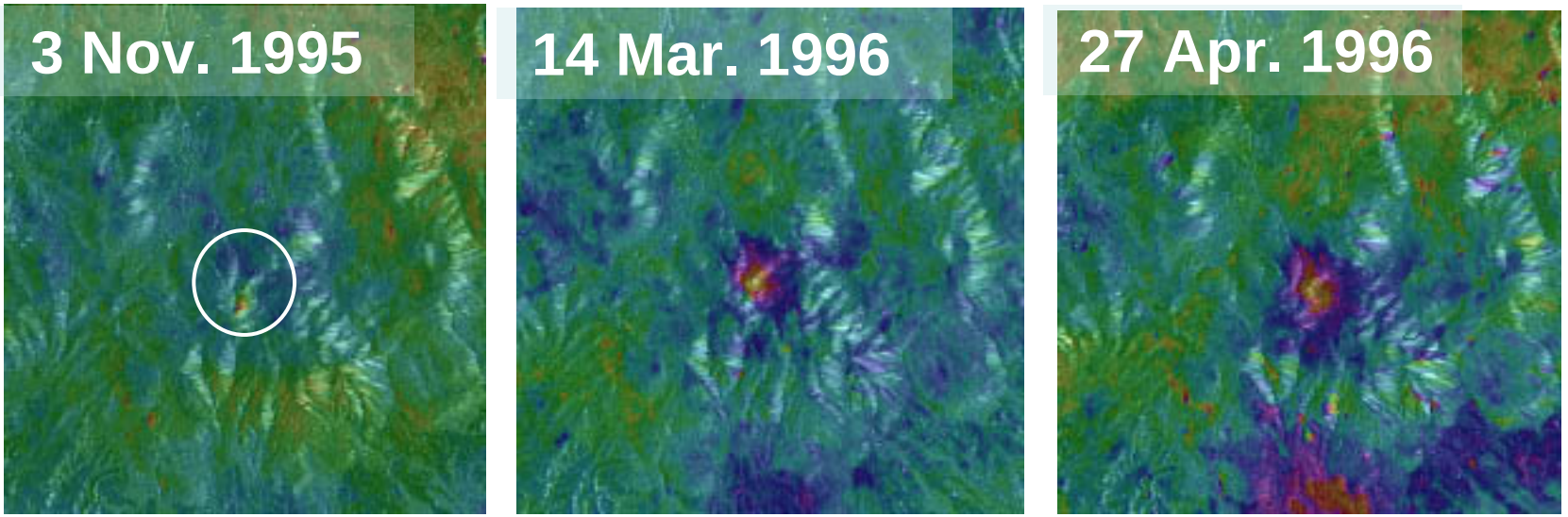






4. Discussion

(1)Crustal movements



Remarkable deformation was shown after some months of the eruption.

deflation source :3×10**5 m**3 / month , depth = 500~600m

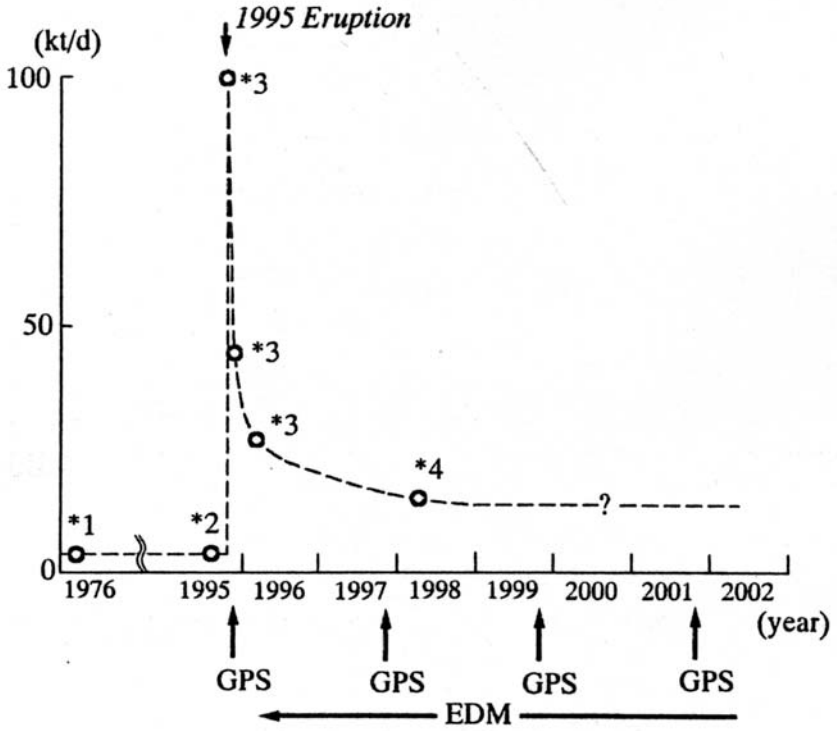
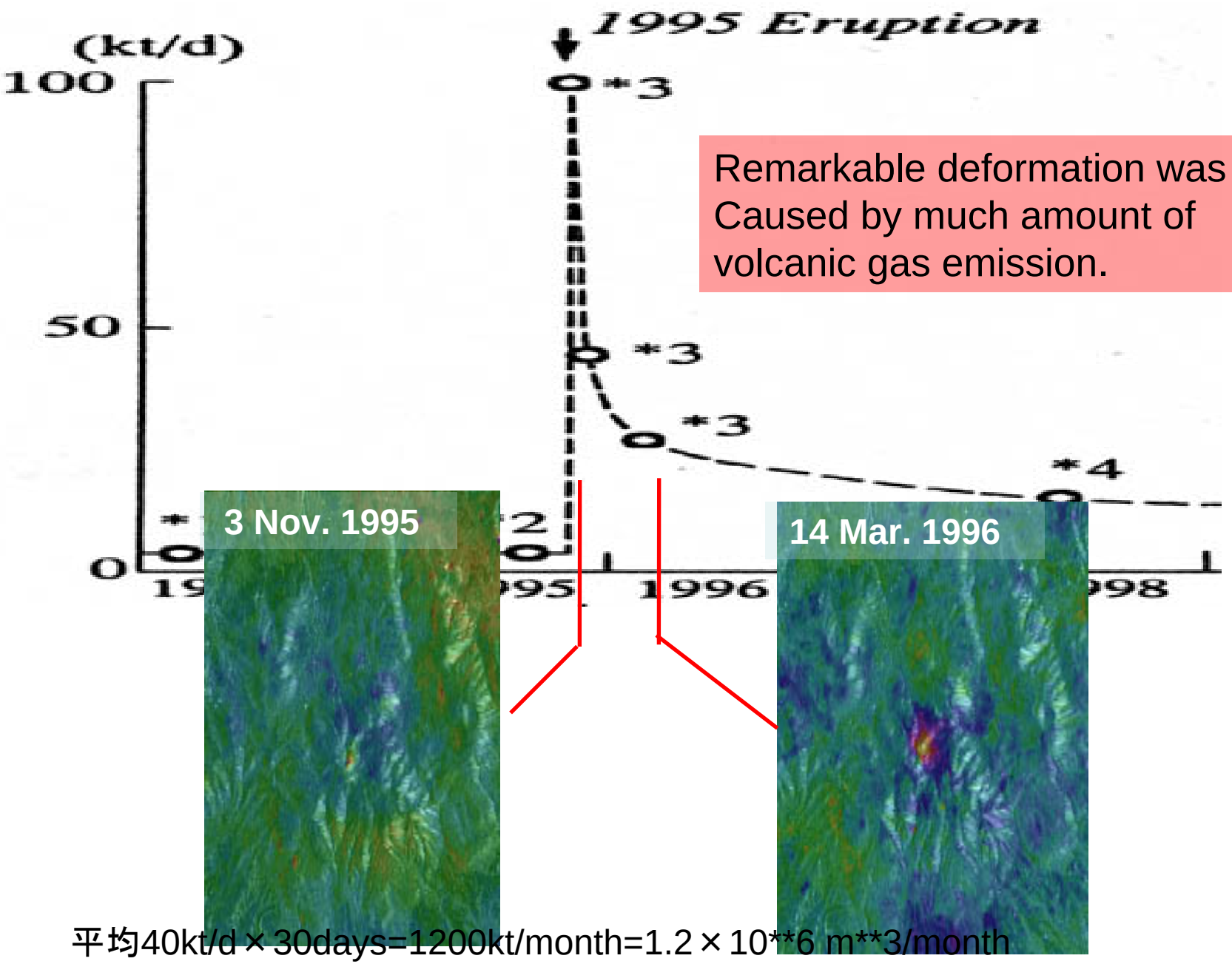


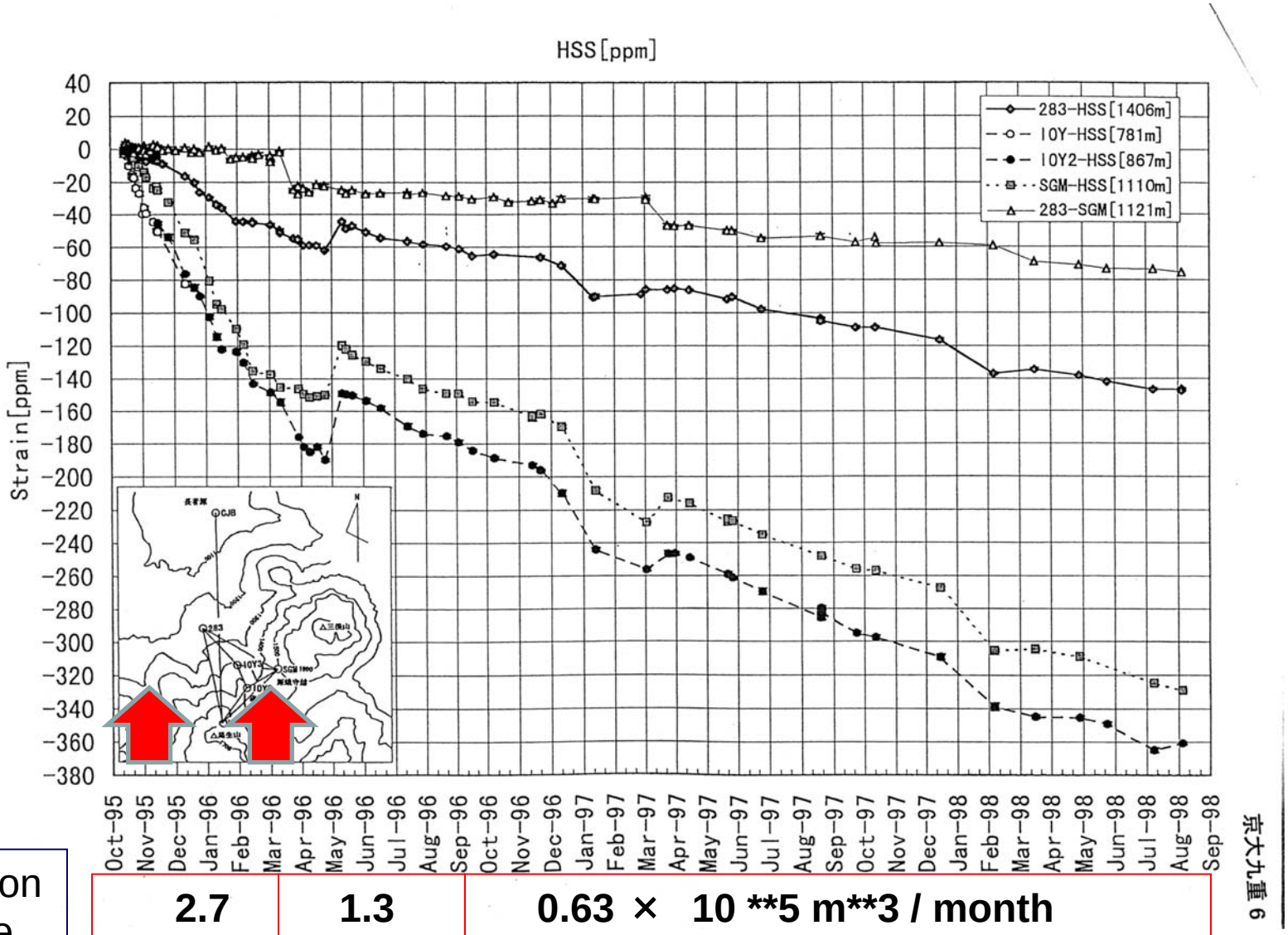
Fig. 7. Time series of the estimated volume of gas emitted from newly opened craters and Iwo-yama fumarolic zone. *1: Ehara *et al.* (1981), *2: Jinguji and Ehara (1996), *3: Hirabayashi *et al.* (1996), *4: Saito *et al.* (1999). Periods of the repeated GPS measurements and period of continuous EDM observations are also shown.

Volume of the gas emitted from the eruption site (Saito *et. al*, 2003).



Remarkable deformation was Caused by much amount of volcanic gas emission.

平均40kt/d×30days=1200kt/month=1.2×10**6 m**3/month



Deflation volume

2.7	**1.3**	**0.63 × 10 **5 m**3 / month**

（京都大学大学院理学研究科地球熱学研究施設　火山研究センター,1998）

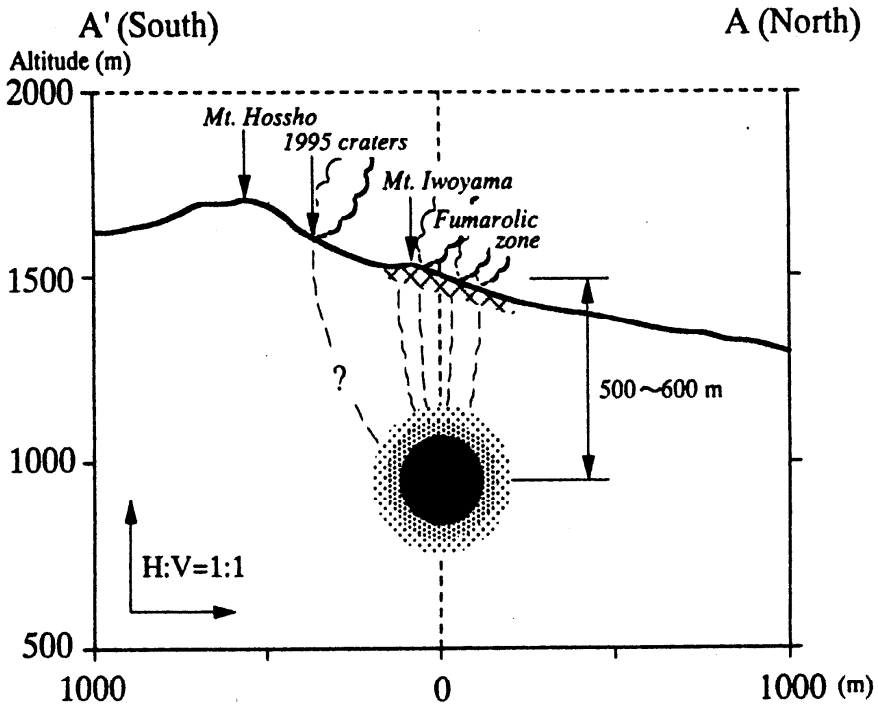


Fig. 6. Schematic diagram showing the relation between the fumarolic zone, newly opened craters and deflation center on a north south section. Location of section A–A′ is shown in Fig. 1.

(Saito *et. al*, 2003)

5. Concluding remarks

Preliminary D-InSAR time series analyses for Kuju volcanic area, Kyushu, Japan, were carried out for 28 JERS-1 SAR data by the Sigma-SAR (Shimada, 1999).

Remarkable deformation was shown after some months of the eruption. These D-InSAR results are consistent with the estimation of cumulated volume of the gas emitted from the eruption site (Saito et. al, 2003).

More detailed research for the crustal deformation and corrections for atmospheric disturbance are required.