Applications of InSAR analysis to volcanoes: Examples from Italy and Kamchatka, Russia

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Overview

Summary of ERS-1/2, ENVISAT observations for Mt. Etna, Italy, and RADARSAT-1 observations for Kamchatkan volcanoes

Etna: 10+ years ERS, 2 years ENVISAT data
- Complex deformation/active structures
- Constraints on InSAR needs: asc/desc, time series, frequent measurements
- Baselines continue to be an issue.

Kamchatka: 5+ years RADARSAT, 2 years ENVISAT data
- Little deformation, only descending tracks, 3 months max. in late June to late Sept.
- Correlation with other strato-volcanoes?
- Uzon caldera actively deformed between 2000 and 2003, with no measurable deformation since.
Mt. Etna rift and fault systems

Mt. Etna 6 year (1993-1999) ascending ERS SAR interferogram
Mt. Etna
Same deformation seen from ascending and descending look directions
1996-2000 west-flank motion

Interferograms from the post-inflation time period show evidence of west-flank motion either as:

Subtraction from a volcano-wide positive LOS displacement (inflation or atmosphere), *top* image.

Or

As an isolated small signal, *bottom* image.

In each case, the **SW trending fault** bounds the south side of this flank motion.
Mt. Etna 2003-2005: A suggestion of deflation and flank motion

Envisat track 129 swath 2

2003-06-11 - 2005-07-20

2004-05-26 - 2005-07-20

2004-08-04 - 2005-06-15
Kamchatka: March 2005 MER image

Sheveluch

Klyuchevskoy
Kamchatka InSAR
RADARSAT-1, ENVISAT

Uzon caldera
2004-2005 RADARSAT-1  Klyuchevskoy Group and Eastern Kamchatka volcanoes

Minor atmospheric effects

RADARSAT-1 45651-51139 
(2004/08/02 - 2005/08/21) 
|Bp| = 321m Beam 7, $\phi = 48^\circ$
Significant atmospheric effects

RADARSAT-1 46337-51482
(2004/09/19 - 2005/09/14)
IBpl = 49m Beam 7, $\phi = 48^\circ$
2004-2005 RADARSAT-1  Eastern and Southern Kamchatka volcanoes

Striking topo-correlated effects

RADARSAT-1 45794-51282
(2004/08/12 - 2005/08/31)
\[ \text{\( |Bp| = 57m \text{ Beam 6, } \phi = 42^\circ \)} \]
Uzon caldera
E. Kam. Volcanic group

Dates, beam, incidence angle, $B_{perp}$ (m)
(a) 2000/08/23-2003/08/08. Beam 7 ($48^\circ$), 54.
(c) 2000/09/19-2003/08/11. Beam 4 ($38^\circ$), 58.
(d) 2000/09/16-2004/08/02. Beam 7 ($48^\circ$), 176.
(e) 1999/09/08-2000/09/02. Beam 6 ($42^\circ$), 483.
(f) 2000/09/02-2003/08/18. Beam 6 ($42^\circ$), 218.
(g) 2003/09/04-2004/08/05. Beam 4 ($38^\circ$), 80.
Uzon caldera
Inverse modeling

Quadtree partitioned data, after Jonsson et al. [2002].

![Image](image_url)
Uzon caldera
Inverse modeling
Conclusions

- Smaller baselines
- Wide incidence angles
- Frequent data required => consistent data acquisition plan in place (more important than previous bullet)
- Background data acquired such that if target area changes, prior data exist
- And of course for Kamchatka - L-band preferred