The 1996 Onikobe Earthquake Swarm: *Revisited*

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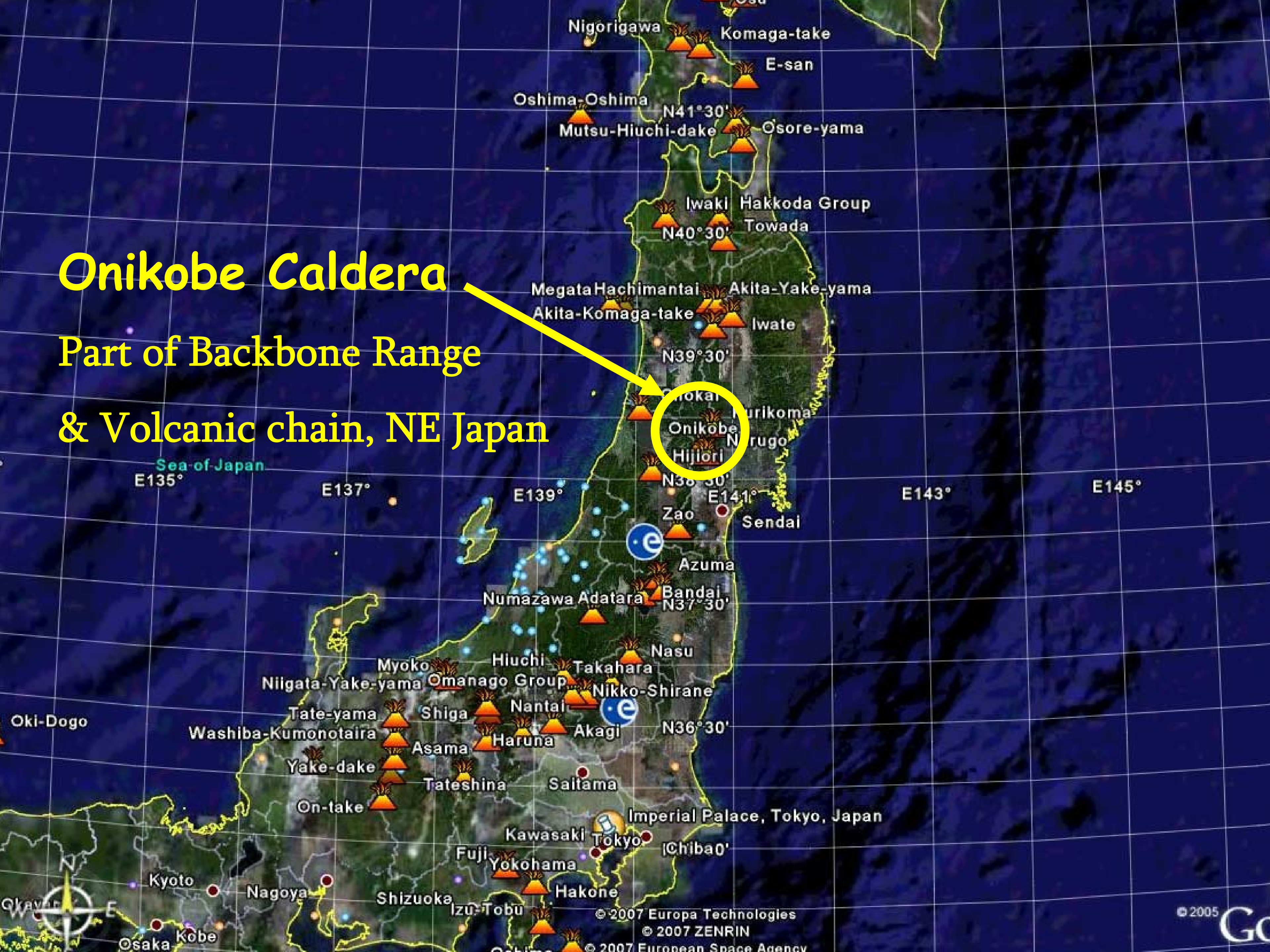
Onikobe Caldera
Part of Backbone Range
& Volcanic chain, NE Japan
Nigorigawa
Komaga-take
E-san
Oshima-Oshima
N41°30'
Mutsu-Hiuchi-dake
Osore-yama
Iwaki
Hakkoda Group
Towada
N40°30'
Megata
Hachimantai
Akita-Yake-yama
Akita-Komaga-take
Iwate
N39°30'
Onikobe
Hijiori
Sea of Japan
E135°
E137°
E139°
E141°
E143°
E145°
Zao
Sendai
Azuma
Bandai
Numazawa
Adatara
Nasu
Myoko
Hiuchi
Takahara
Niigata-Yake-yama
Omanago Group
Nikko-Shirane
Nantai
Oki-Dogo
Tate-yama
Shiga
N36°30'
Washiba-Kumonotaira
Akagi
Asama
Haruna
Yake-dake
Tateshina
Saitama
On-take
Imperial Palace, Tokyo, Japan
Kawasaki
Tokyo
Chiba
Fuji
Yokohama
Kyoto
Nagoya
Hakone
Shizuoka
Izu-Tobu
Osaka
Kobe
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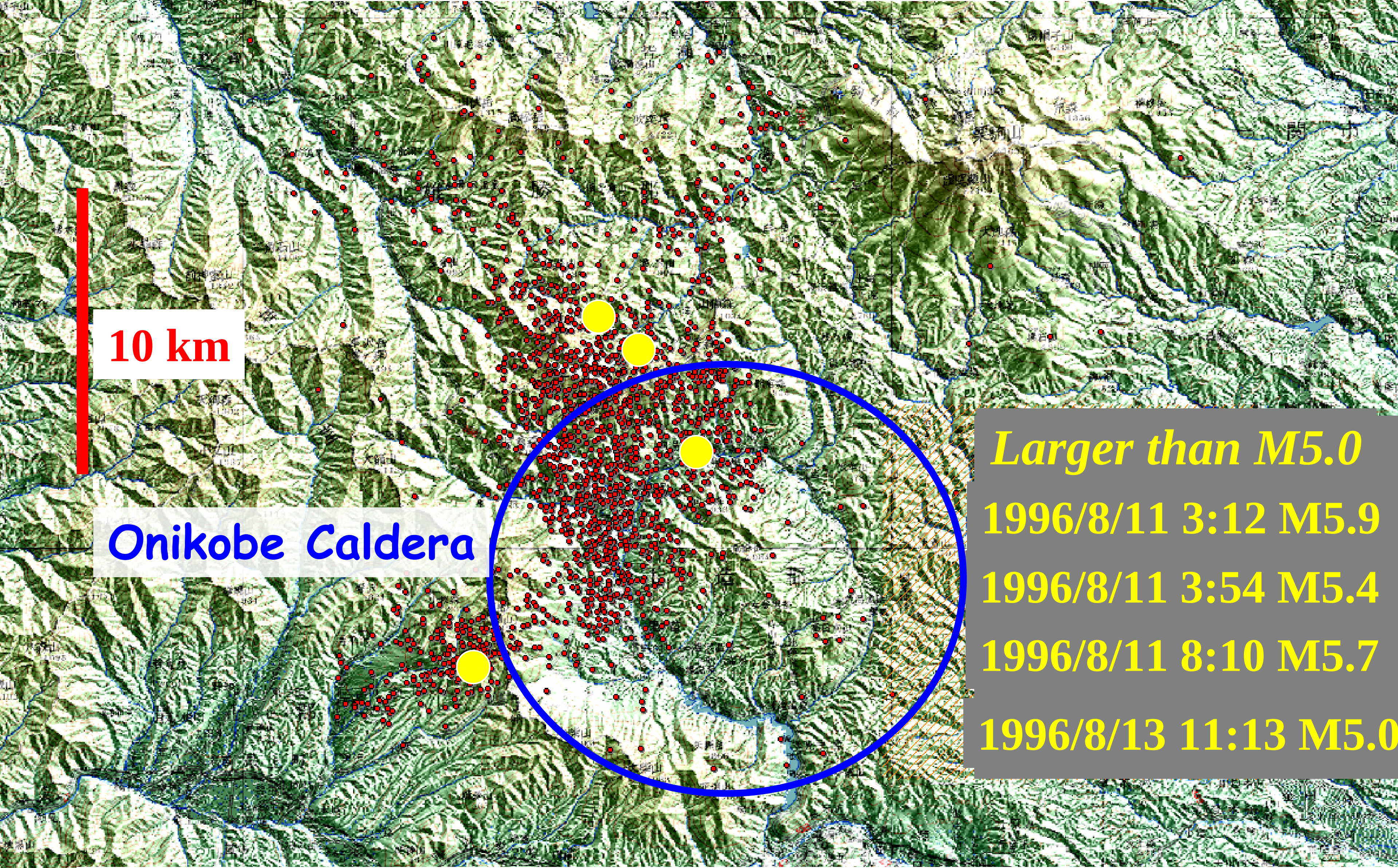
Onikobe Earthquake swarm (1)



Hypocenters provided by JMA (1996/8/11~1996/9/30)

Onikobe earthquake swarm (2)

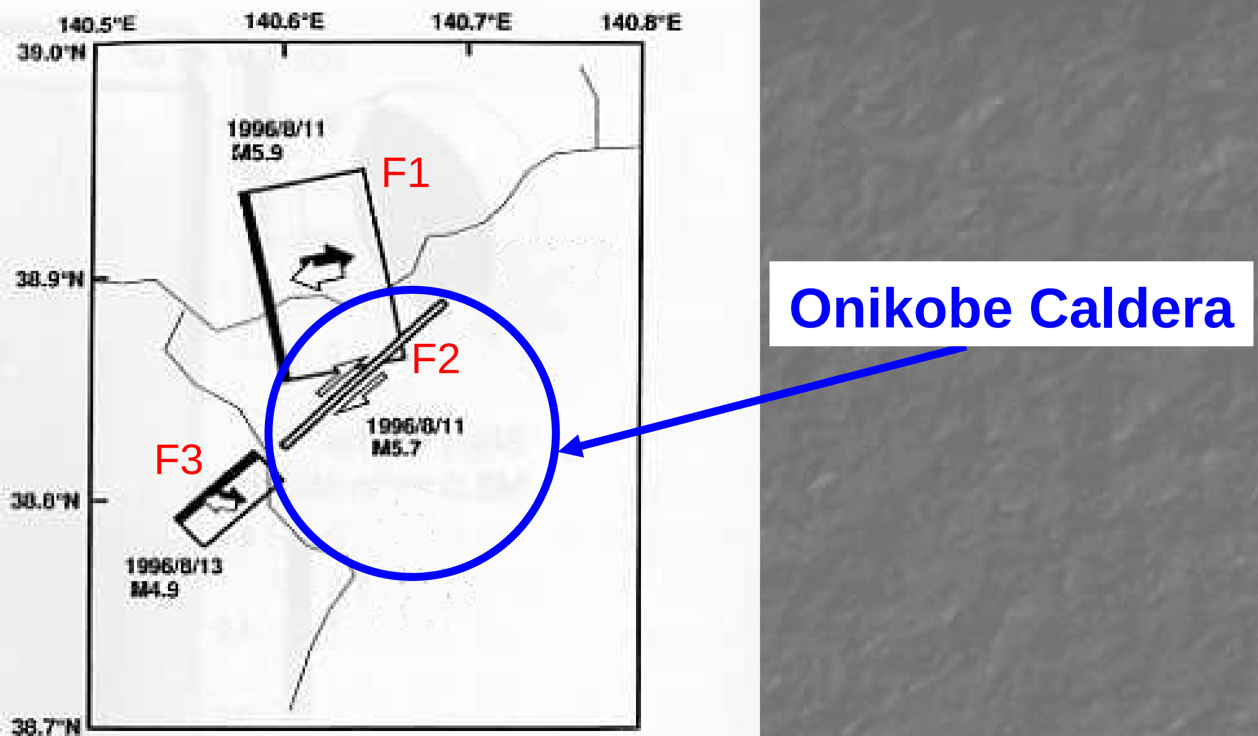


Fig. 8. Fault planes of relatively large earthquakes that occurred in the period from 1976 to 1996 in Onikobe area (Umino *et al.*, 1998).

Fault models inferred from seismic observations (modified after Umino et al., 1998)

Motivation and Scope

1, Fault model inferred from the seismic data can't explain the surface deformation derived by InSAR (Yarai et al., 2003; Aoki 2003)

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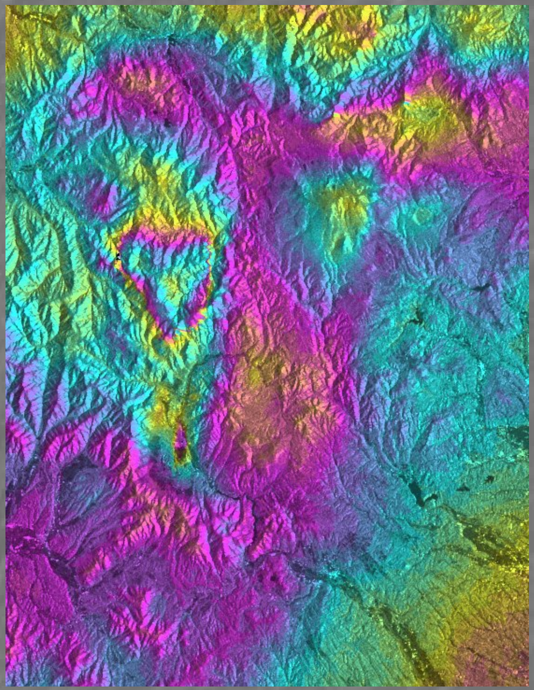
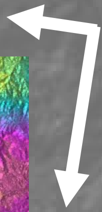
Need better fault model including aseismic slip

2, Linkage between topographic evolution and fault activity.

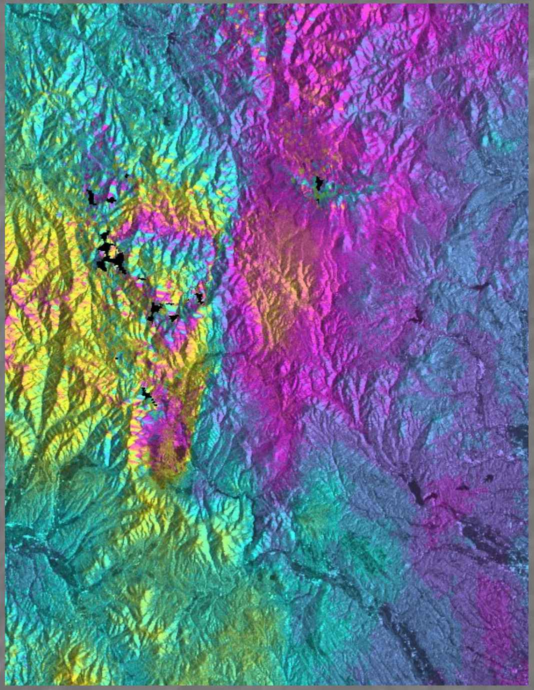
Interferograms for Good Pairs

Pair 1
(950723-961005)

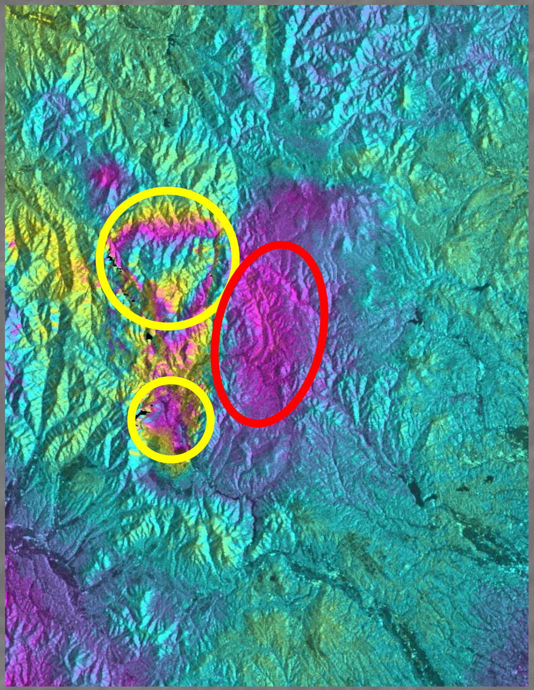


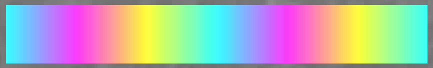


Pair 2
(960412-971219)



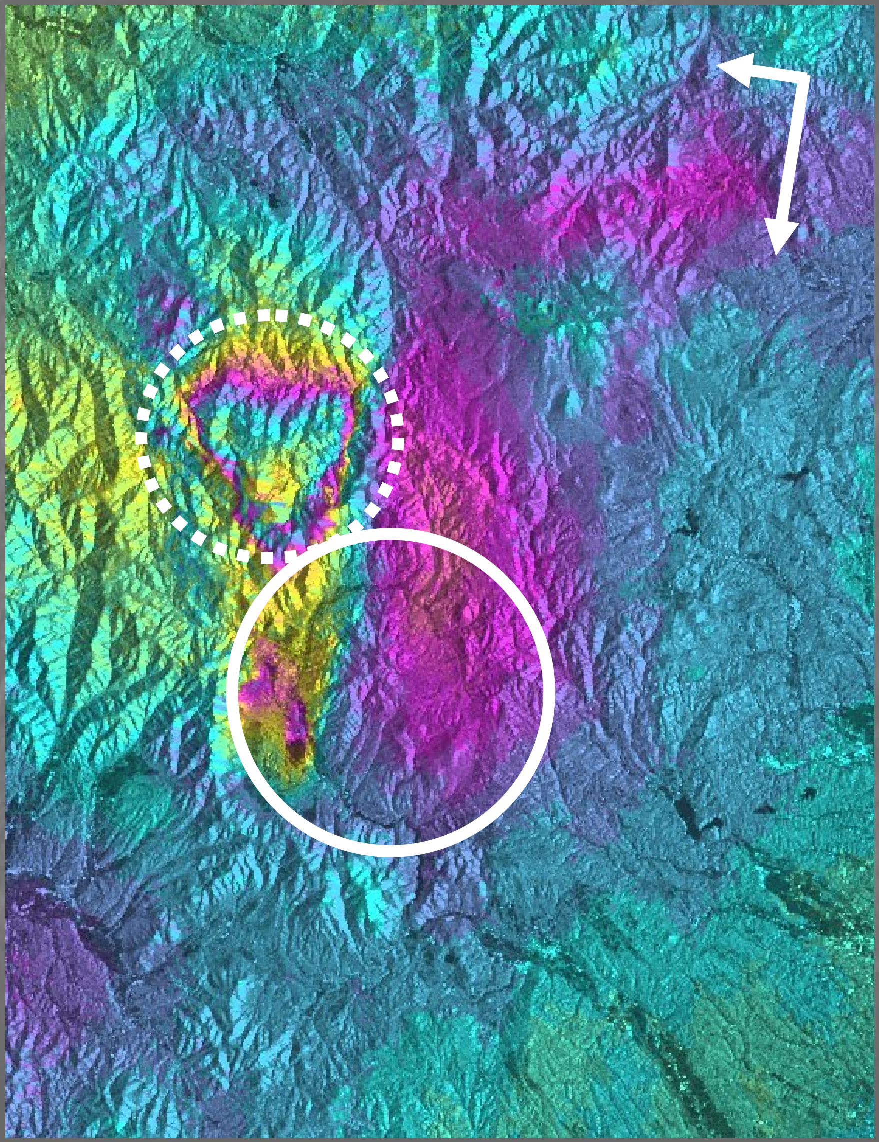
Pair 3
(960709-980613)





JERS-1 (L-band) processed with GAMMA
Independent Dates, DEM:GSI 50m-mesh

Averaged Interferogram

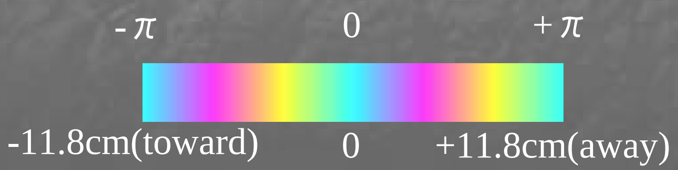


Characteristics:

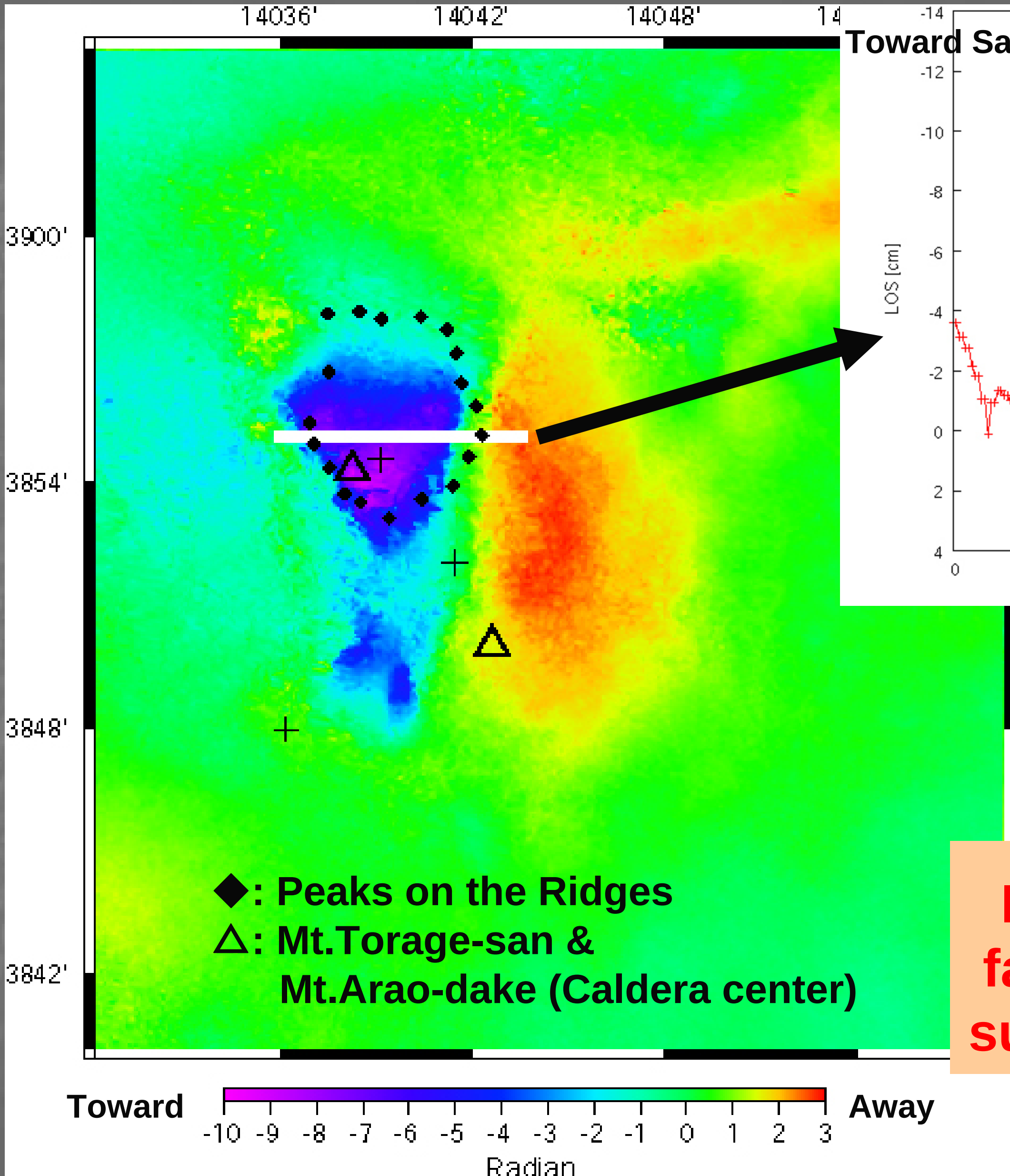
1, **Mt.Torage-san Area**
Reversed triangle region of LOS < 0 with
Steep phase gradient of east & west edge

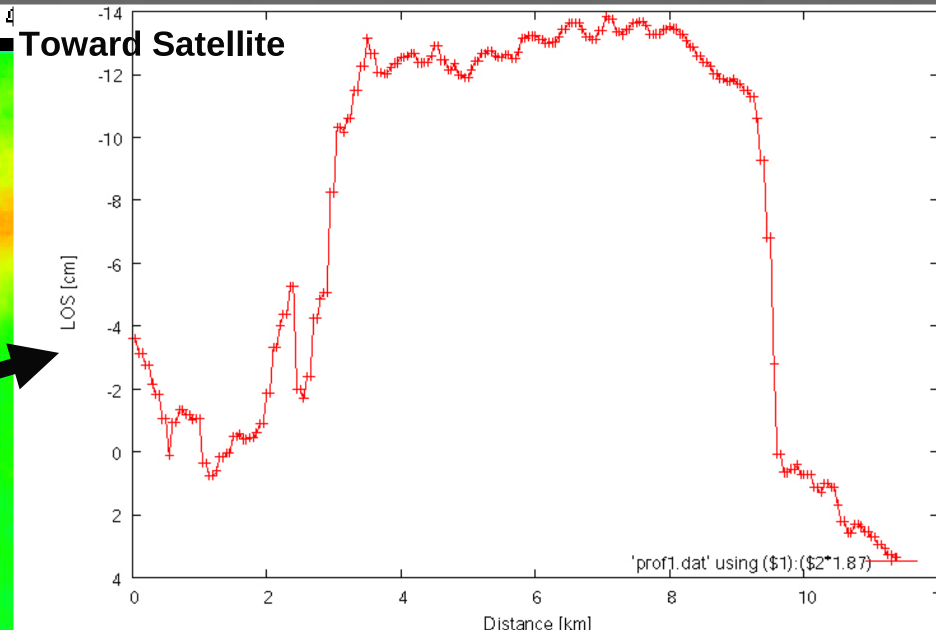
2, Positive LOS over NE part of the Onikobe caldera

3, Small wavelength LOS <0 areas around western part of the Onikobe caldera



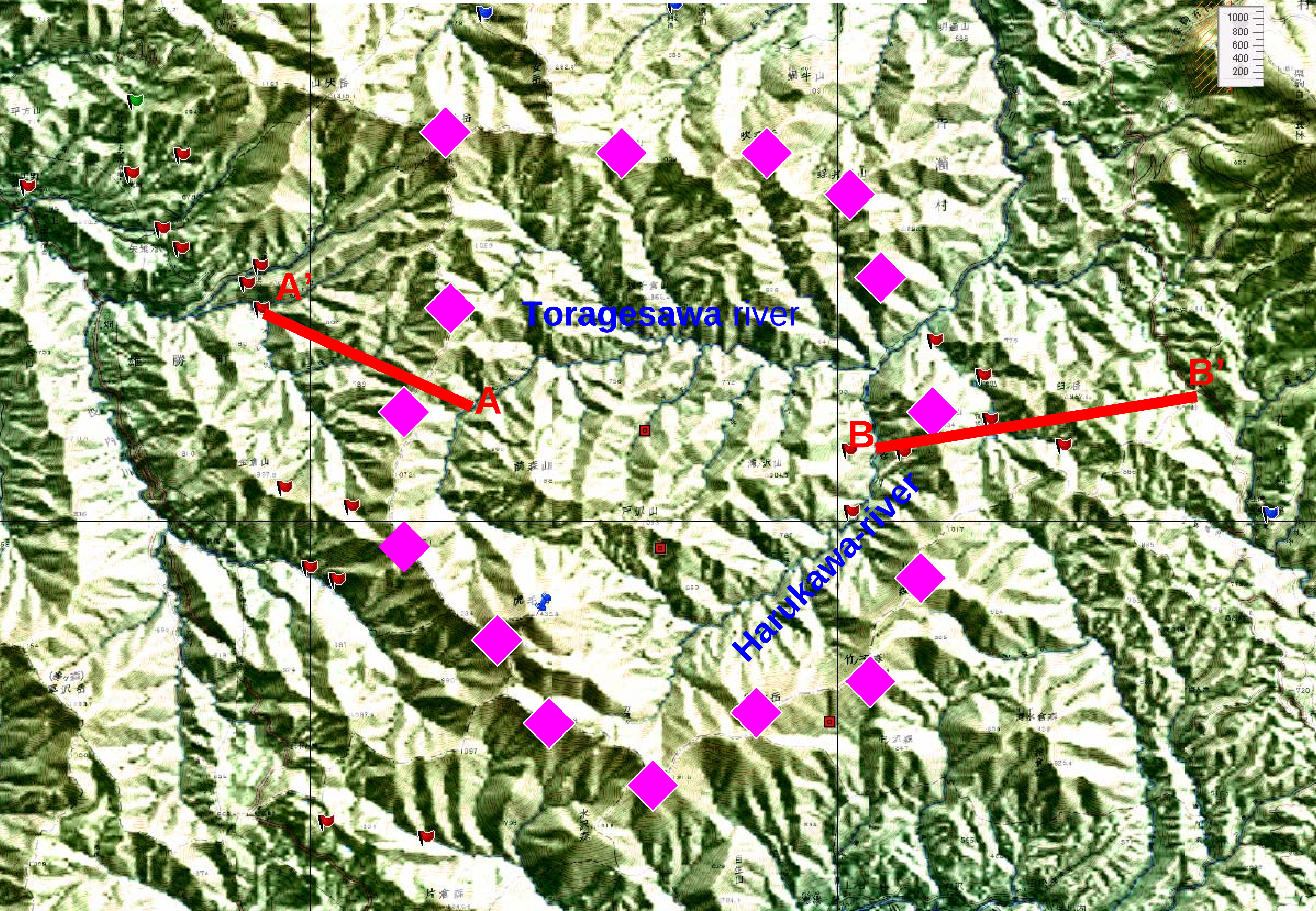
Steep Gradient





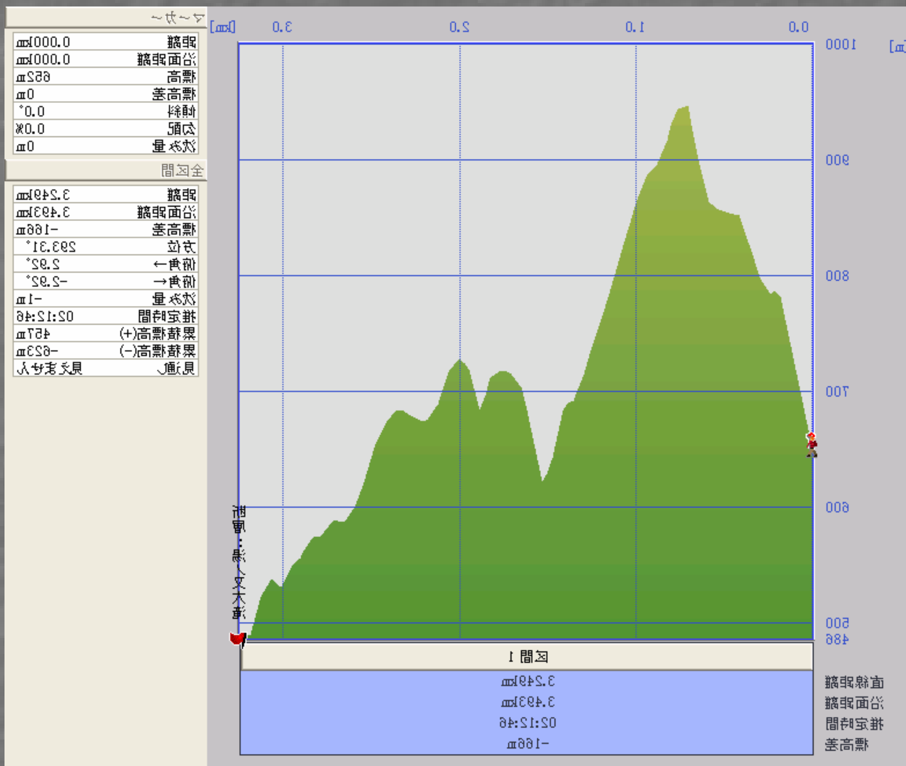
It is clear that the current fault model cannot explain such a steep phase gradient

Topography of Uplifted Area

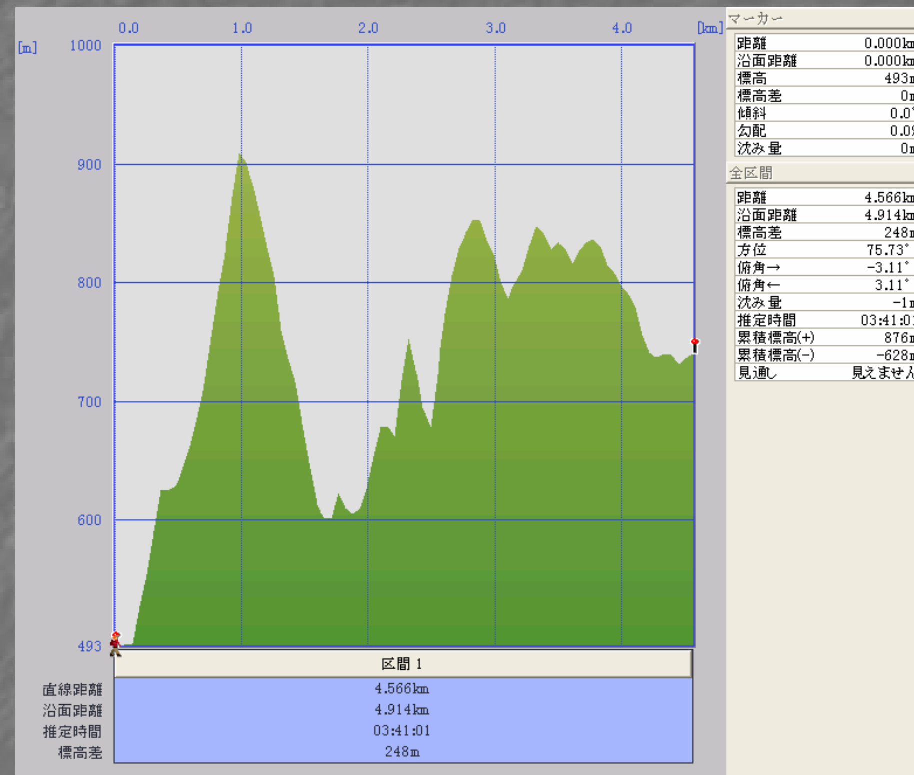


Topographic Cross-sections

A'　A



B　B'



Sharp Ridge
Like Caldera Wall

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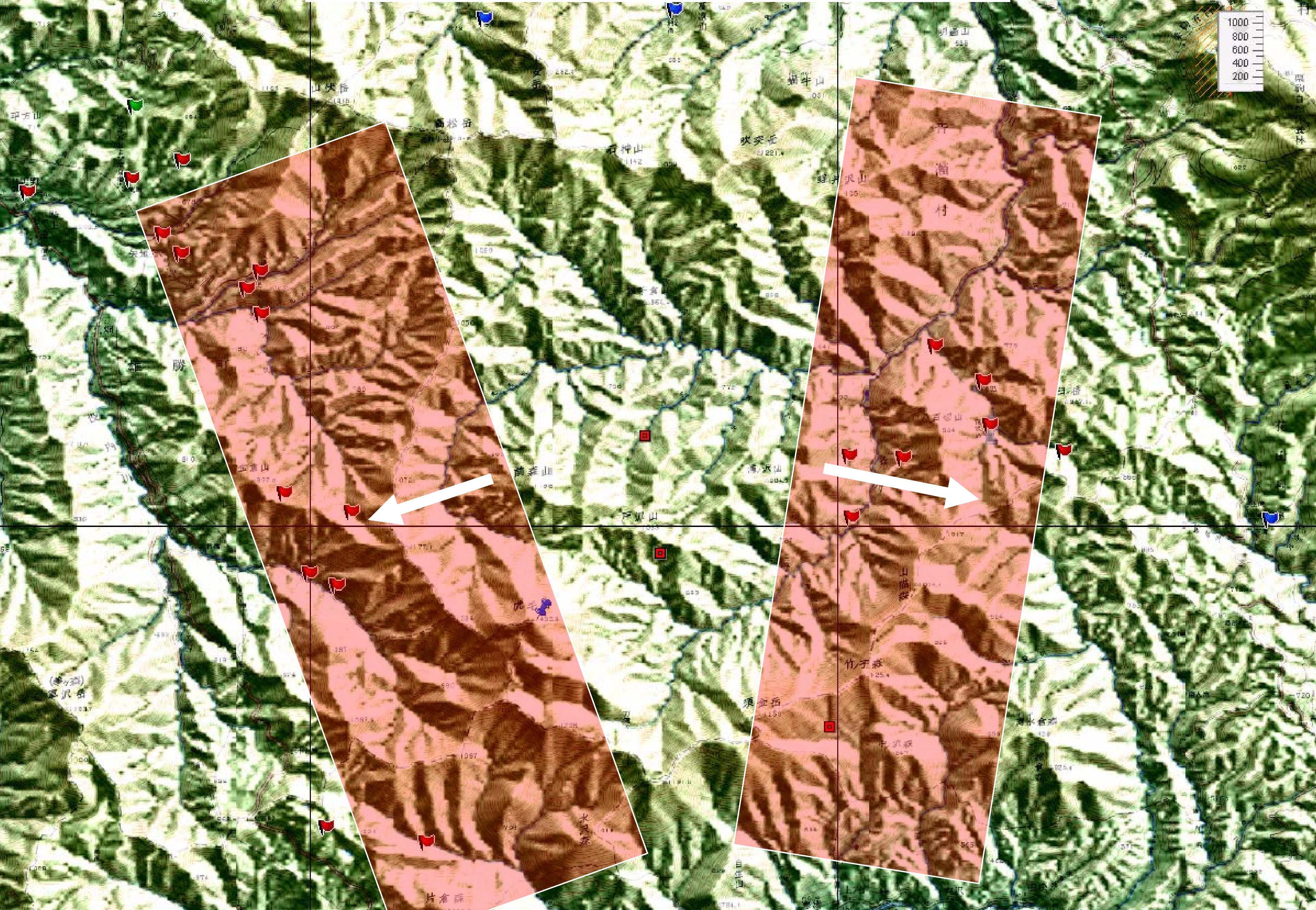
Fault related structure

Another Two Thrust Faults



Construction of Fault Model

Initial Model:

F1: M5.9+M5.4 (Aug11, Thrust), after Umino et al. (1998)
F2: M5.7 (Aug 11, Strike slip), U98
F3: M5.0 (Aug 13), U98
F4: Western Ridge, Thrust (down to E), Shallow, Small Mo
F5: Eastern Ridge, Thrust (down to W), Shallow, Small Mo

Forward modeling by Okada (1992)

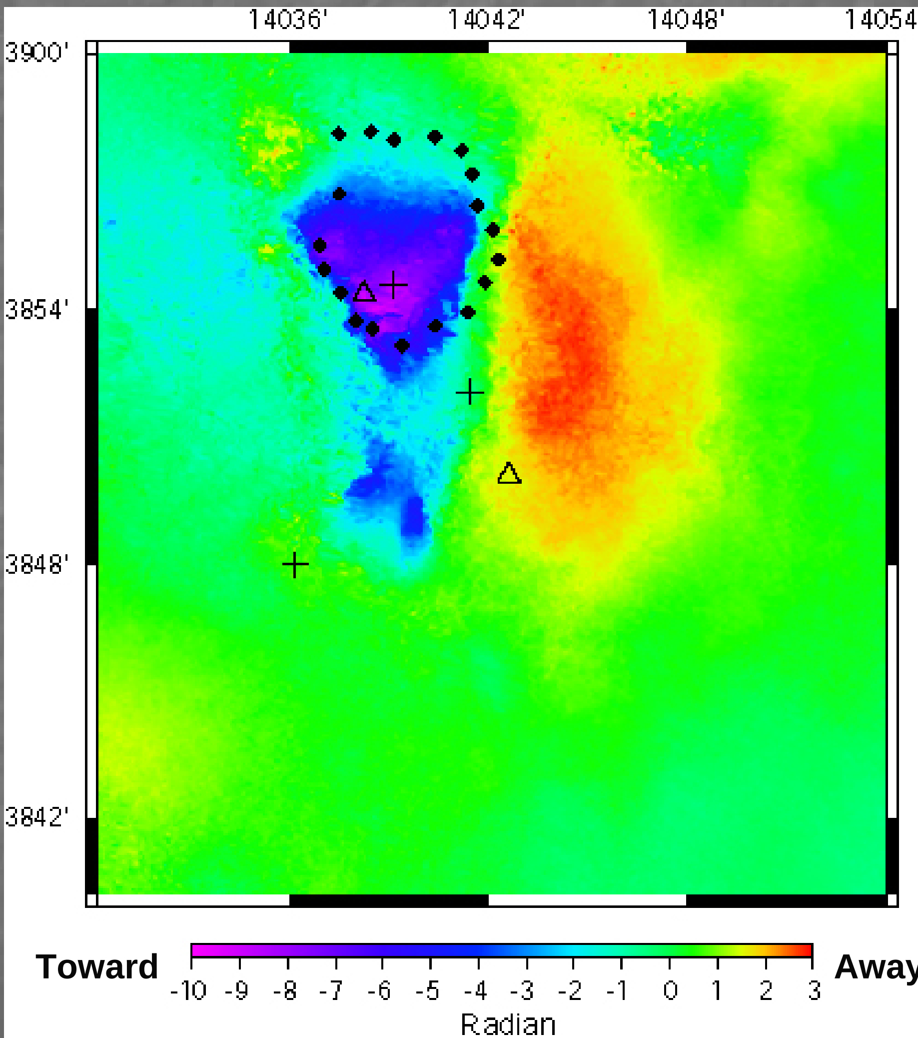
→ Modifying fault parameters (Trial & Error)
Rectangular Fault, Uniform slip

Best Model (at present):

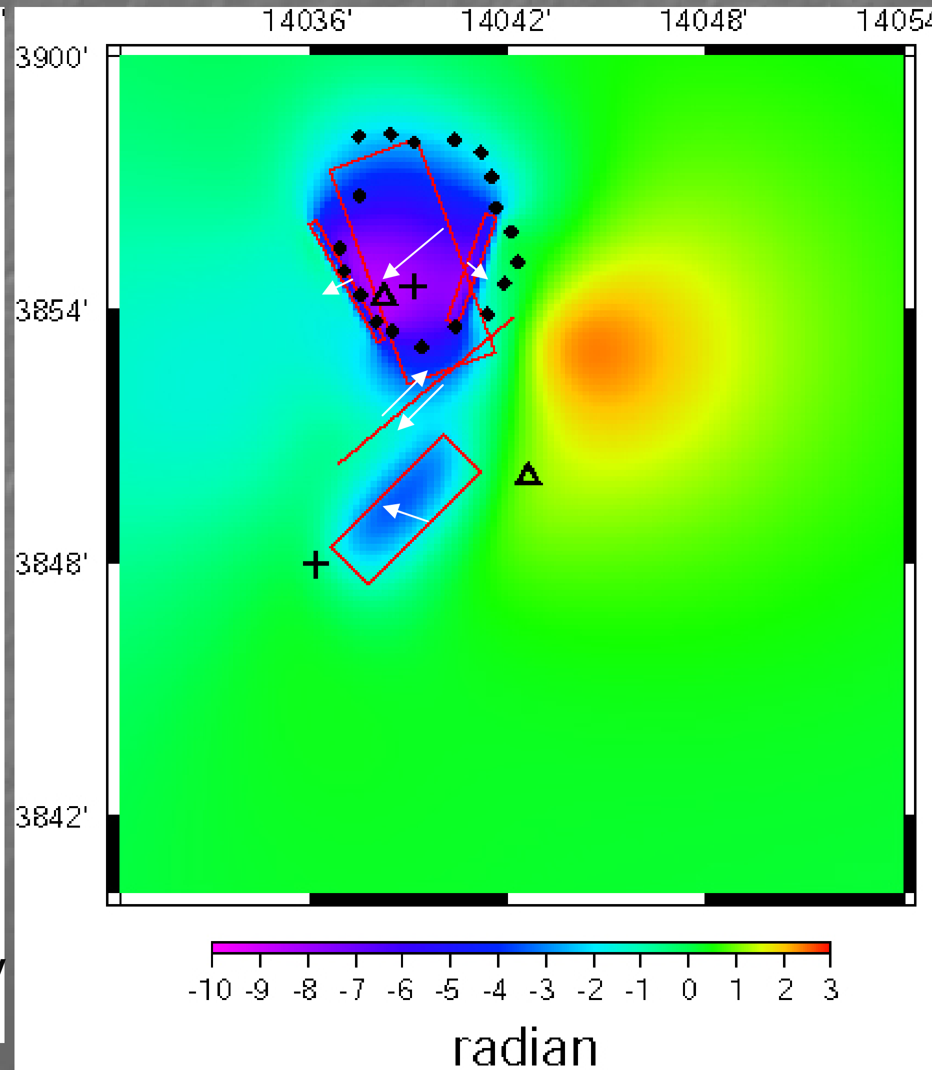
	Latitude (deg)	Longitude	Length (km)	Width	Depth	Dip(deg)	Strike	Slip Angle	Slip(m)
F1:	140.633	38.918	10.0	5.3	6.7	40.0	N20W	108.0	0.52
F2:	140.640	38.867	10.0	6.5	6.0	90.0	N50E	180.0	0.6
F3:	140.630	38.820	7.0	3.0	3.0	40.0	N45E	115.0	0.3
F4:	140.600	38.910	6.0	4.0	2.5	85.0	N30W	80.0	0.2
F5:	140.663	38.915	5.0	6.0	3.5	85.0	N20E	70.0	0.2

Result (1)

Observed LOS

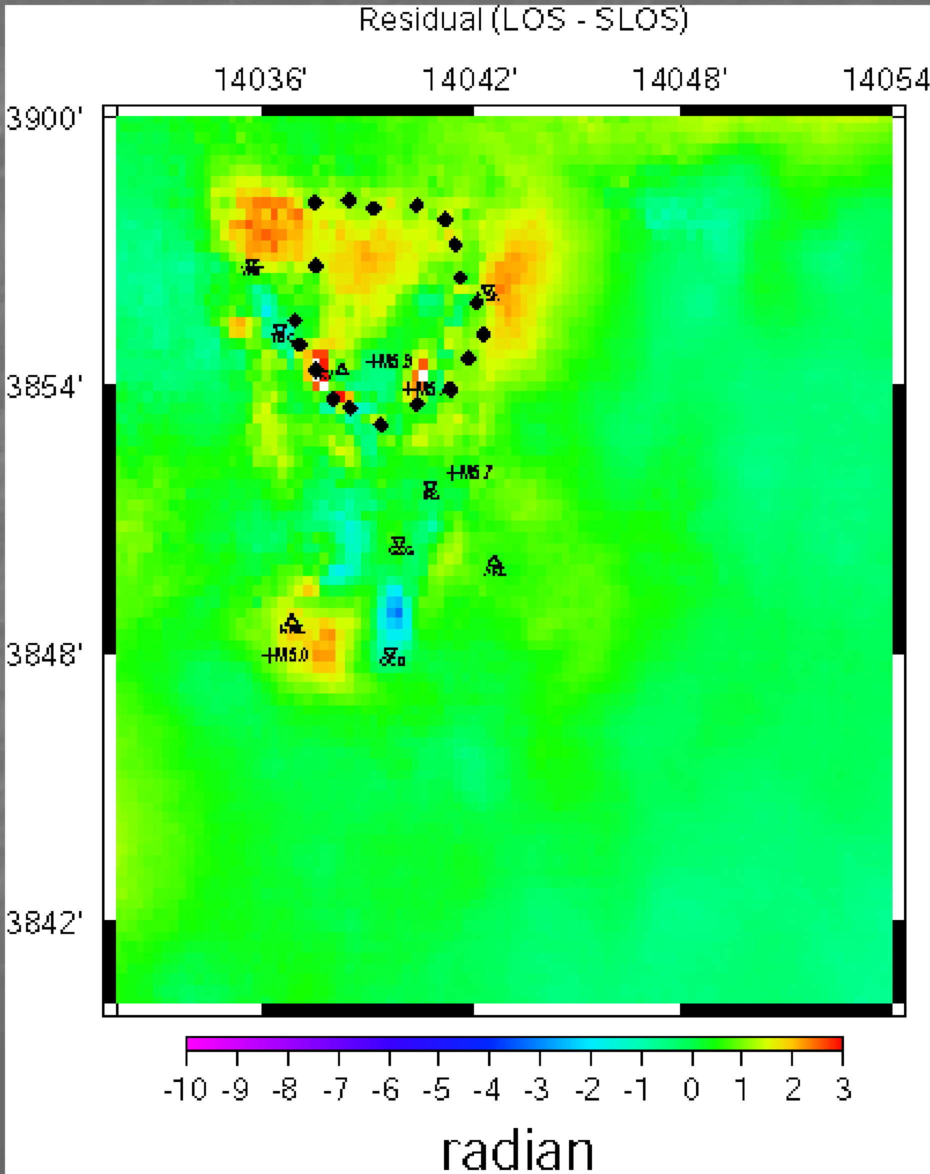


Synthetic LOS



Result (2)

Residual (LOS – Synthetic LOS)



Error: ±3rad(~5.7cm), Short-Wavelength

Need Further Improvement…

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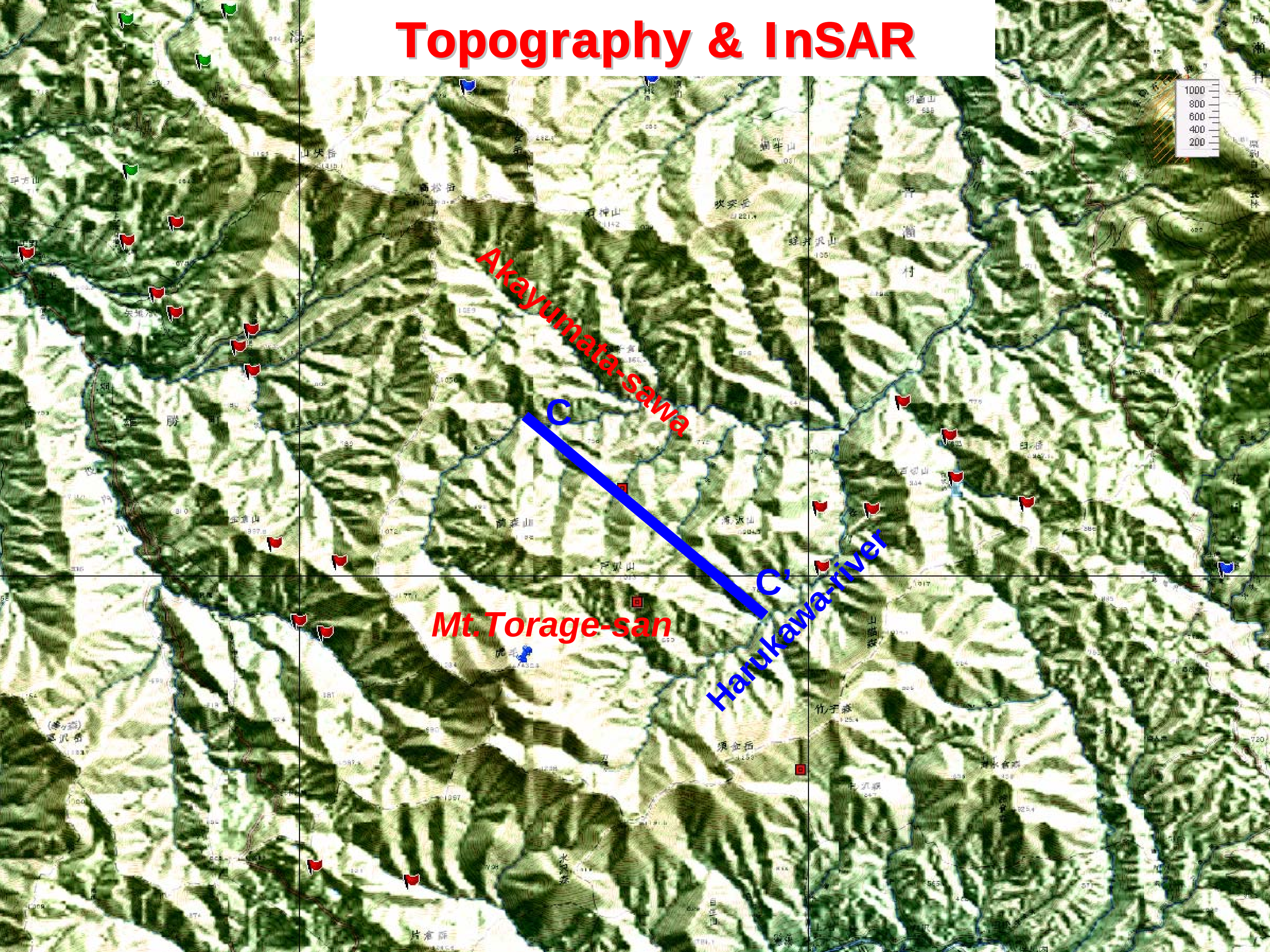
Grid Search

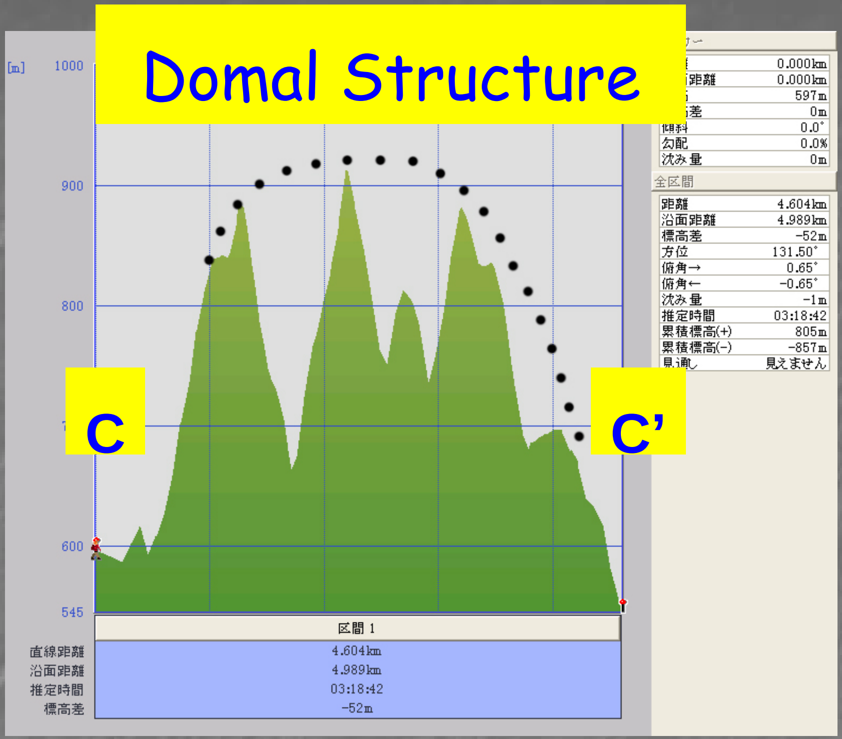
↓

Slip Distribution by Inversion

Topography & InSAR



Topographic Growth & Thermal Activity



Air View of Uplifted Area from NE

GSI 50m-DEM + 1:50000 Map with Kashmir 3D

Summary

- Sharp phase change across the eastern and the western border of Harukawa and Torage-sawa drainage area can be explained by introducing two high-angle thrust faults (not identified from seismic data).

- Those rivers and sharp ridges surround a domal structure where uplift (LOS < 0) signal is maximum. Such events would intermittently contribute the topographic growth on a long time-scale.

- Non-uniform slip should be considered.

Acknowledgement:
This study is funded from JSPS.
The original JERS-1 level-0 data are copyrighted by, and courtesy of METI/JAXA.

END