Creeping distribution on the Longitudinal valley fault at Yuli area estimated by precise leveling survey, Southeast Taiwan 2

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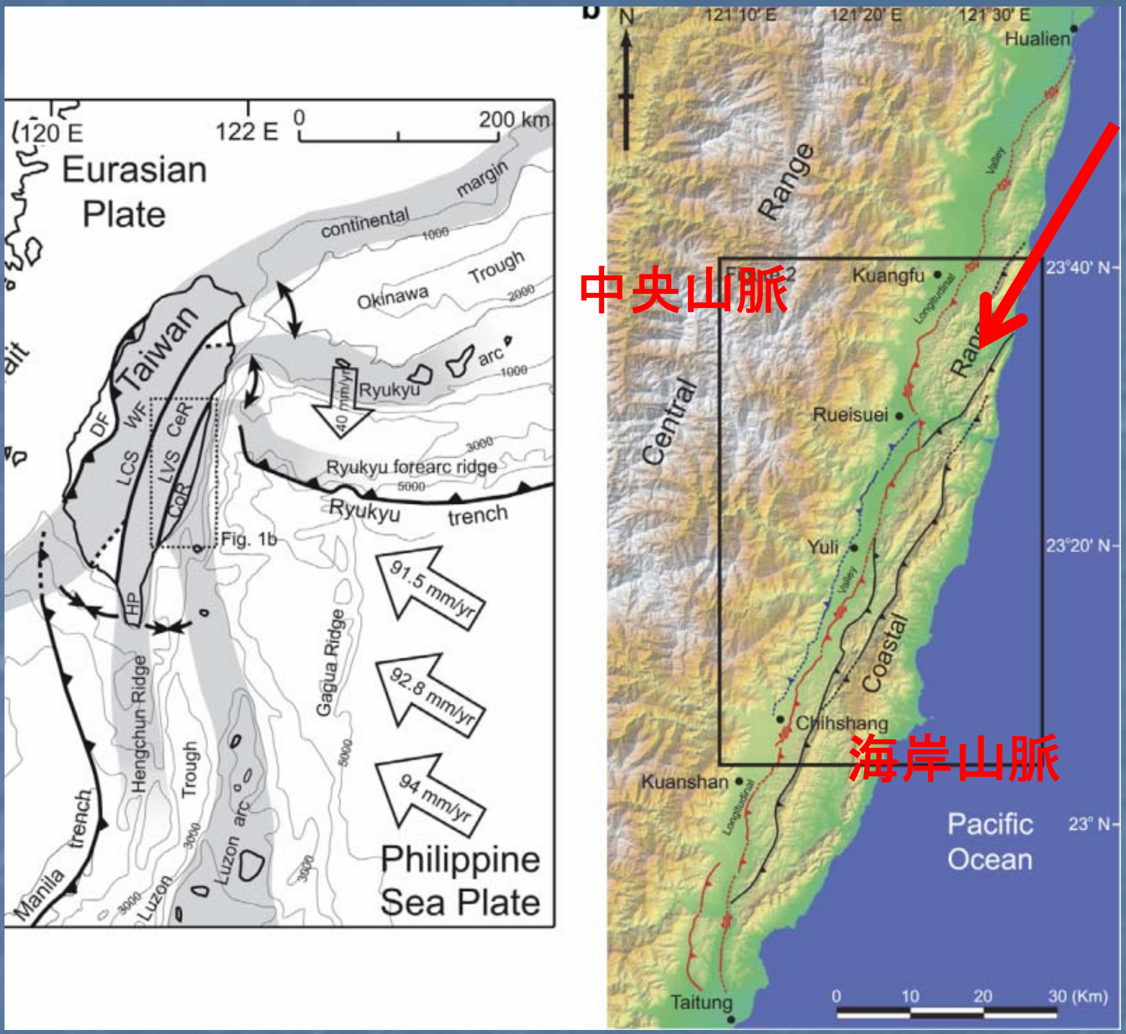
Outline of our presentation

1. Introduction of Longitudinal valley fault

2. Precise leveling survey in Yuli area

3. preliminary result of modeling

Location of Longitudinal valley fault



Shyu et al., 2007

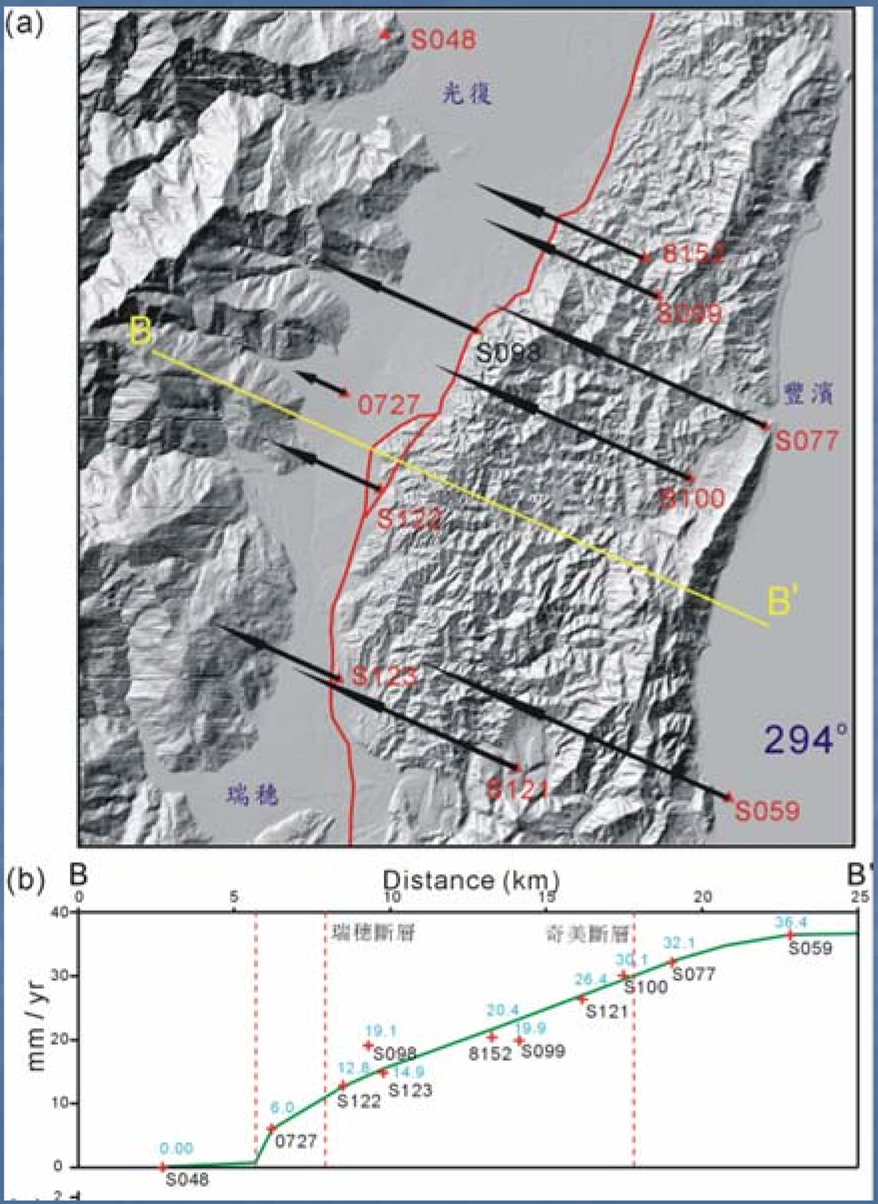
Longitudinal valley fault (台東縦谷断層)

collision boundary between the Eurasian plate and Philippine sea plate.

high deformation rate

Deformation of Longitudinal valley fault(North)

GPS 1992-1999



Wen-shan Chen et al., 2007)

Horizontal deformation projected perpendicular to the fault:

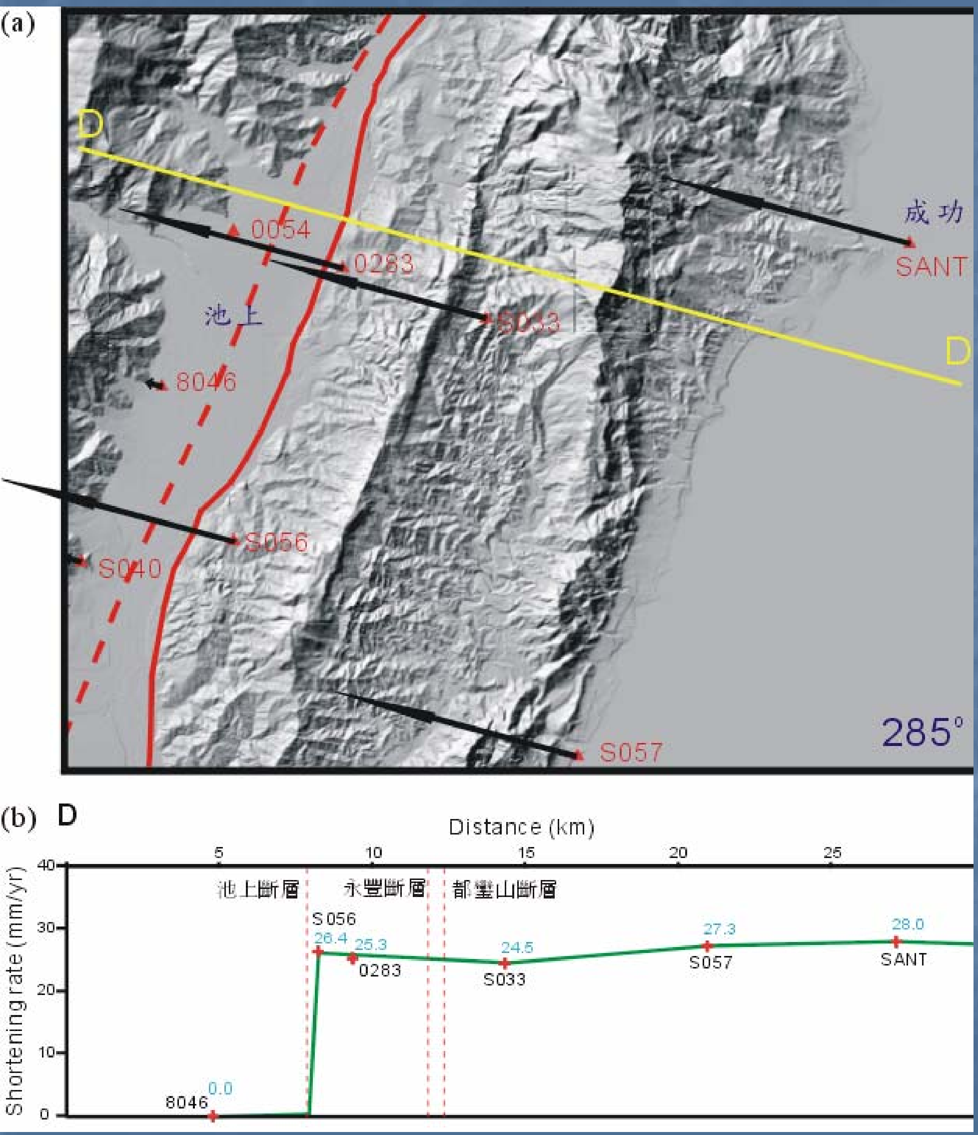
Smooth curve

↓

Fault at north part is rocked and accumulate strain.

Deformation of Longitudinal valley fault(South)

GPS1992-1999



Horizontal deformation projected perpendicular to the fault:

Drastic change near the fault

↓

Fault at south part is creeping and don't accumulate strain.

Wen-shan Chen et al., 2007)

Purpose of our research

Difference of deformation patterns between north and south.

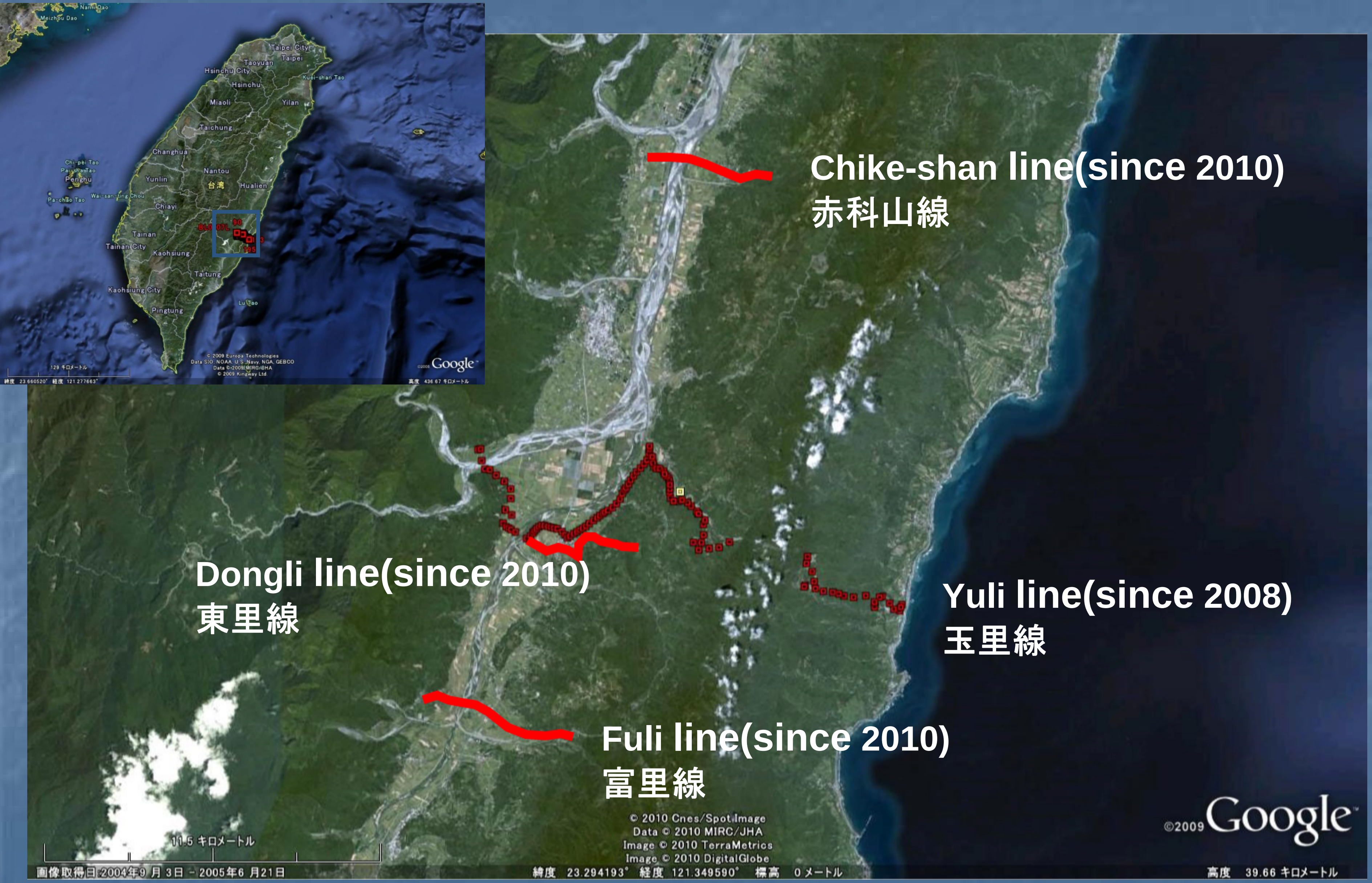
South(Creep)	Central(transition zone)	North(Rock)
No significant asperity	?	Asperity

Next step,
the deformation of central part should become clear.

Leveling survey and modeling of creep distribution in the central part.

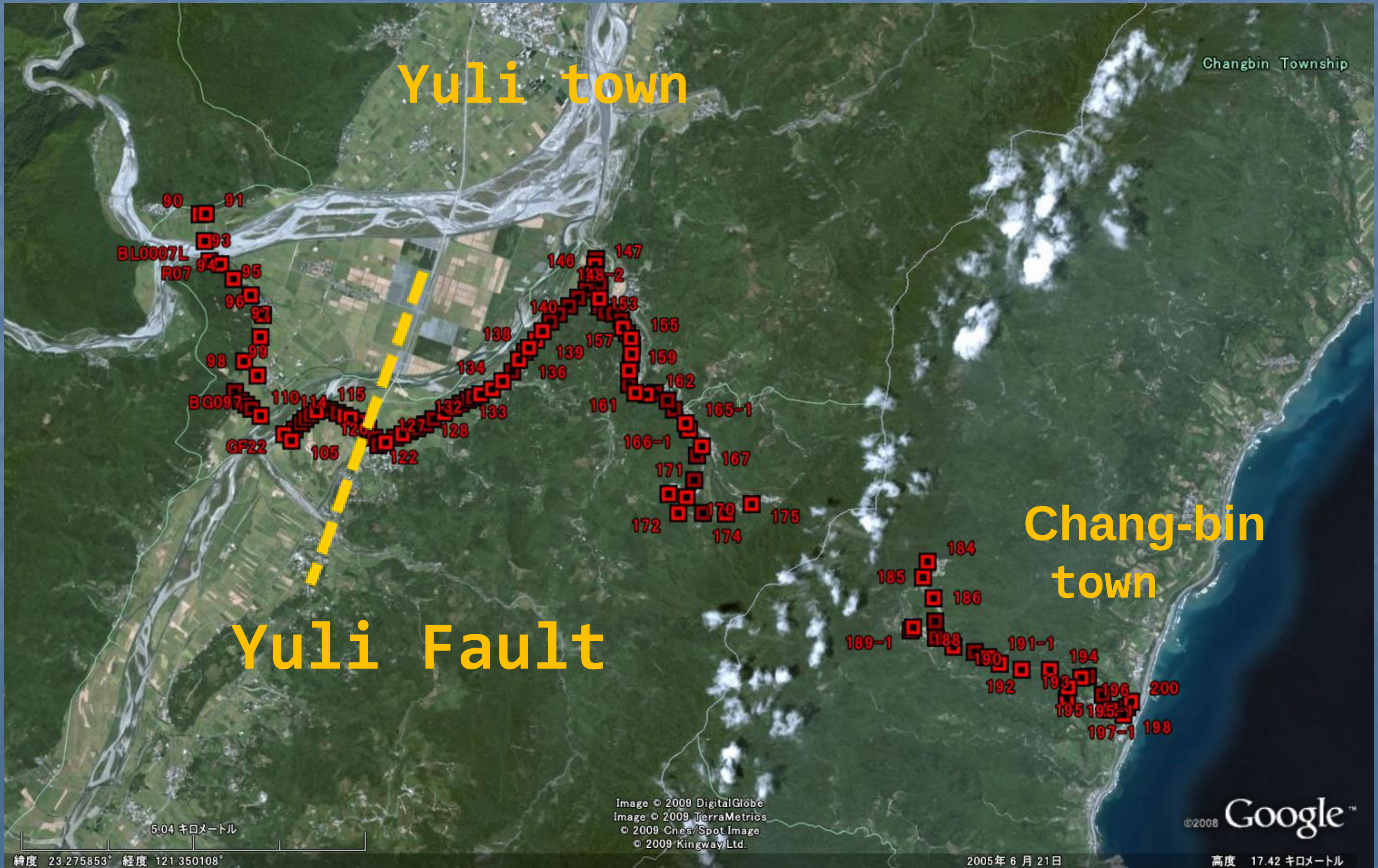
The understanding of transition zone may give important information to understand what the cause of the fault creep in south part is.

Leveling survey in Yuli area



Leveling survey at Yuli line

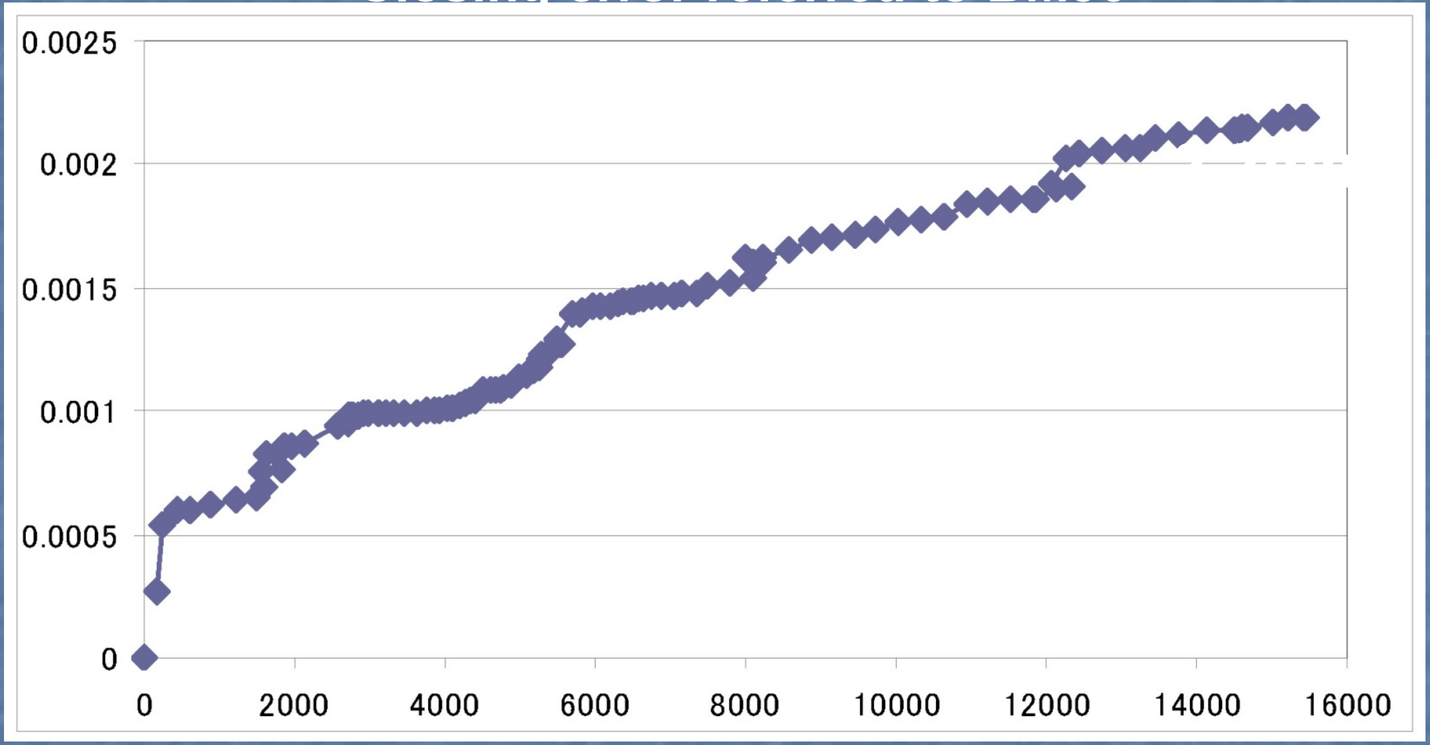
- about 30km leveling route
- dense leveling network　(The installation interval of benchmarks near the fault area is about 100 m.)
- observation : Aug.2008, Aug.2009, Aug.2010



Closing error

Leveling route was measured two times for checking the observation error.

Closing error referred to BM90

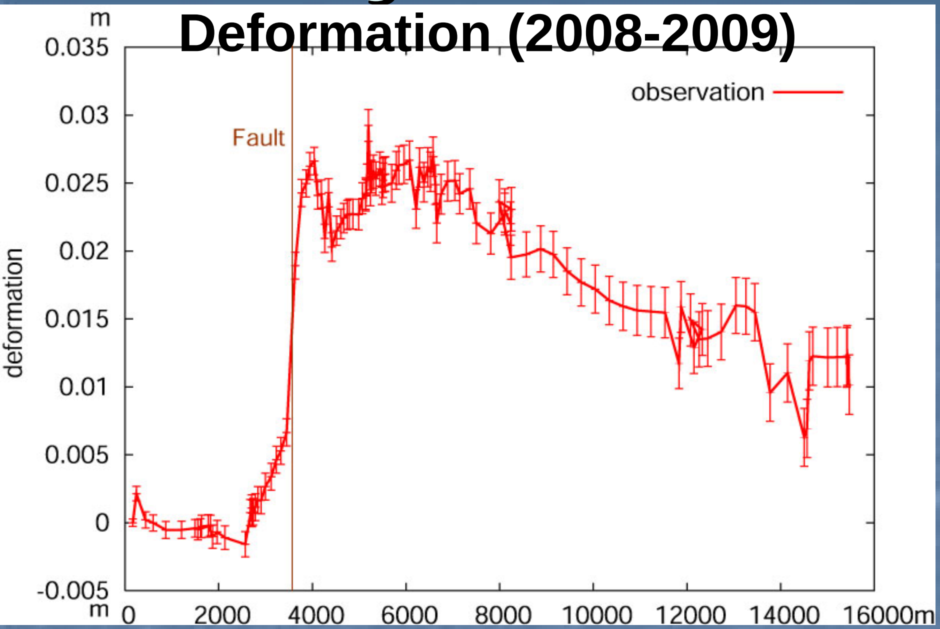


Distance (m)

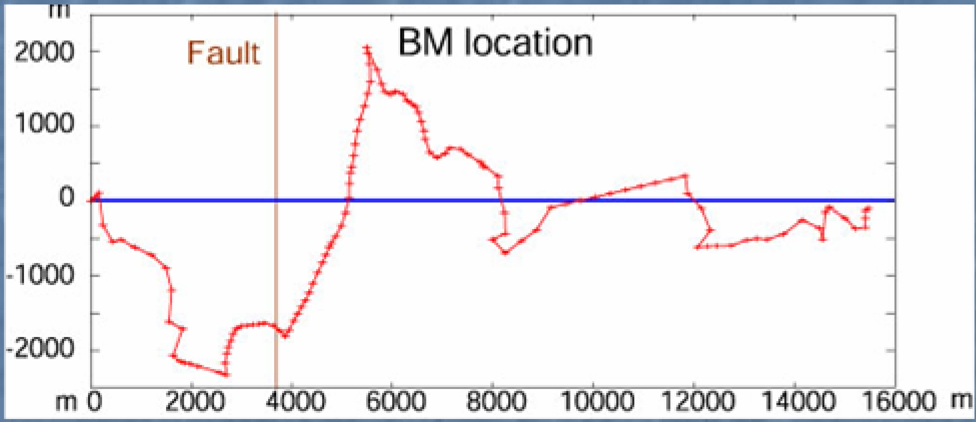
Maximum of about 2.2mm

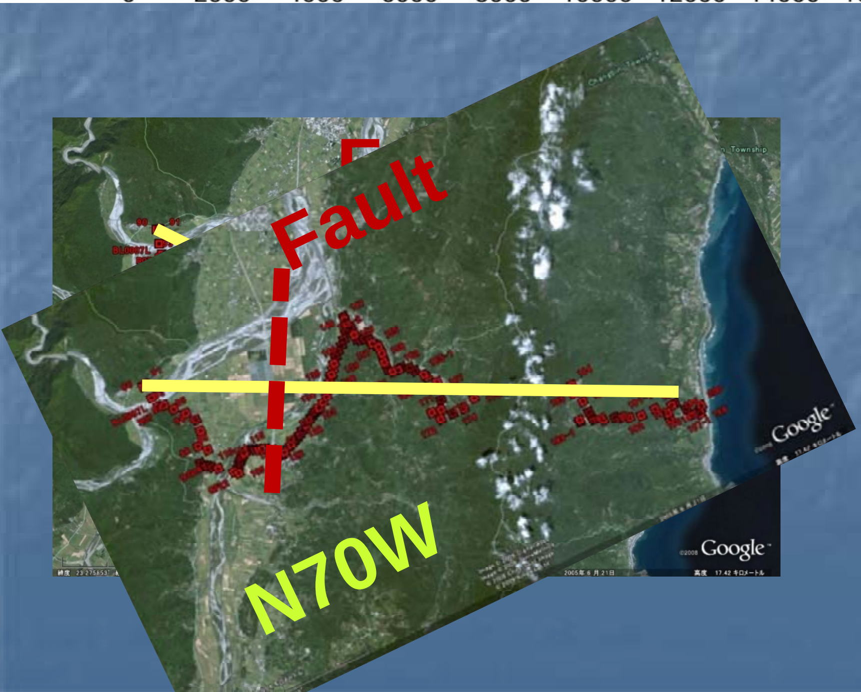
We detected vertical deformation with high accuracy.

Projection on fault perpendicular



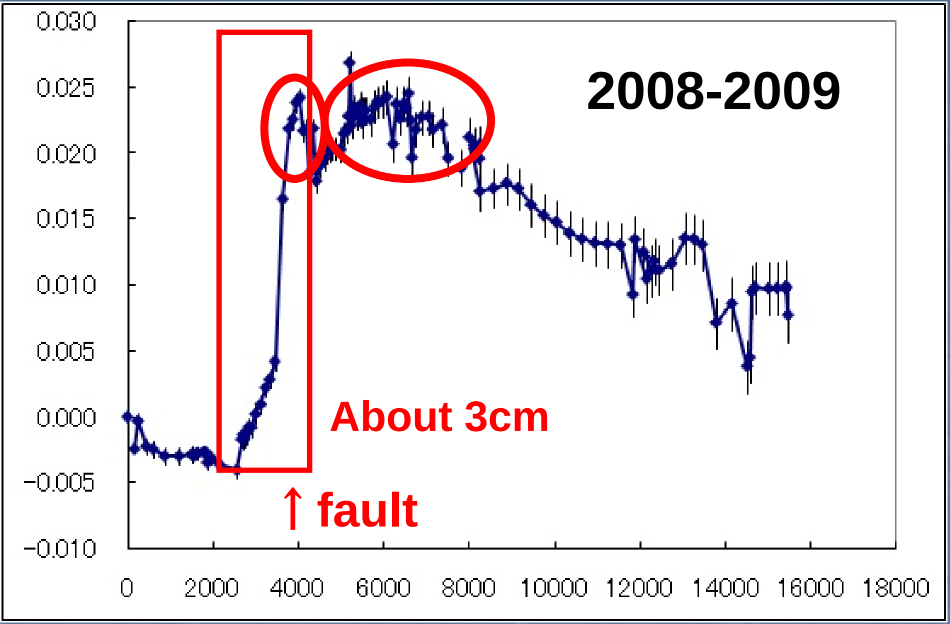
Deformation is projected to fault perpendicular direction

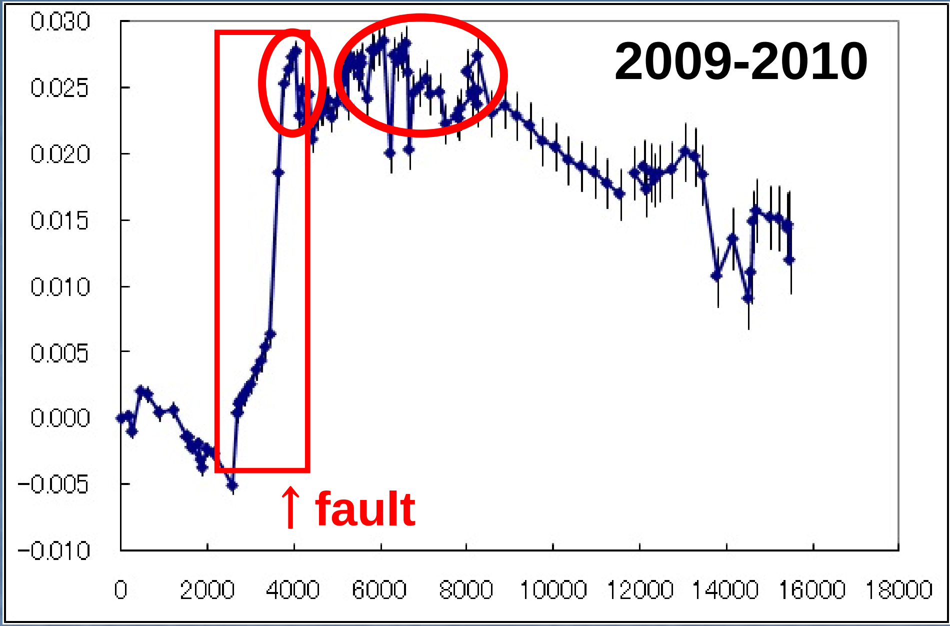


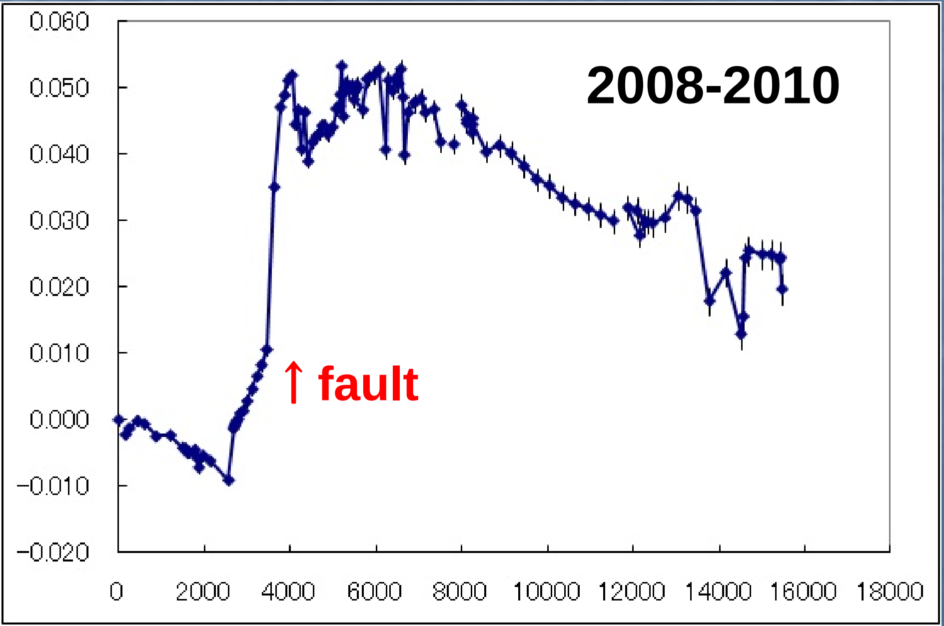


↑the linear distance along the fault perpendicular direction from west end of the leveling line.

Vertical deformation







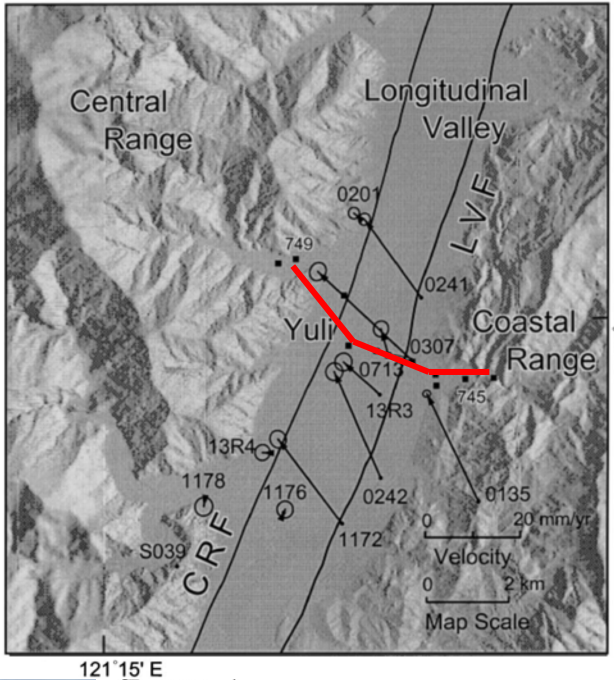
About 3.0 cm uplift just close the fault.

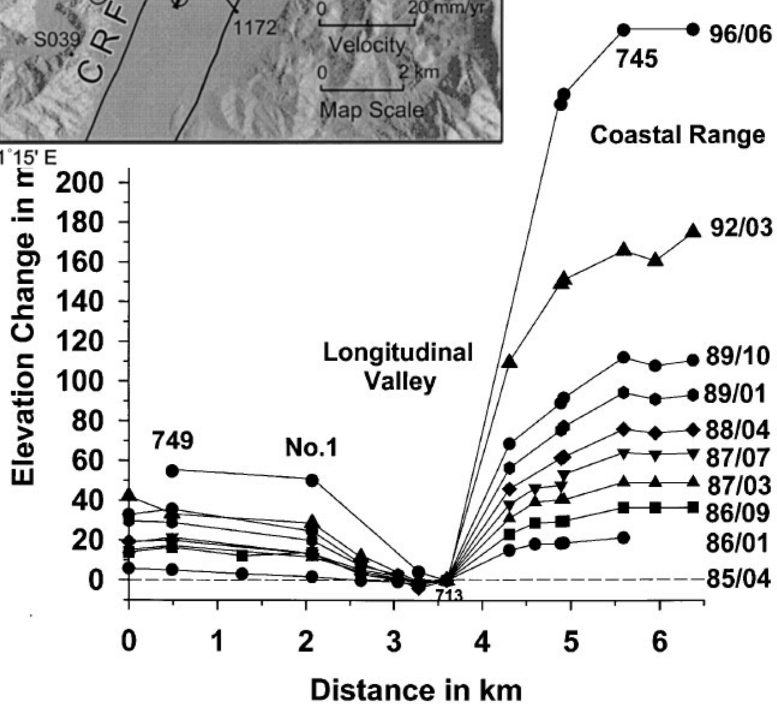
Two peaks of the deformation

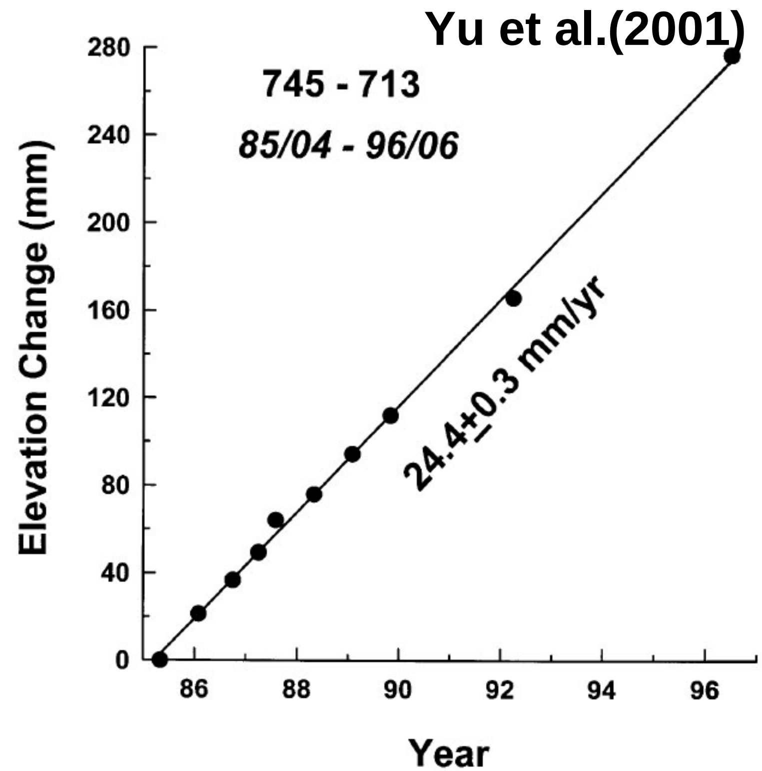
Deformation patterns of 2008-2009 and 2009-2010 are almost same.

Steady creep with constant rate

Yu et al.(2001) made leveling in 11 years and show the steady creep with constant rate.



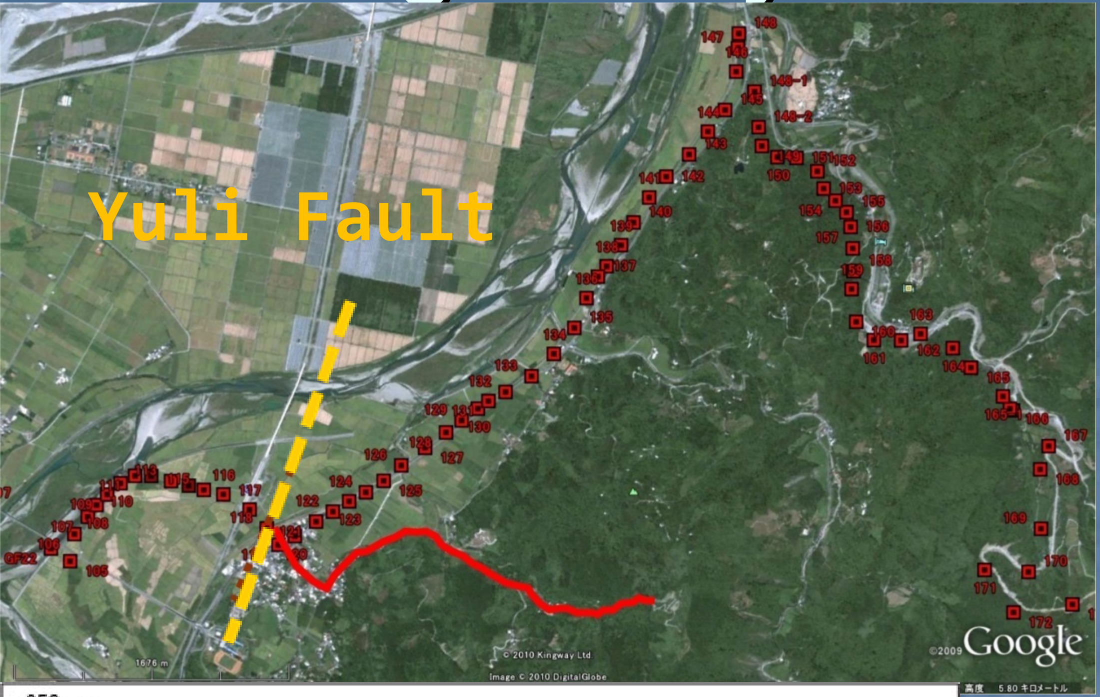


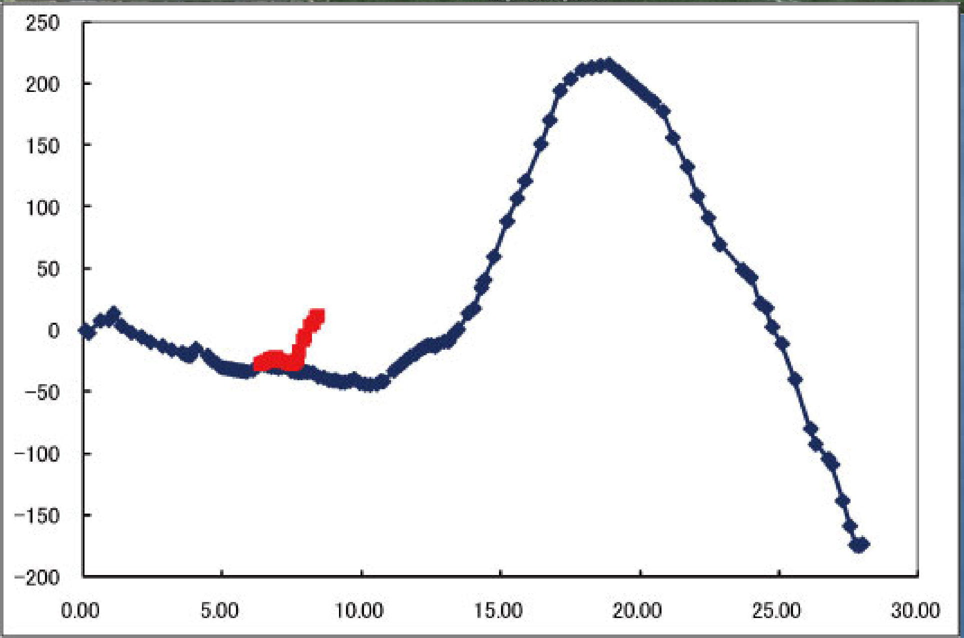


Our result is consistent with the result of Yu et al.(2001)

...ion changes between BM 745 and BM 713 from 1985 to 1996.

Leveling survey at Dongli line(東里線)

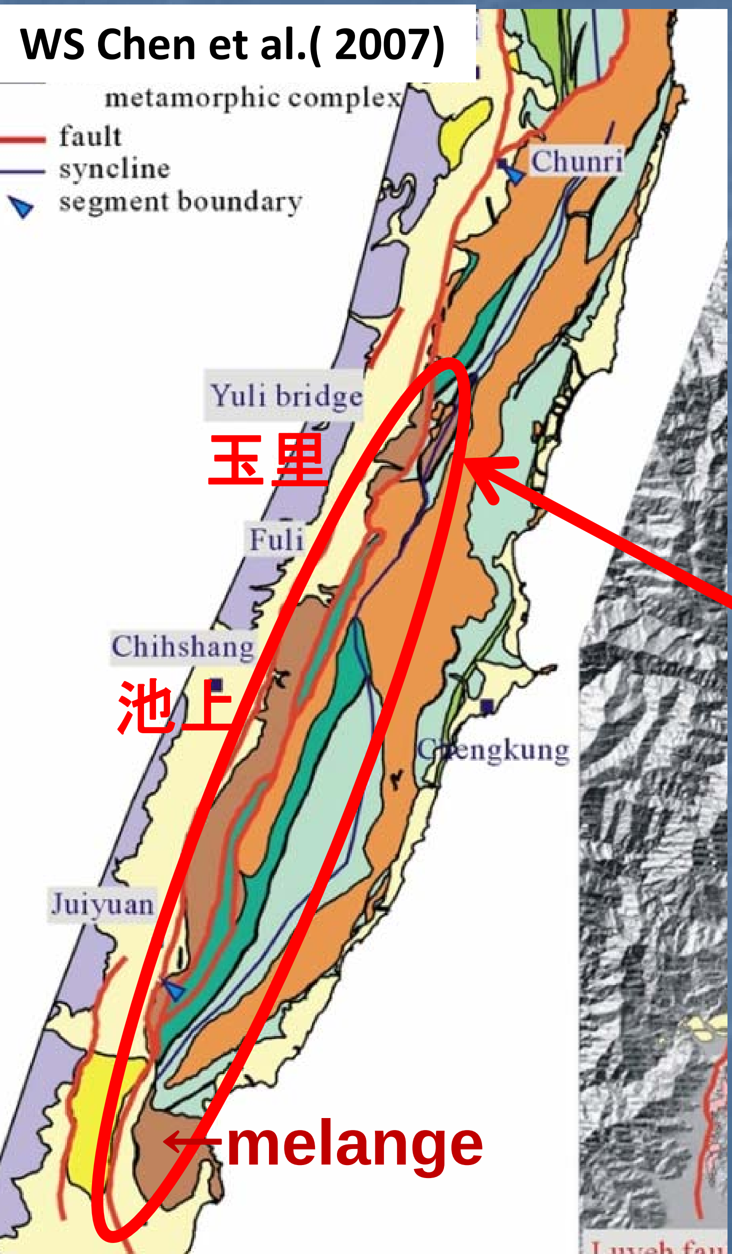




We extend to fault perpendicular direction by 5km in 2010.

Next year, we will show you a result!

Leveling survey at Chike-shan line



We note the spatial distribution of the tectonic melange.

Tectonic melange:
mixture of rock materials fractured by tectonic movement.

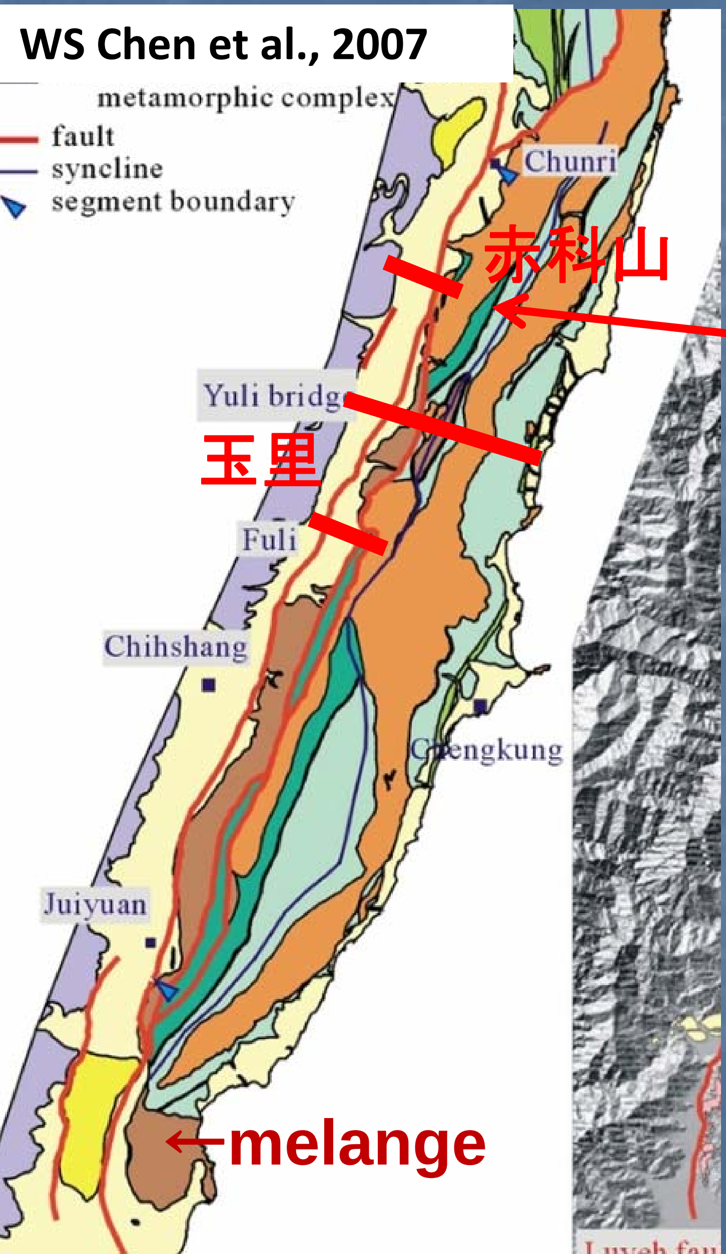
tectonic melange is exposed on the surface of the southern half of the fault.

Yuli is northern margin of the tectonic melange.

Creeping area corresponds with the spatial distribution of the melange.

Tectinic melange is candidate of the cause of the creeping.

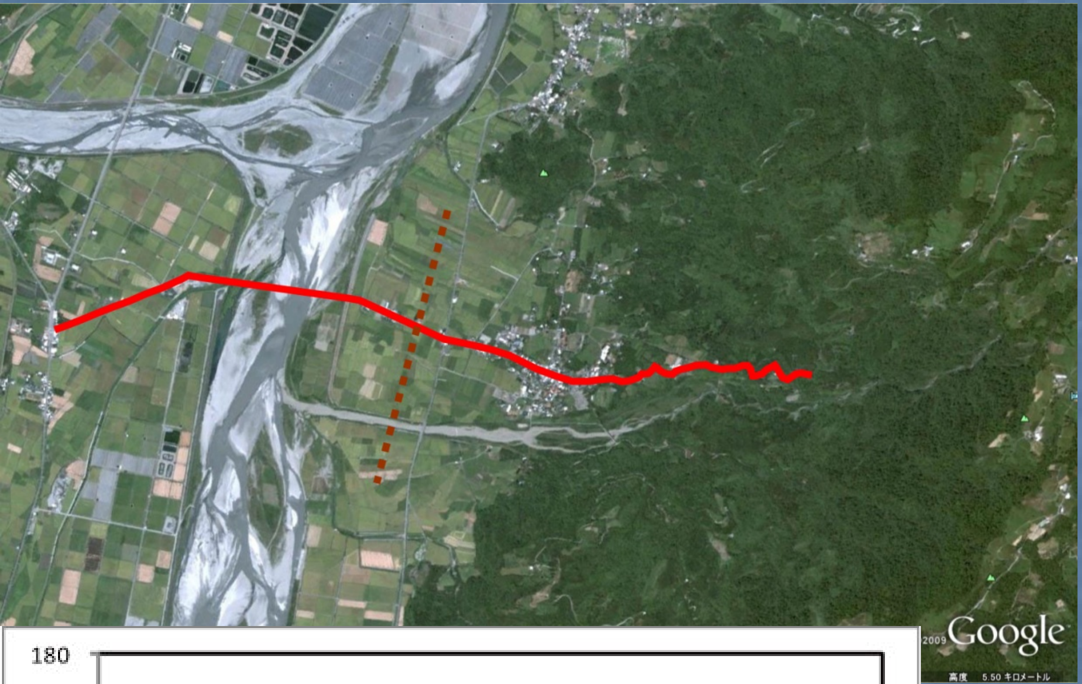
Leveling survey at Chike-shan line

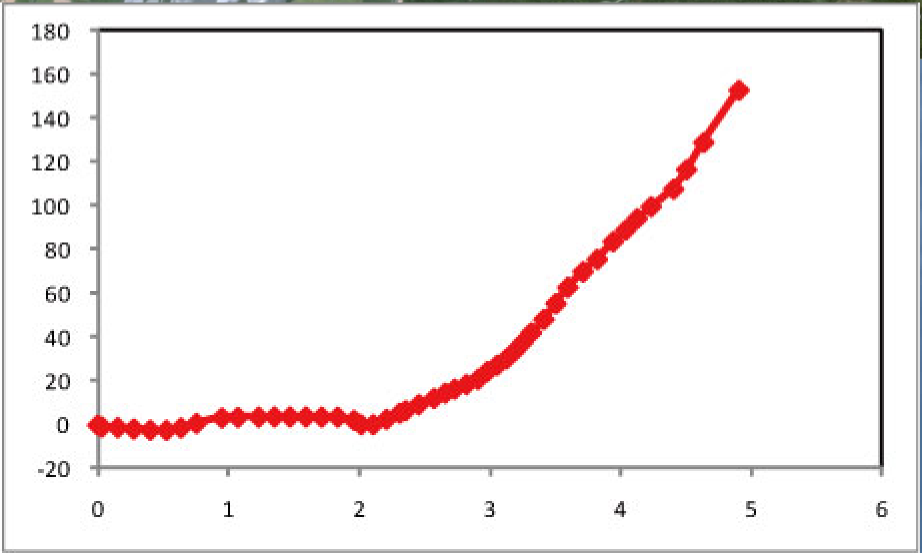


Tectinic melange is candidate of the cause of the creeping.

In order to ensure our hypothesis, we established new leveling routes near Chike-shan (赤科山), north part of Yuli , and surveyed it in August 2010.

Leveling survey at Chike-shan line (赤科山線)



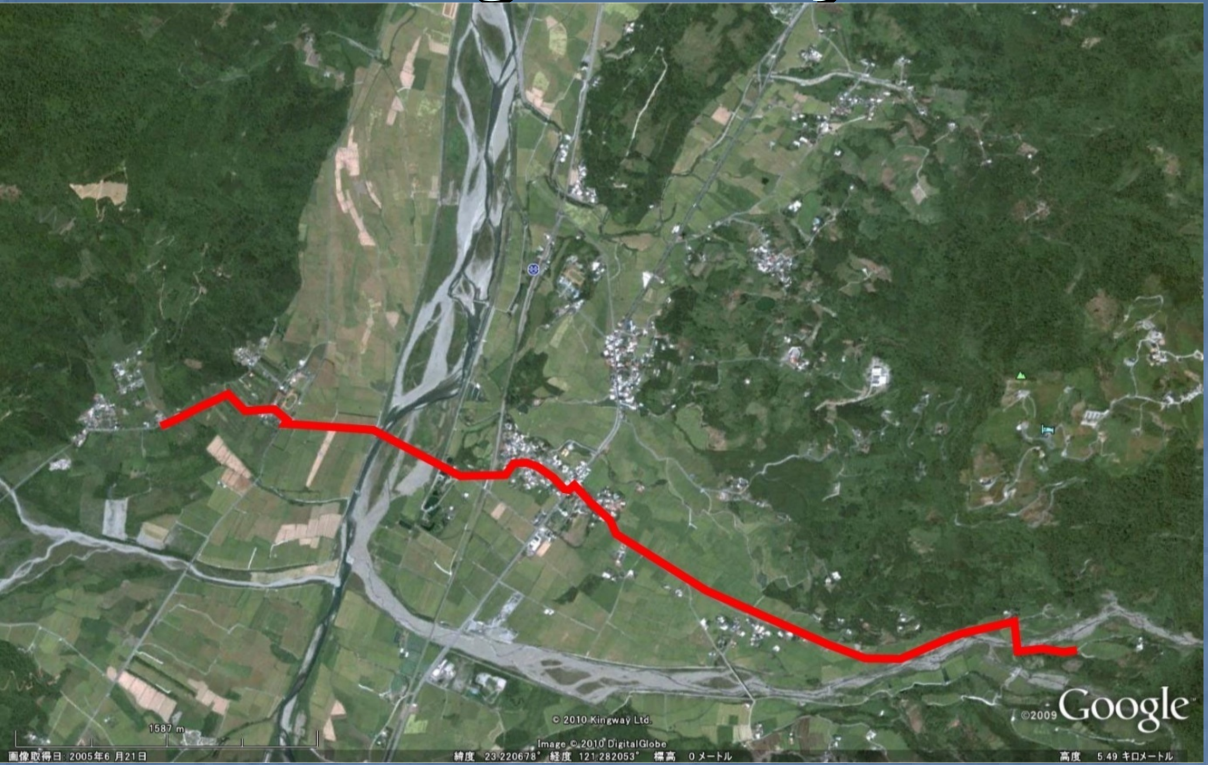


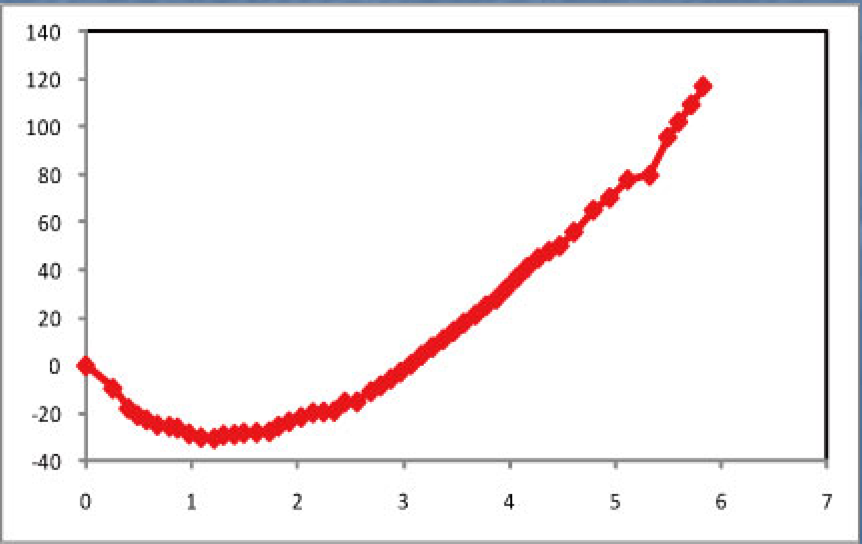
5 km leveling route.

About 5km north from northern margin of the Tectonic melange

Next year, we will show you a result!

Leveling survey at Fuli line(富里線)



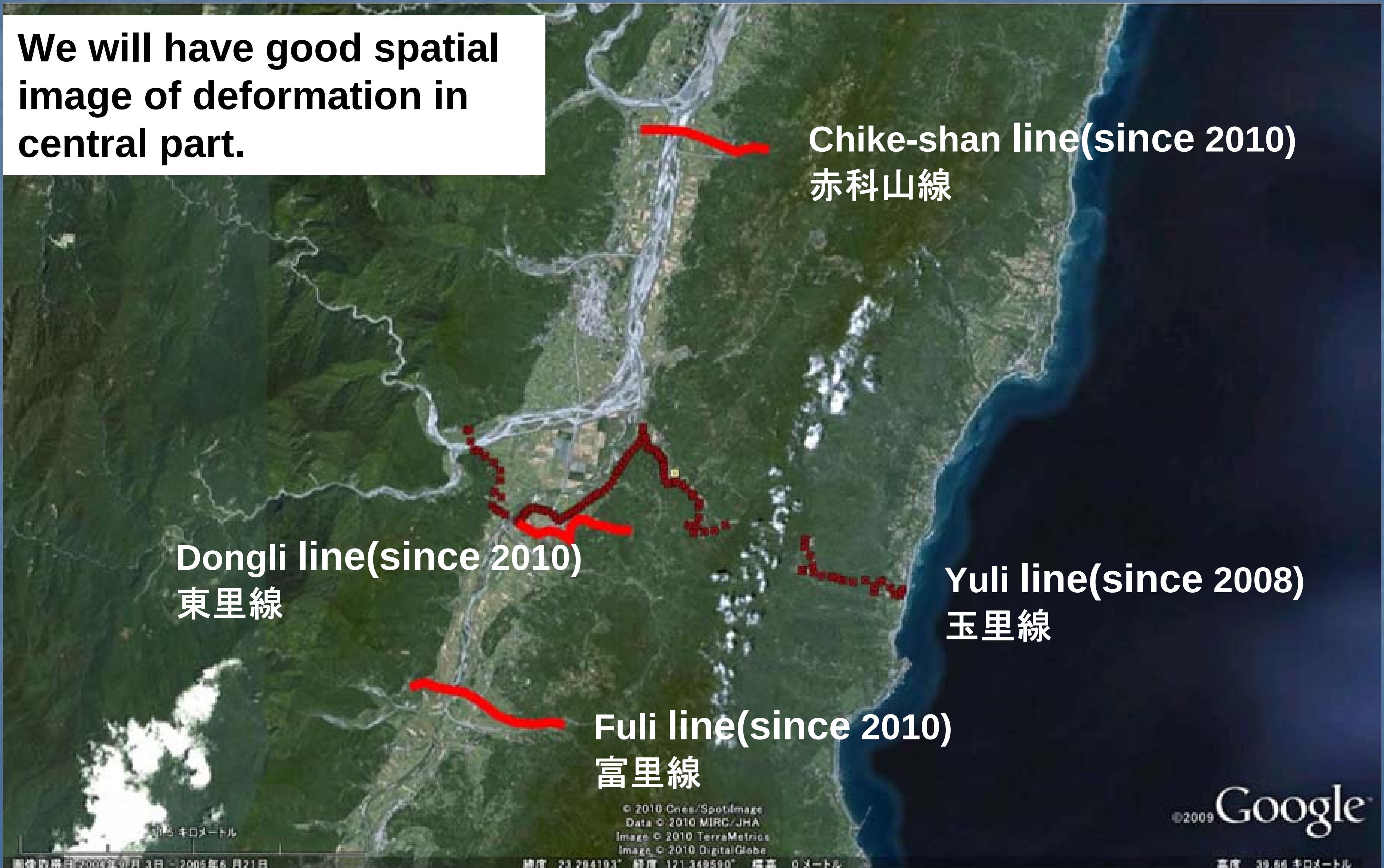


Dr.Matta checked the deformation in this area using the photogrammetric method.

Next year, He will compare it with leveling result.

Improvement of spatial image of deformation

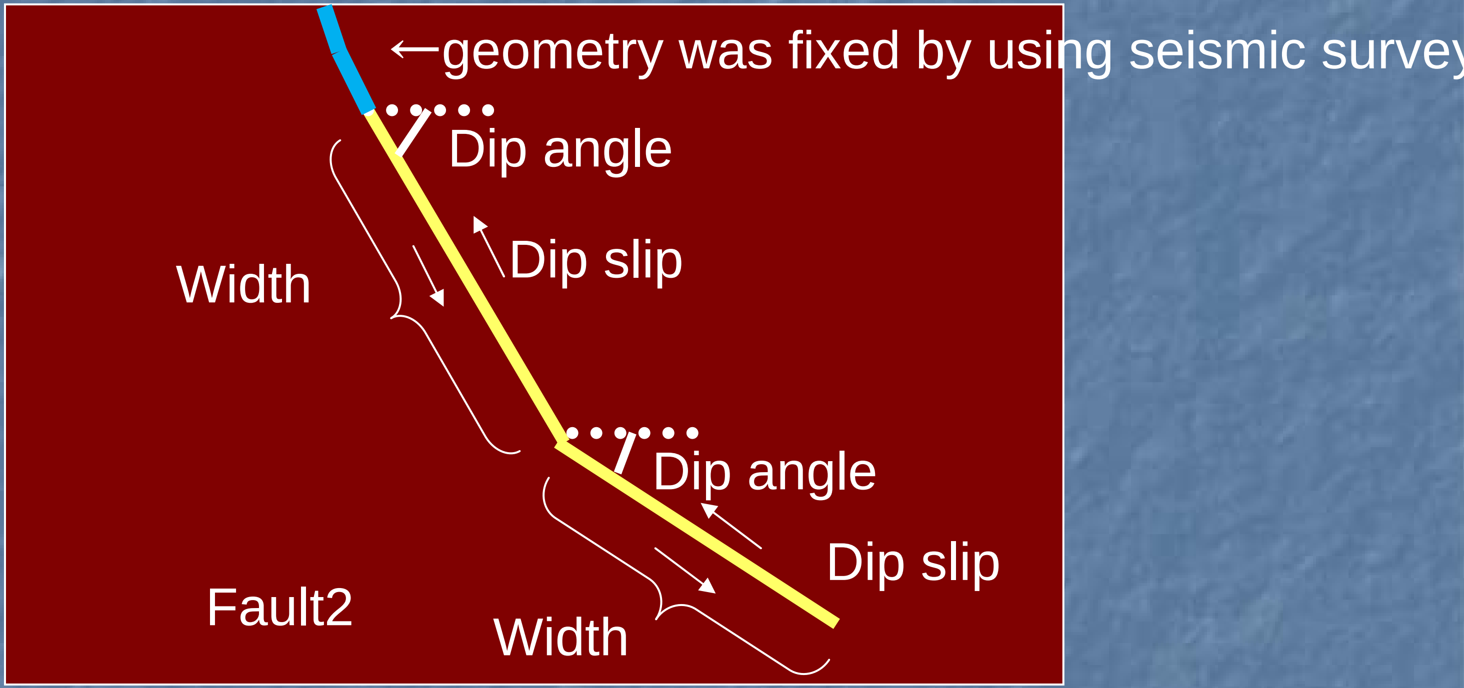
We will have good spatial image of deformation in central part.



Model setting1

We adopted a two-dimensional reverse fault model.

Fault parameters

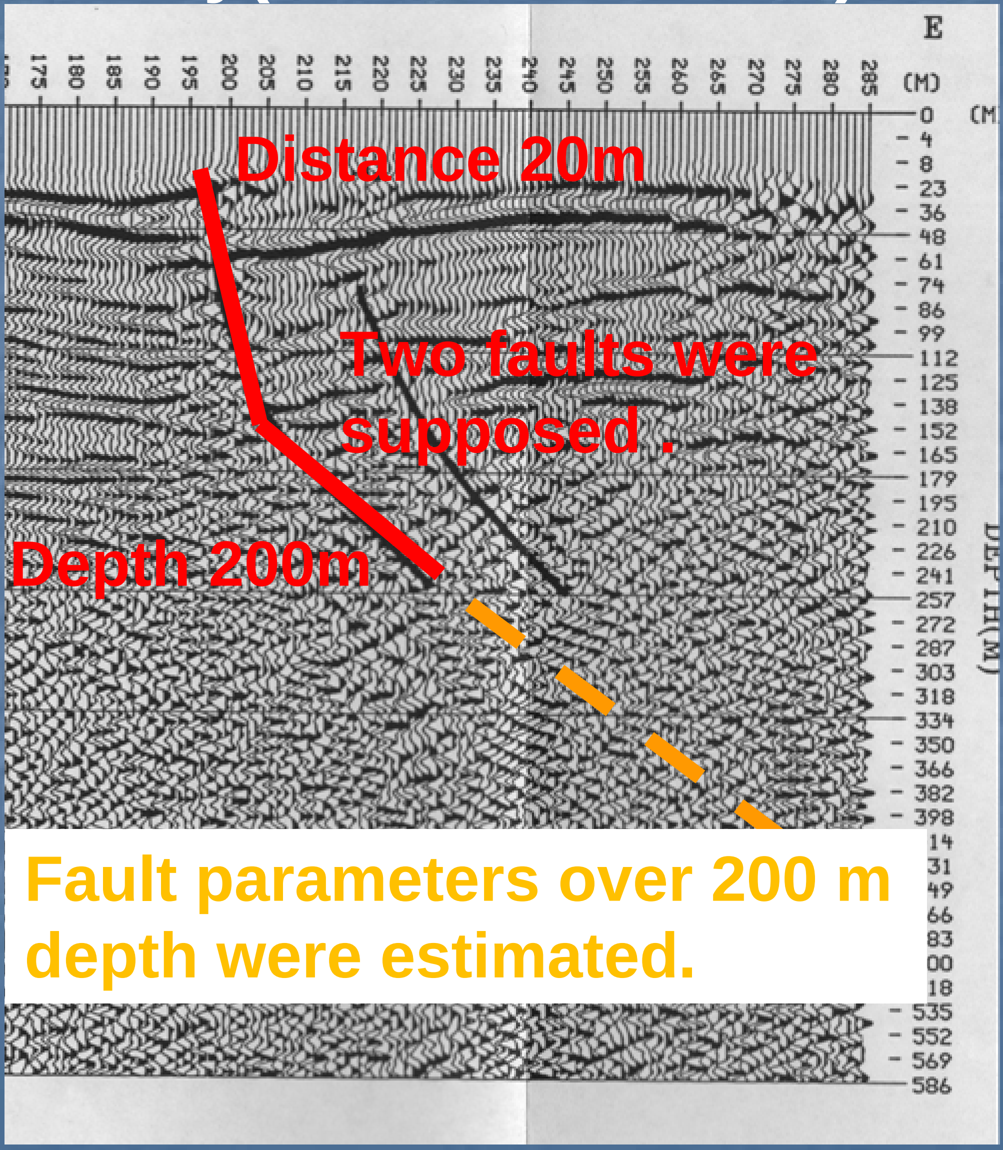


Fault parameters over 200 m depth were estimated using Genetic Algorithm

Shallow part of the fault geometry

Seismic reflection survey(Chen et al. 2010)

The location of seismic reflection survey



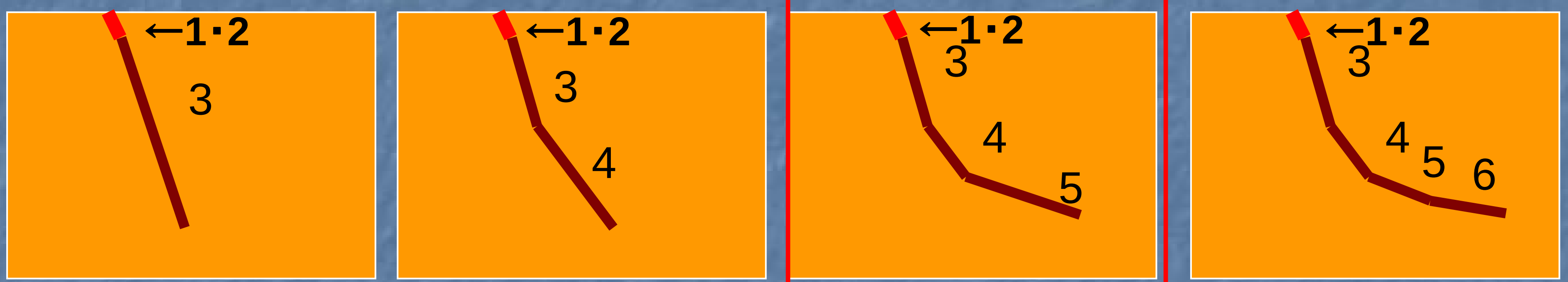
Fault parameters over 200 m depth were estimated.

Model setting 2

We assumed four types of fault model.

We determined best model based on Akaike's information criteria (AIC).

3 faults **4 faults** **5 faults** **6 faults**



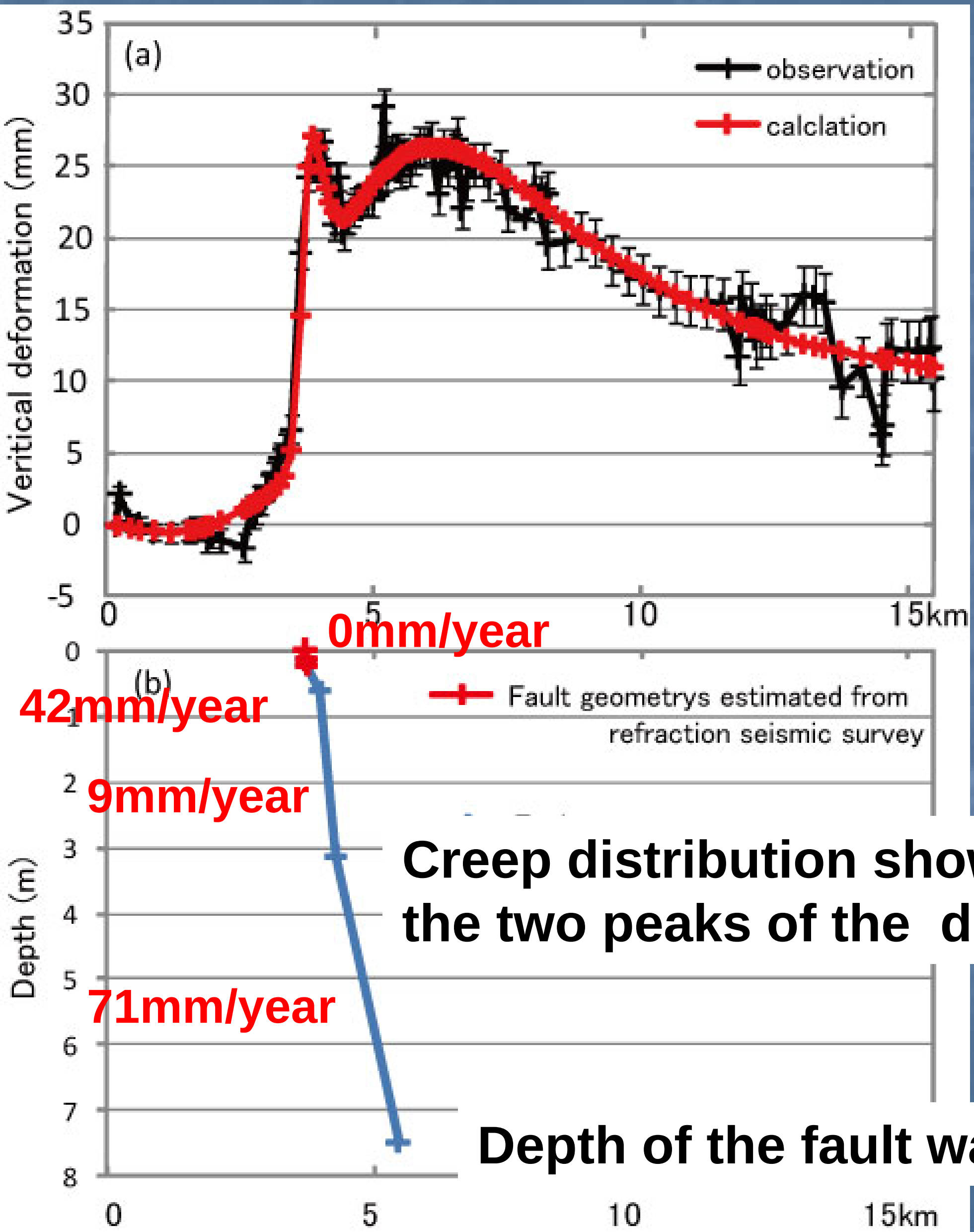
AIC values

3 faults	4 faults	5 faults	6 faults
478	470	397	605

Best model

5 faults model is selected as optimal model by AIC

Optimal model

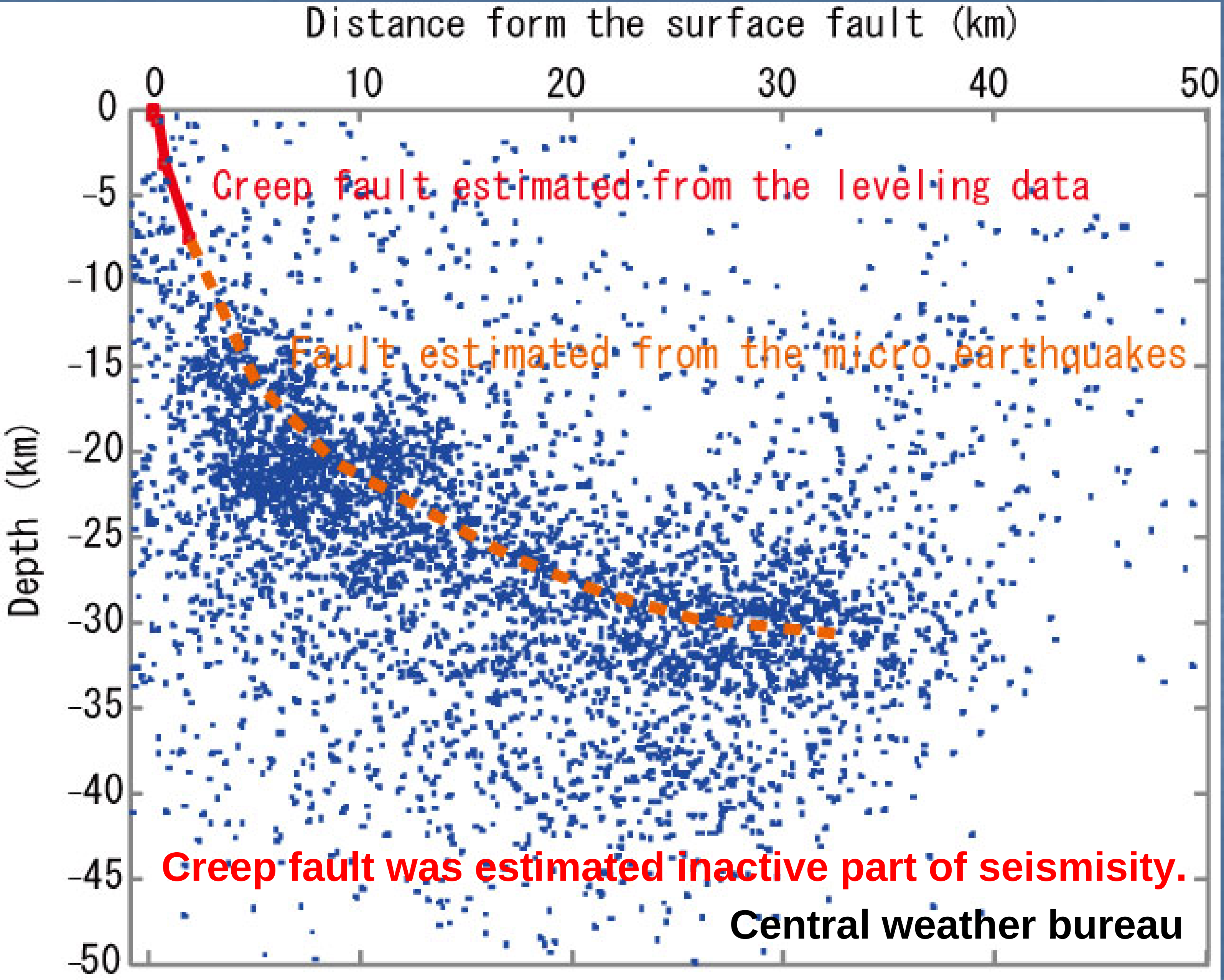


fault1	dip slip (mm/year)	0
fault2	dip slip (mm/year)	0
fault3	Width (m)	500
	dip angle (degree)	−55
	dip slip (mm/year)	42
fault4	Width (m)	2500
	dip angle (degree)	−85
	dip slip [illegible]	9
fault5	[illegible]	[illegible]500
	dip angle (degree)	−75
	[illegible] (mm/year)	71

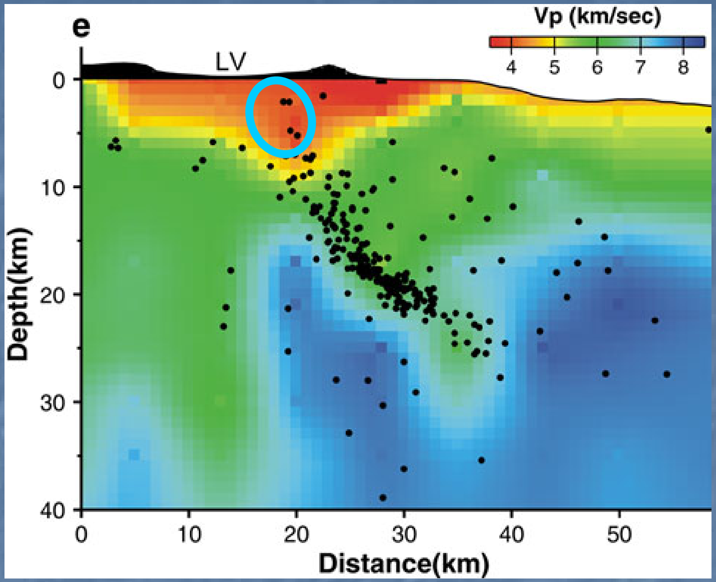
Creep distribution shows complex pattern to explain the two peaks of the deformation

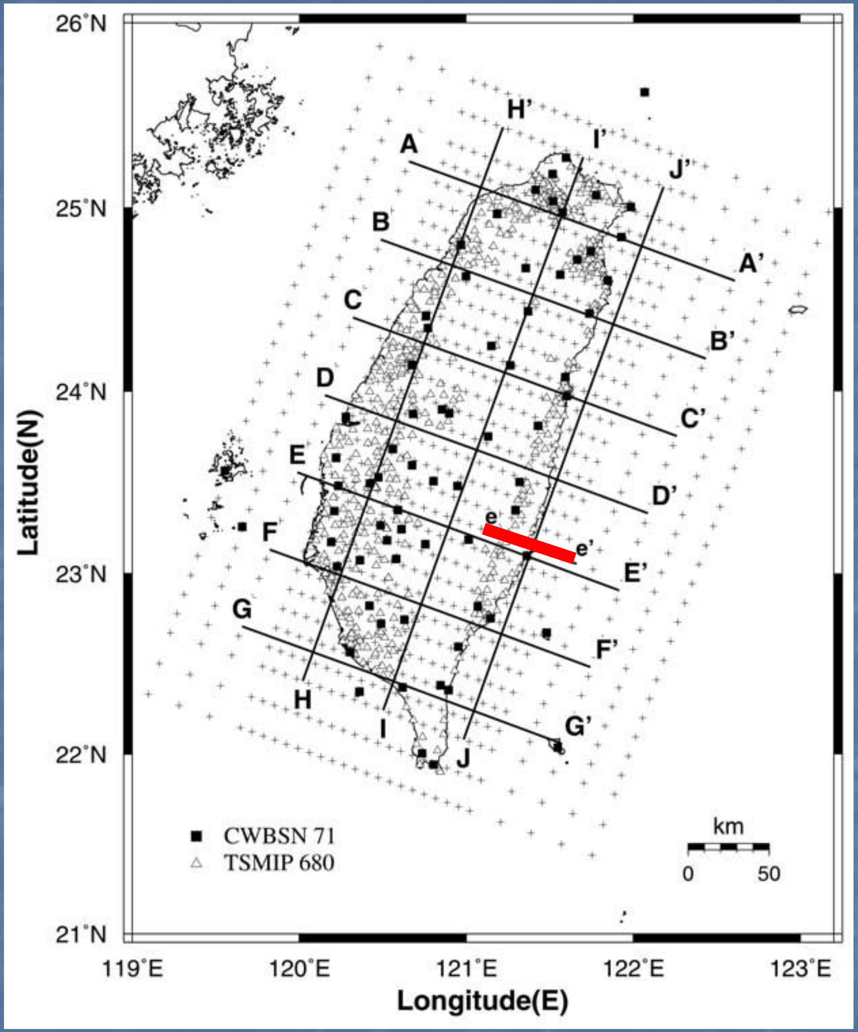
Depth of the fault was estimated to be 7.5 km

Geometry of fault and micro-earthquakes



Comparison with P-wave tomography



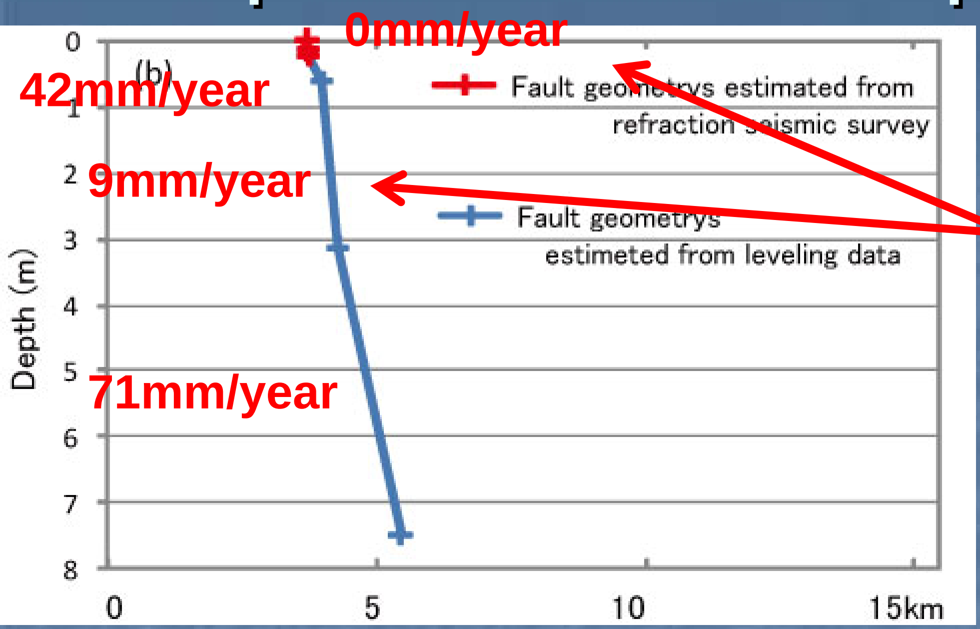


•Low P velocity zone shallower than 10km (Wu et al.,2007)

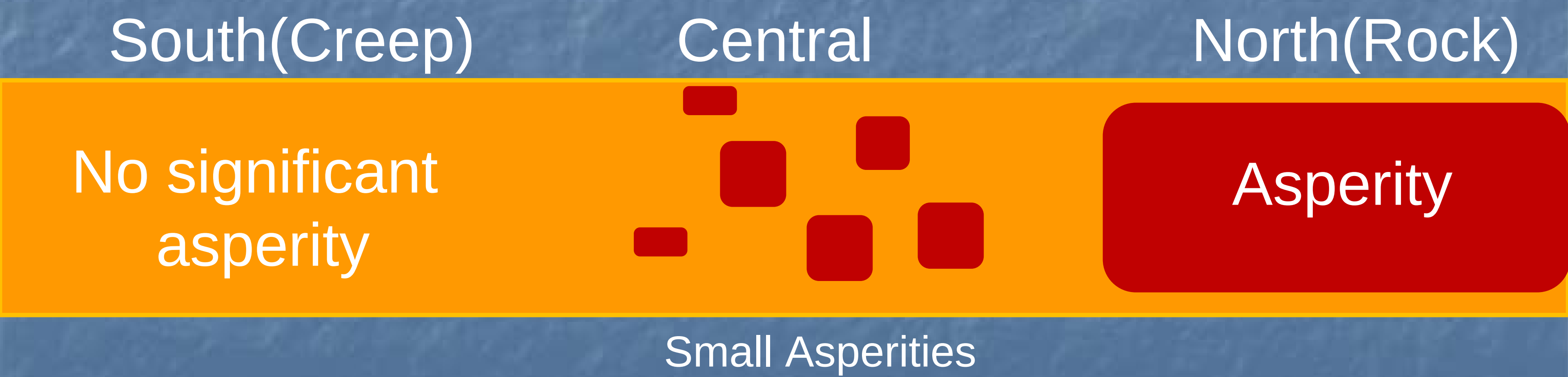
•Creeping area estimated the leveling is shallower than 7.5km.

Creep area may be composed of water rich and soft objects.
One possibility of the object is the tectonic melange.

Interpretation of complex creep distribution



The parts with small amount of the creep may mean small asperities.



Some small asperities may exist in the central part.

Summary

•Four leveling routes are established in Yuli area.

•The vertical deformation of about 3cm/year were detected by the precise leveling survey in the period from 2008 to 2010.

•The two-dimensional model with five reverse faults were estimated as a optimal model.

•Creeping area is estimated to be shallower than 7.5 km.

•Some small asperities may exist in the central part.