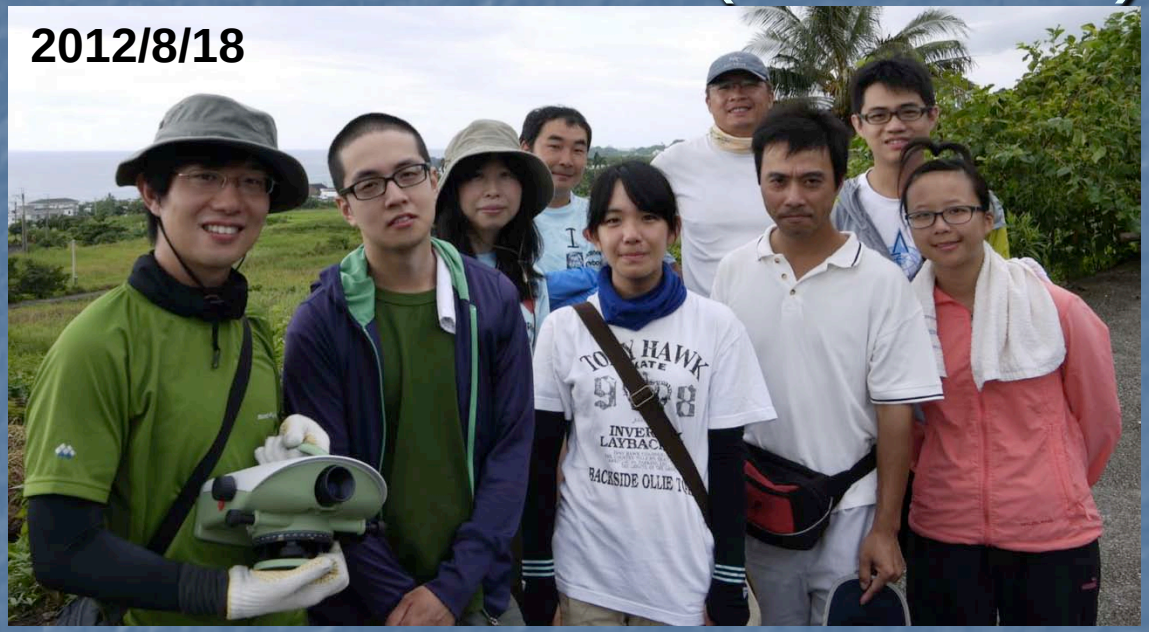
A preliminary report on the large aseismic creep detected by precise leveling survey at the central part of the Longitudinal valley fault, Southeast Taiwan (2008-2012)



Masayuki Murase(Nihon Univ., Japan),
Nobuhisa Matta (Nagoya Univ., Japan),
Cheng-Horng Lin（Academia Sinica, Taiwan）,
Wen-shan Chen （National Taiwan Univ., Taiwan),
Naoji Koizumi (AIST,Japan)

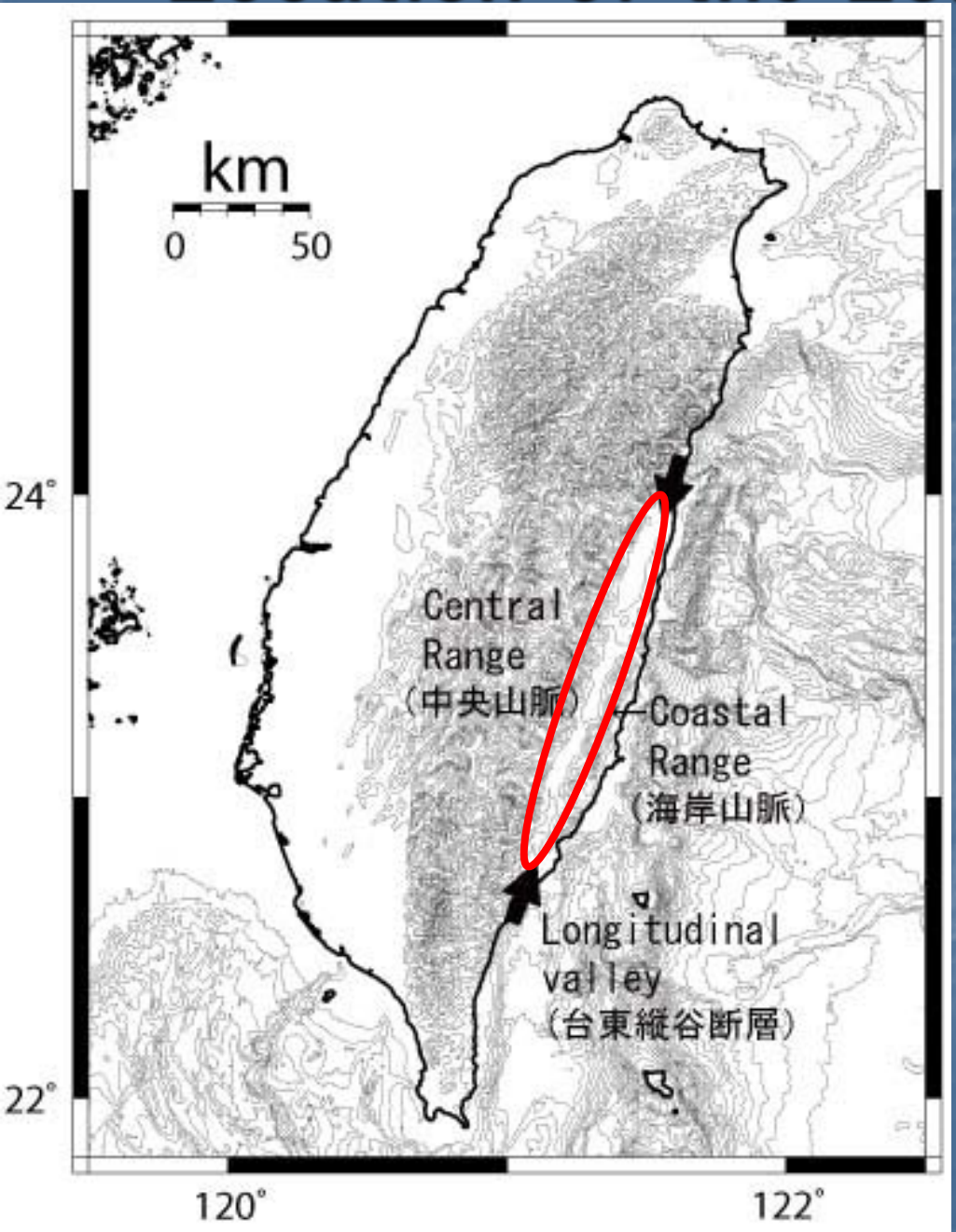
Outline of our presentation

1. Introduction of
   the longitudinal valley fault (LVF)

2. Precise leveling survey
   in the central part of LVF

3. The vertical deformation of LVF
   (preliminary result)

Location of the Longitudinal valley



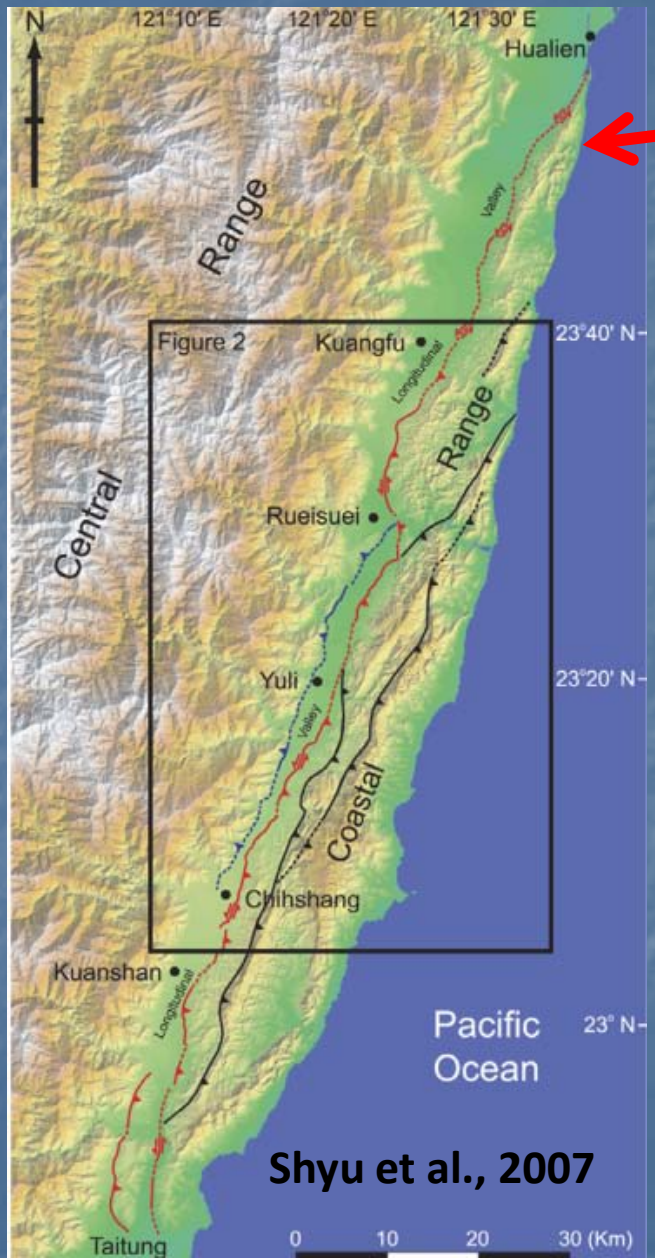
Longitudinal valley (台東縱谷)

Taiwan has two mountain ranges.

The longitudinal valley is narrow valley sandwiched in between two ranges.

The length of the valley is about 150km.

Location of the Longitudinal valley fault



Longitudinal valley fault (LVF) (Reverse fault)

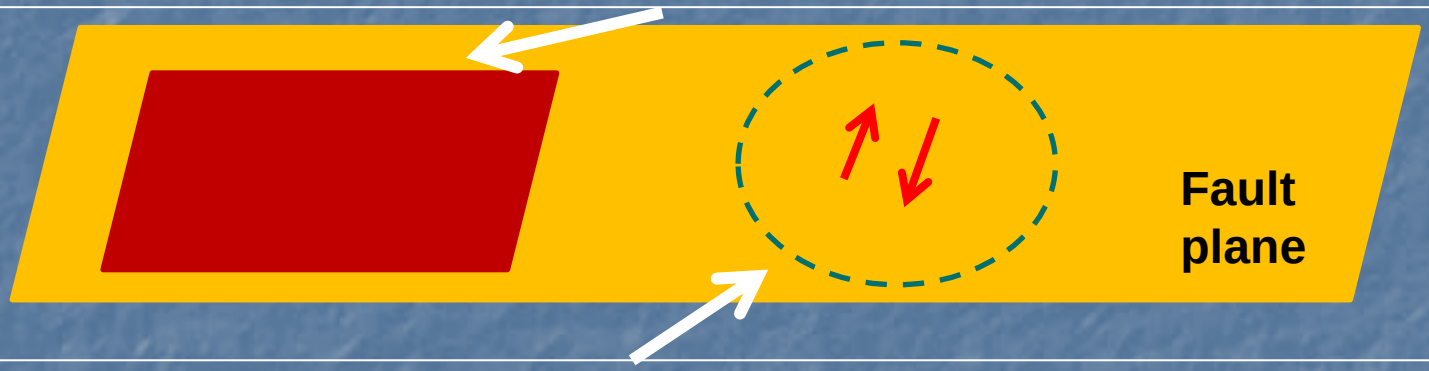
collision boundary between the Eurasian plate and Philippine sea plate.

Based on GPS, It become clear that the south LVF is creeping aseismically.

Locked section and creeping section

Fault may be classified into two sections, Locked section and creeping section.

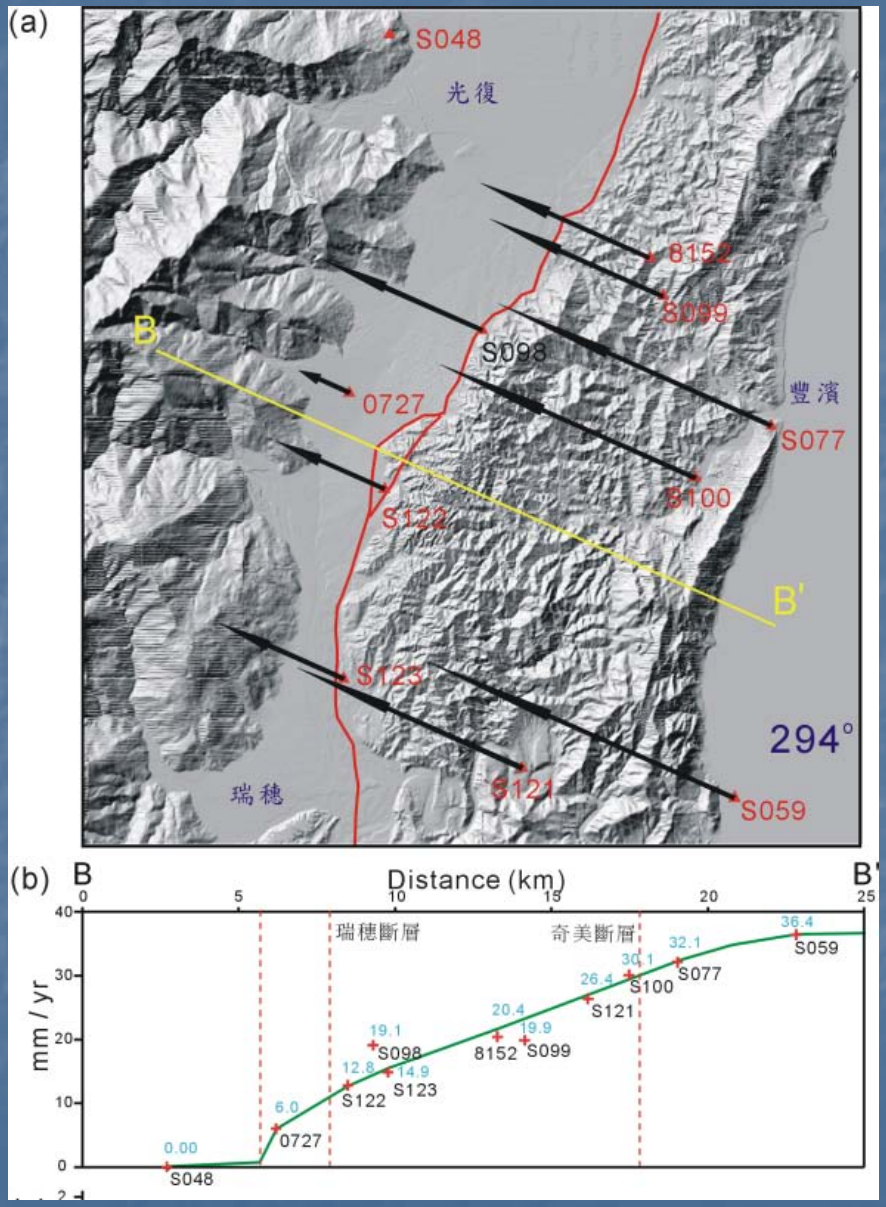
Locked section (Asperity):
This segment accumulate strain in the inter-seismic period and have large slip when earthquake occur.
Small or no deformation will be expected near the fault in the inter-seismic period .



Creeping section:
This section does not accumulate strain, due to have a aseismic creep in the inter-seismic period.
Large earthquake may be unable to occur in this section.
Large deformation will be expected near the fault in the inter-seismic period .

Deformation of North LVF

GPS 1992–1999



Wen-shan Chen et al., 2007)

Horizontal deformation projected perpendicular to the fault:

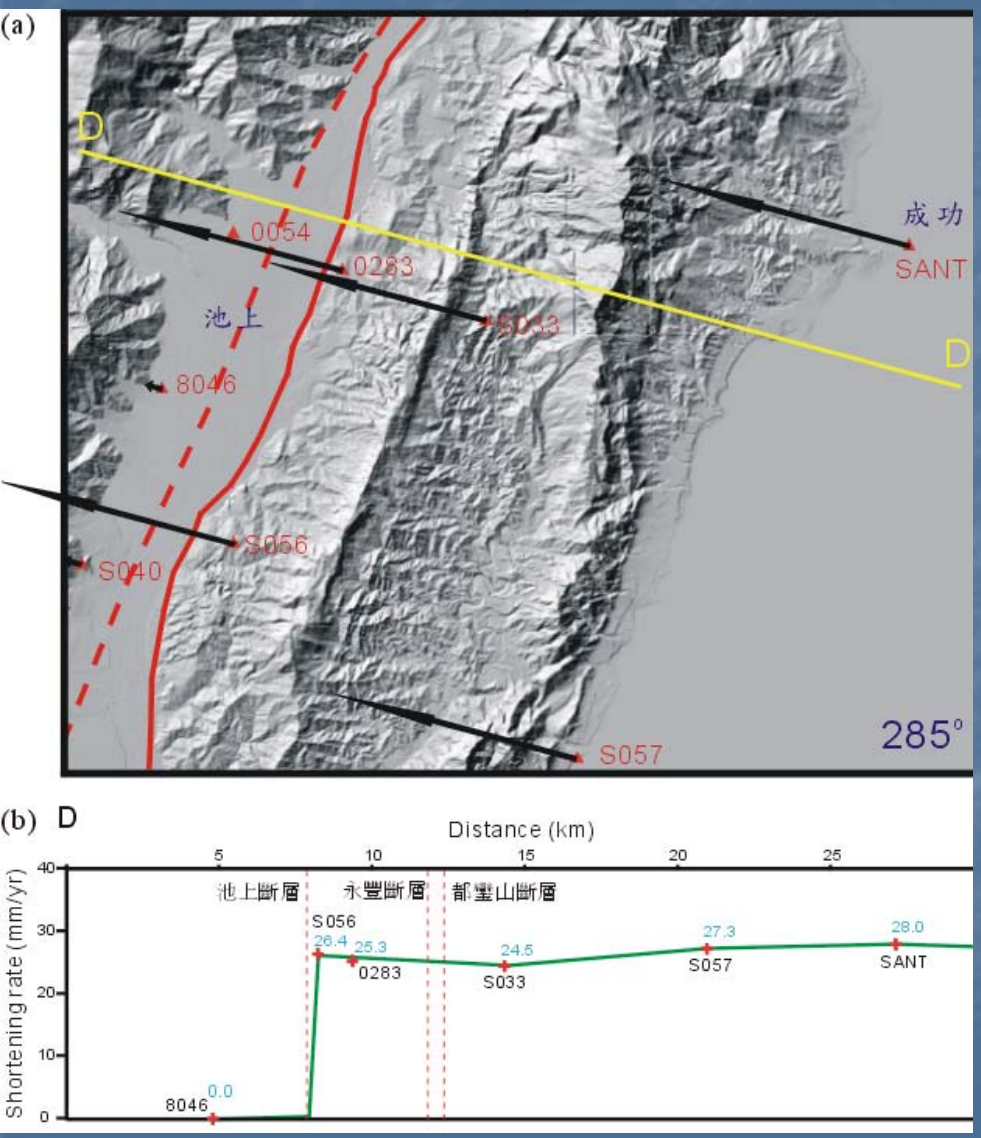
Smooth curve
Small deformation near fault

↓

Fault at north part is rocked and accumulate strain.

Deformation of South LVF

GPS1992-1999



Horizontal deformation projected perpendicular to the fault:

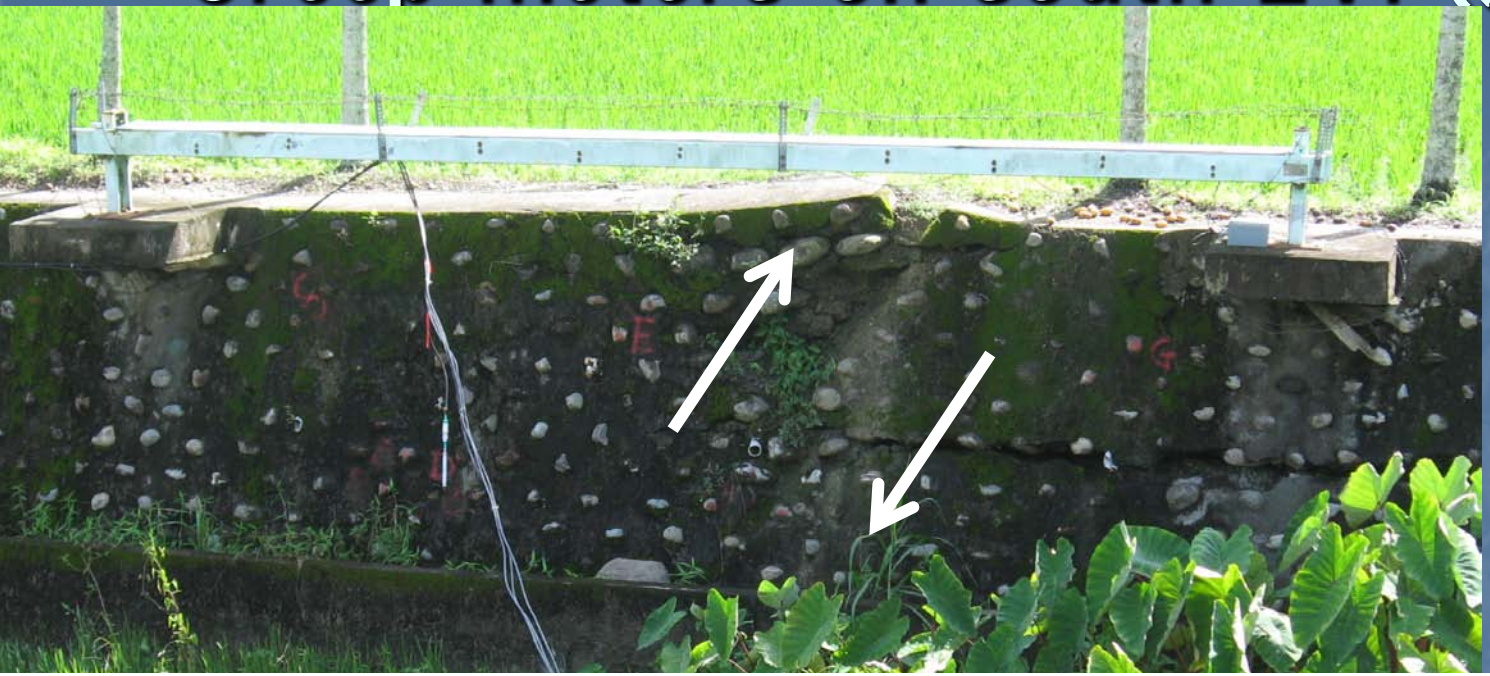
Drastic change near the fault

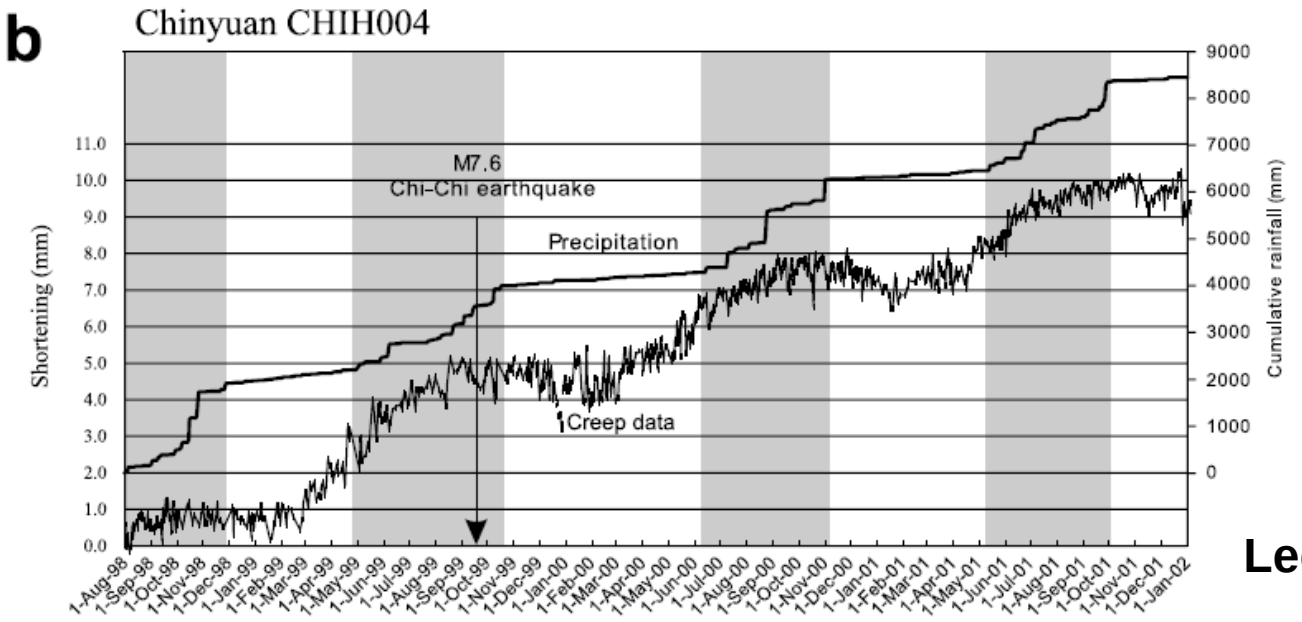
↓

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

Wen-shan Chen et al., 2007)

Creep meters on south LVF(池上)

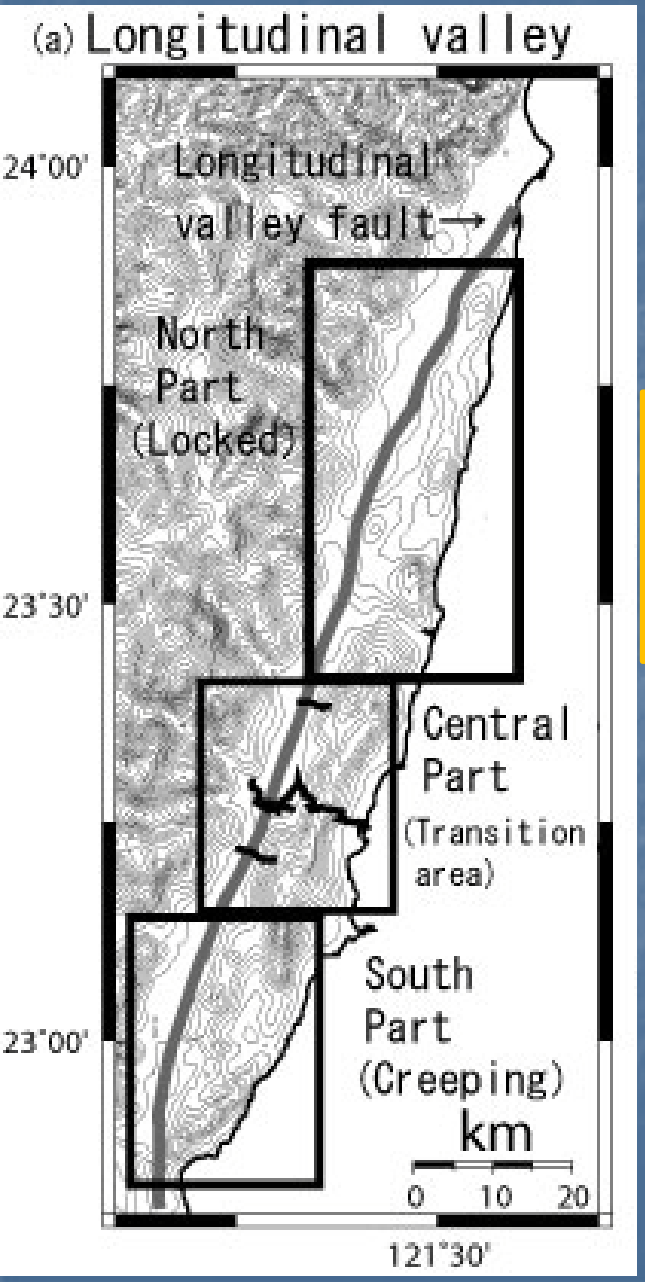




1999-2001
Total shortening:
9.0 mm
Average rate:
3.0 mm/yr

Lee et al.(2003)

Purpose of our research



Difference of deformation patterns between north and south.

- **North segment may be locked.**
- **South segment may be creeping.**

South(Creep) Central North(Rock)

No significant asperity ? Asperity

Nobody knows the detail deformation of the central part of LVF.

We want to know what kind of deformation occur In the central LVF. And we want to make clear where is the northern end of creeping area.

Precise Leveling

Repeatability of the precise leveling is better than that of GPS.
Only the vertical deformation is detected.

LVF is reverse fault

↓

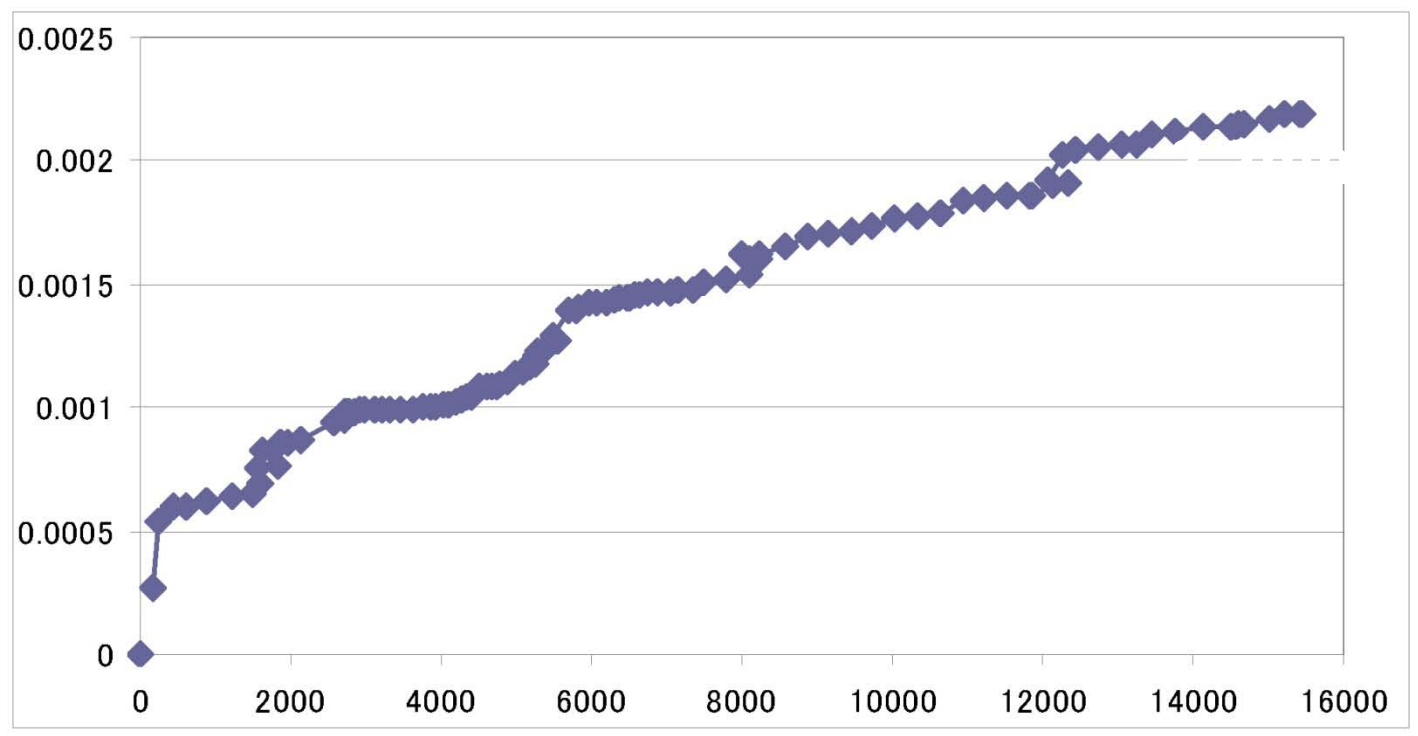
Large vertical deformation will be expected.

It is an advantage to make the leveling!

Closing error

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

Closing error referred to BM90 (2008 data)



Maximum of about 2.2mm

We detected vertical deformation with high accuracy.

Our benchmarks

The small nail was used as benchmark.

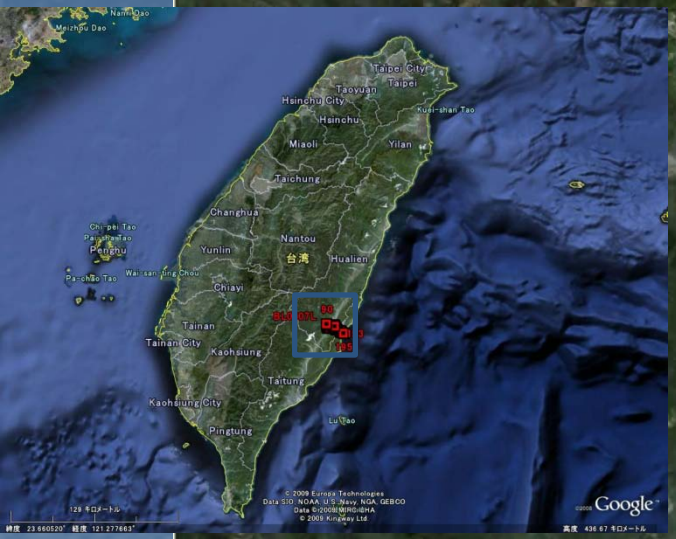
↓

It is very easy to make dense network

Yuli line

- **123 benchmarks were installed on the Yuli line.**
- **The installation interval of benchmarks near the fault area is about 100 m.**

Leveling lines in the central part of LVF



Reishuei line(since 2011)
瑞穂路線

Chike-shan line(since 2010)
赤科山路線

Yuli line(since 2008)
玉里路線

Dongli line(since 2010)
東里路線

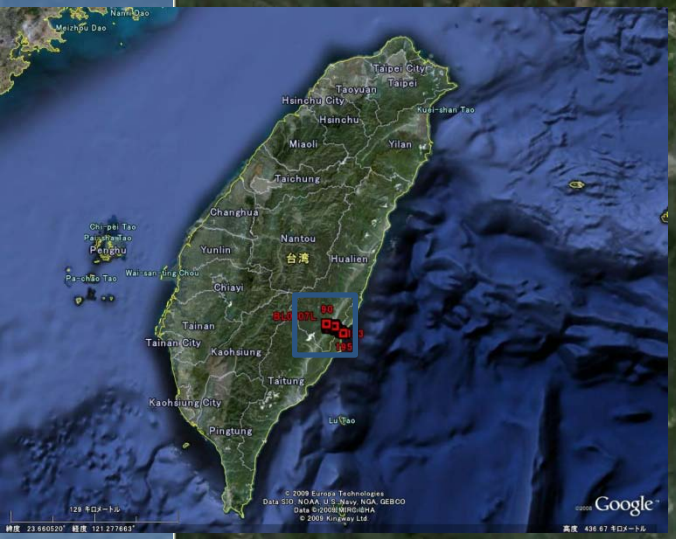
DongChu line(since 2011)
東竹路線

Fuli line(since 2010)
富里路線

10.2 km

Google

Leveling lines in the central part of LVF



Reishuei line(since 2011)
瑞穂路線

Chike-shan line(since 2010)
赤科山路線

Yuli line(since 2008)
玉里路線

Dongli line(since 2010)
東里路線

DongChu line(since 2011)
東竹路線

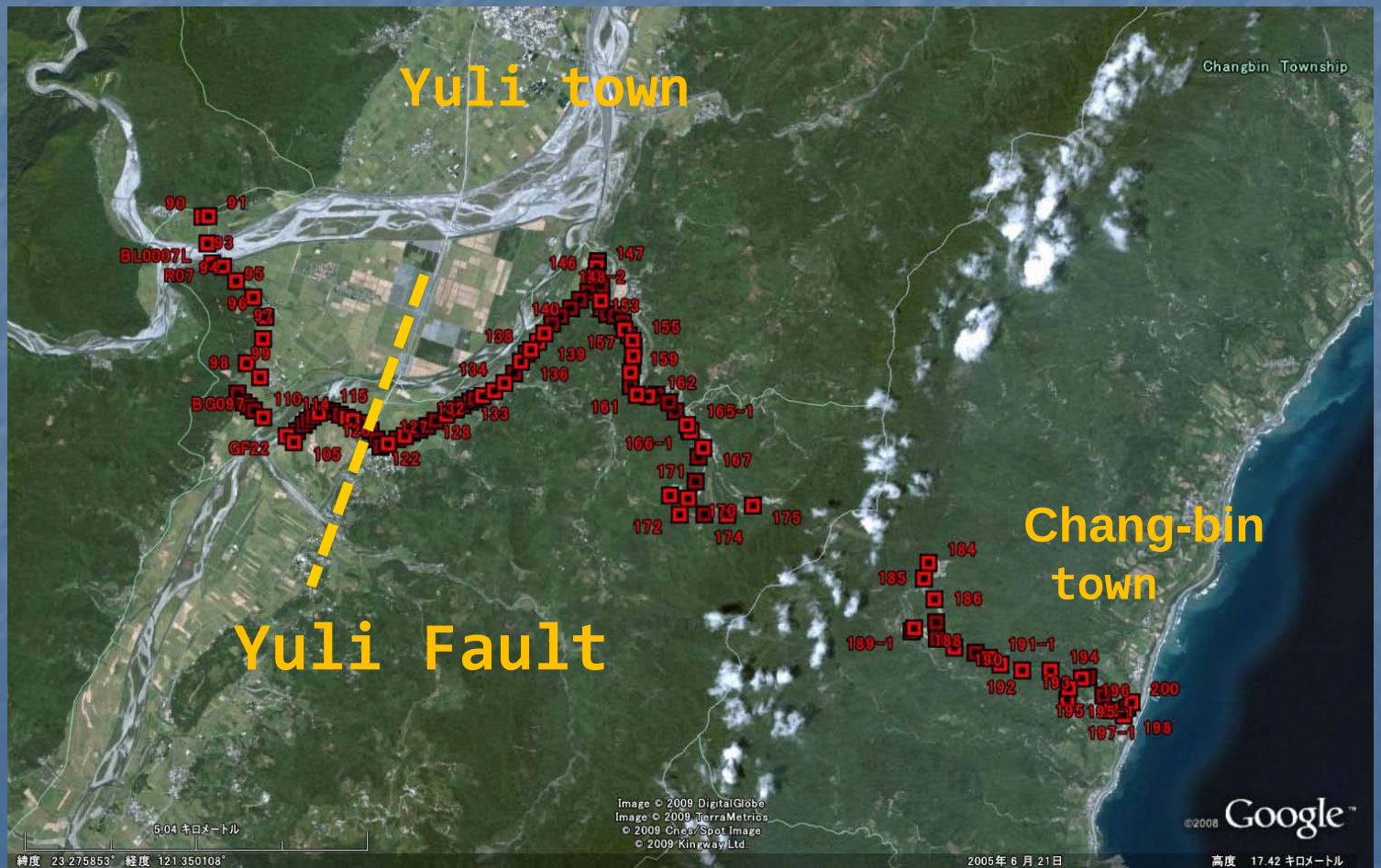
Fuli line(since 2010)
富里路線

10.2 km

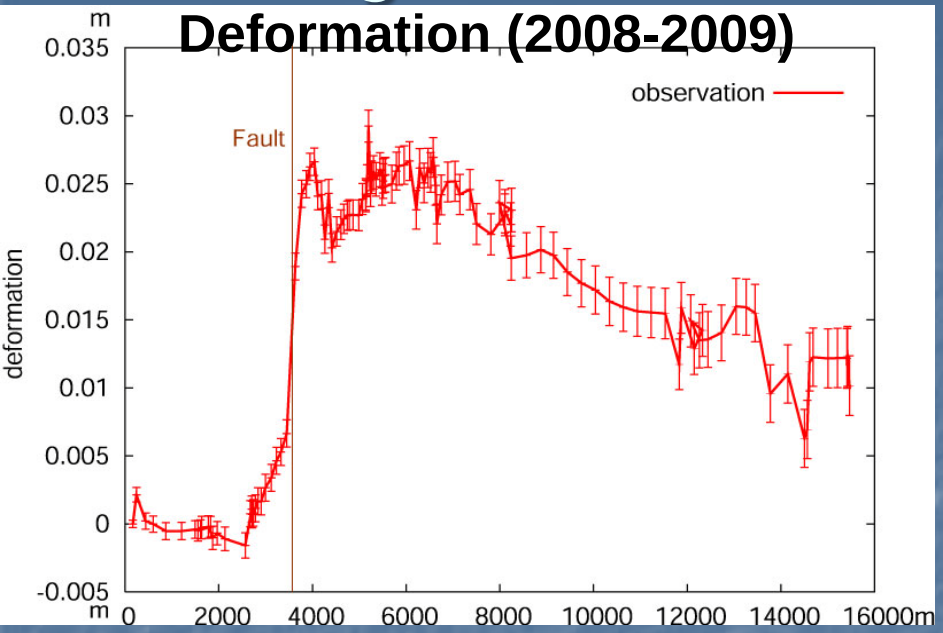
Google

Leveling survey at Yuli line

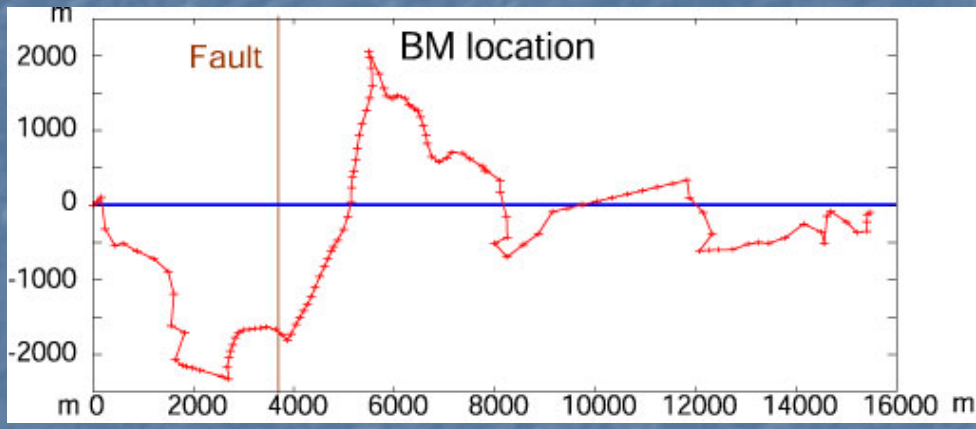
- about 30km leveling route
- observation : Aug.2008, Aug.2009, Aug.2010, Aug.2011, Aug.2012



Projection on fault perpendicular

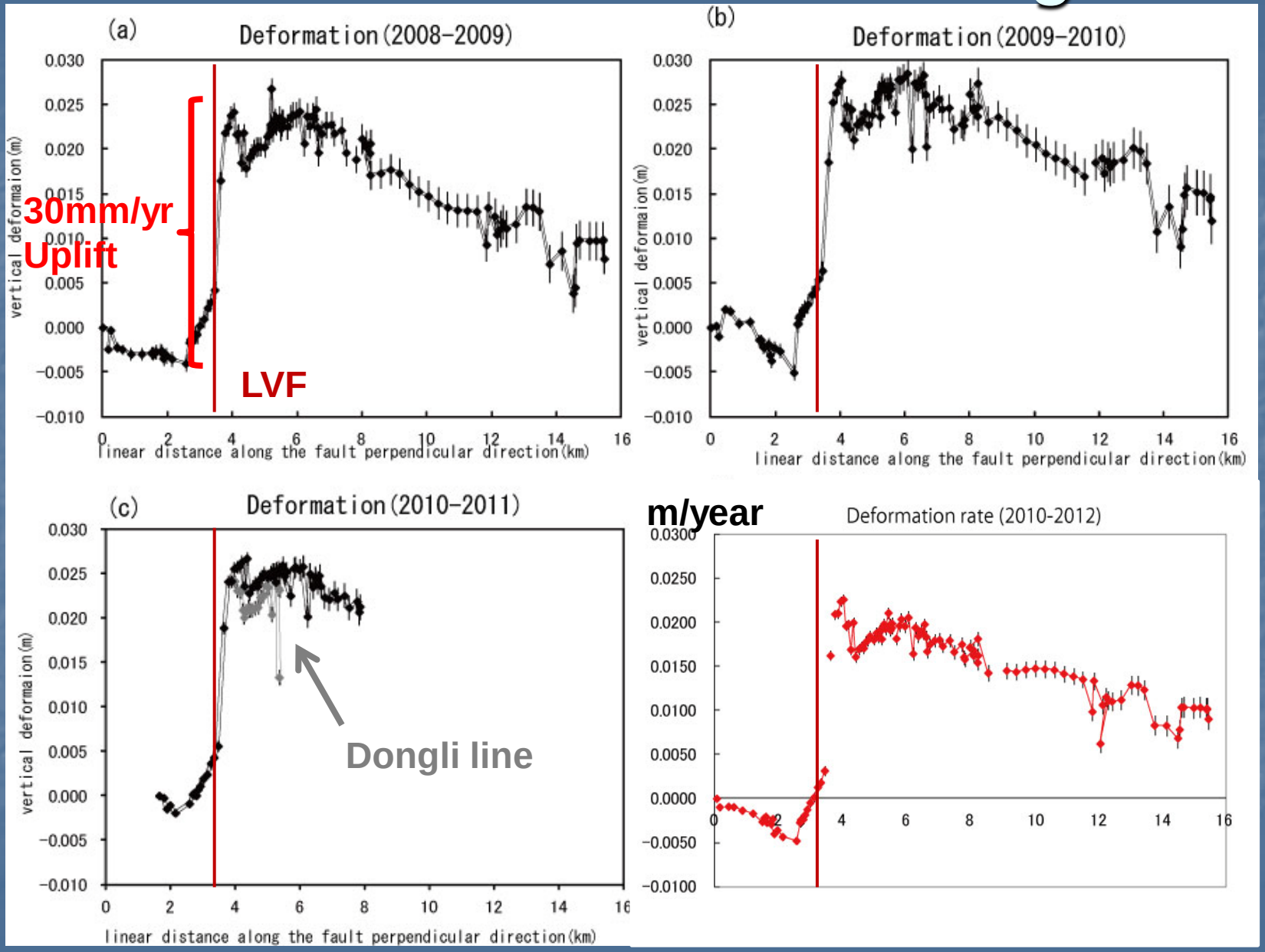


Deformation is projected to fault perpendicular direction



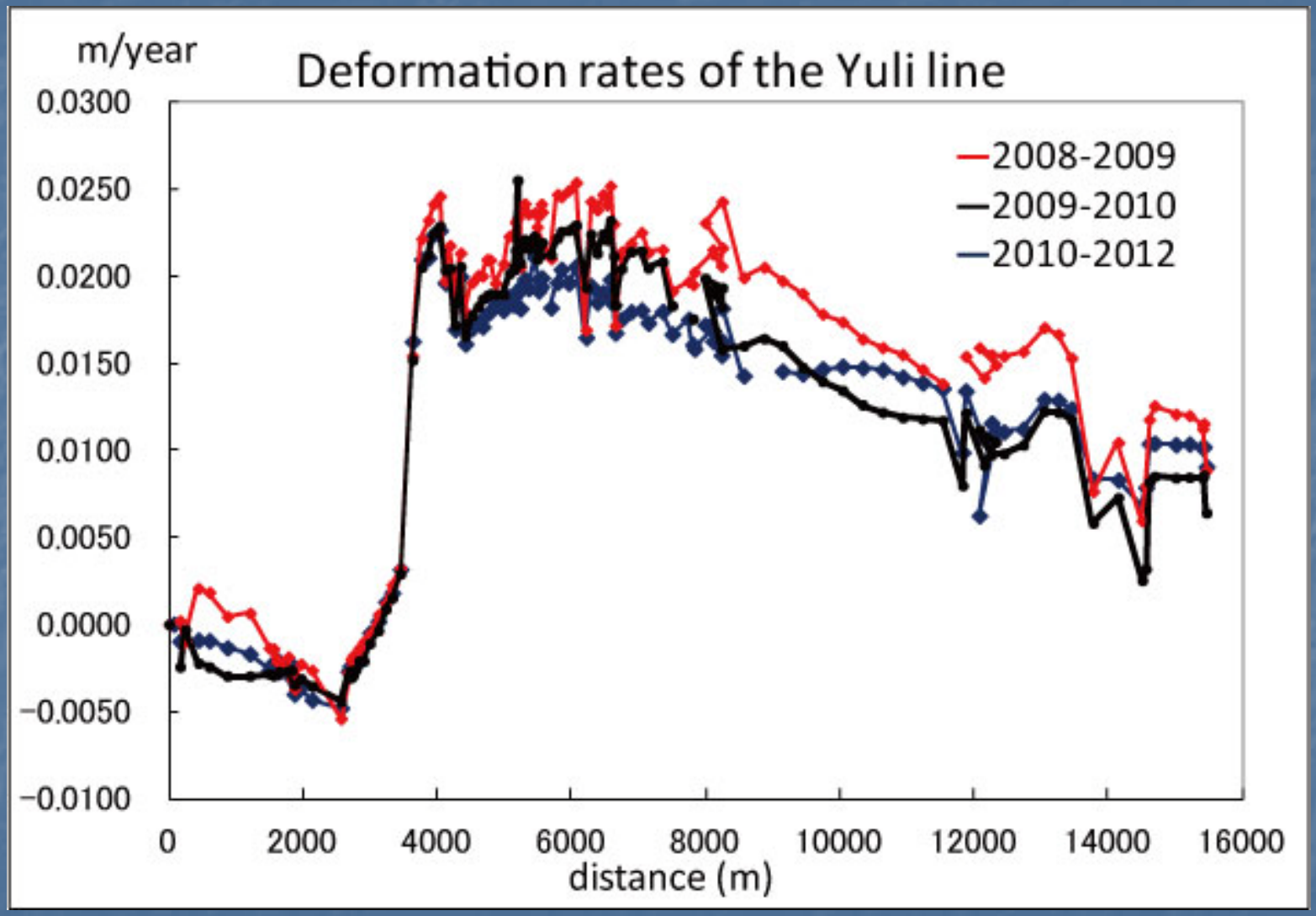
↑the linear distance along the fault perpendicular direction from west end of the leveling line.

Deformations of Yuli and Dongli lines



Large creep of 3 cm/year occur just close to the LVF in Yuli

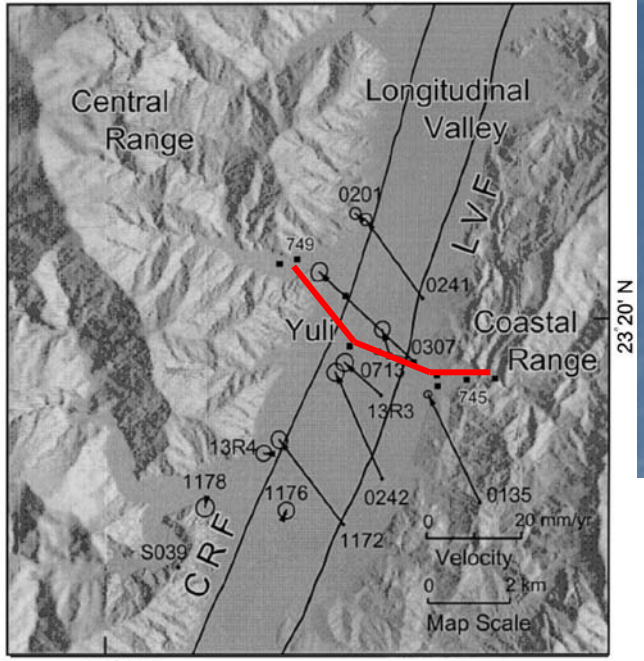
Deformations of Yuli lines

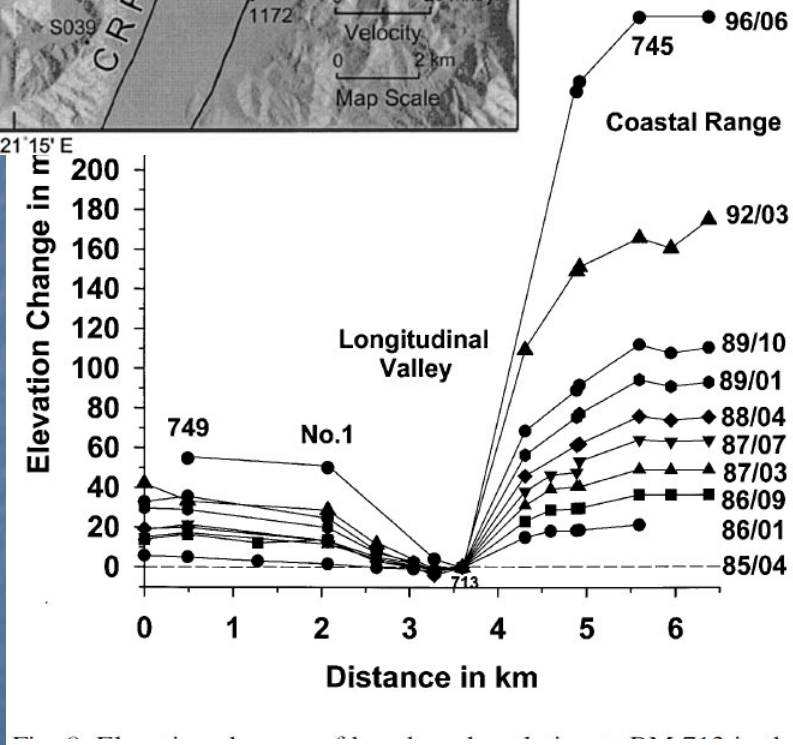


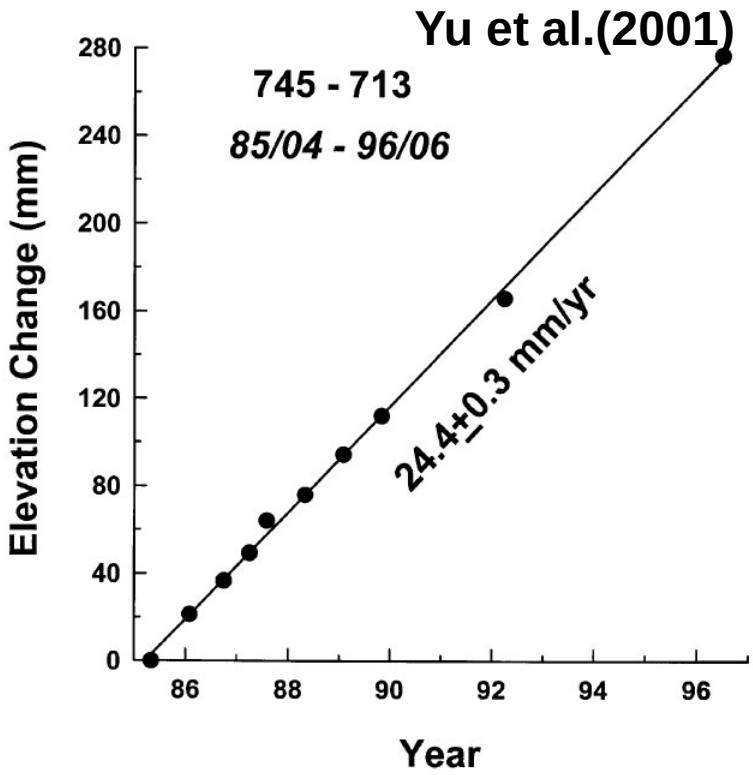
Deformation patterns observed in 3 period are almost same within observed error.

Steady creep with constant rate

Yu et al.(2001) conducted leveling survey of 5 km line for 11 years and show the steady creep with constant rate.



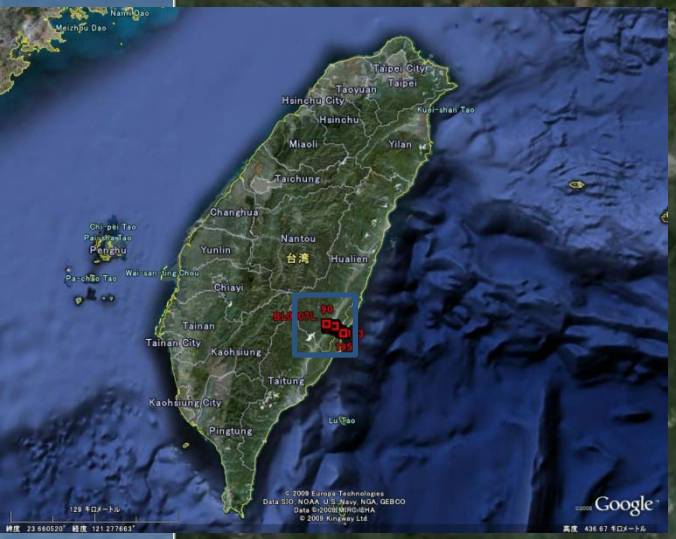




Our result is consistent with the result of Yu et al.(2001)

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

Leveling lines in the central part of LVF



Reishuei line(since 2011)
瑞穂路線

Chike-shan line(since 2010)
赤科山路線

Yuli line(since 2008)
玉里路線

Dongli line(since 2010)
東里路線

DongChu line(since 2011)
東竹路線

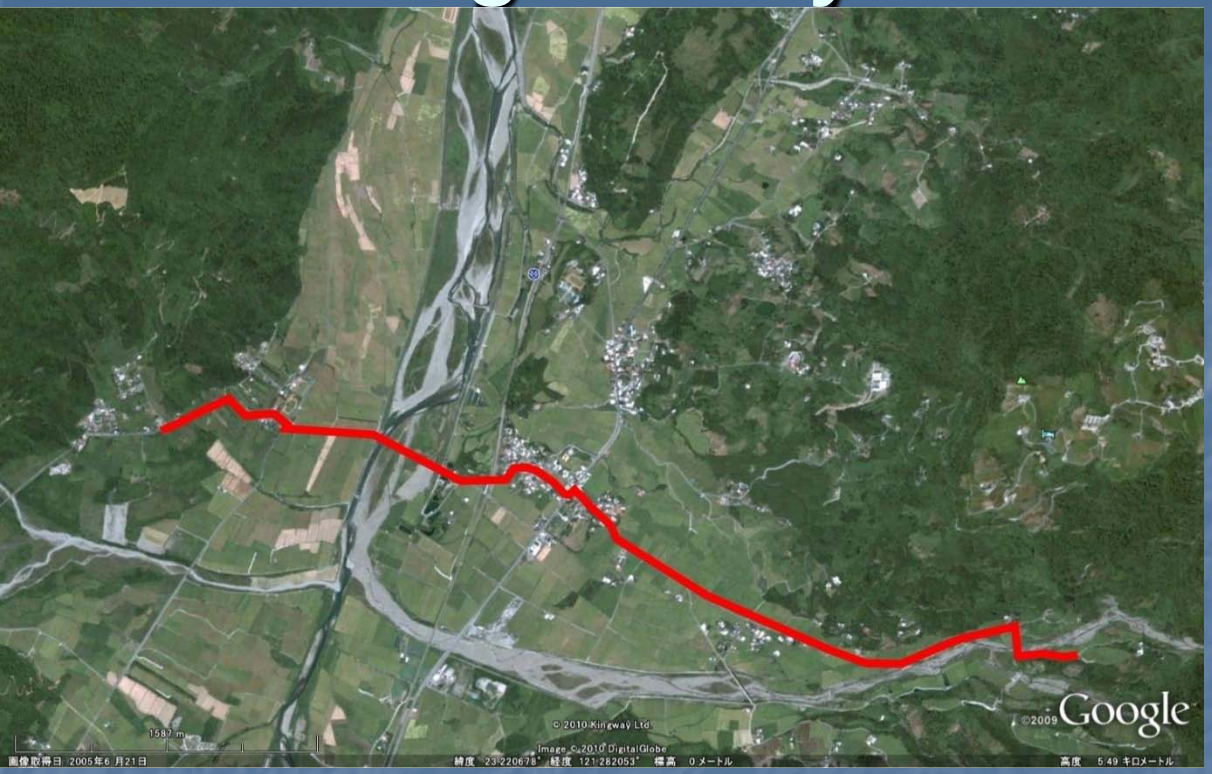
Fuli line(since 2010)
富里路線

10.2 km

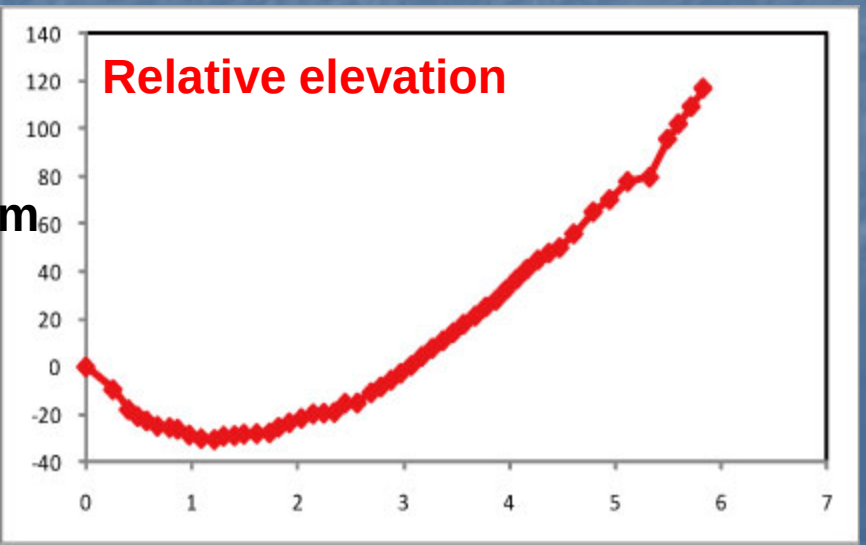
Image © 2012 TerraMetrics
Image © 2012 GeoEye
Image © 2012 DigitalGlobe

Google

Leveling survey at Fuli line(富里線)

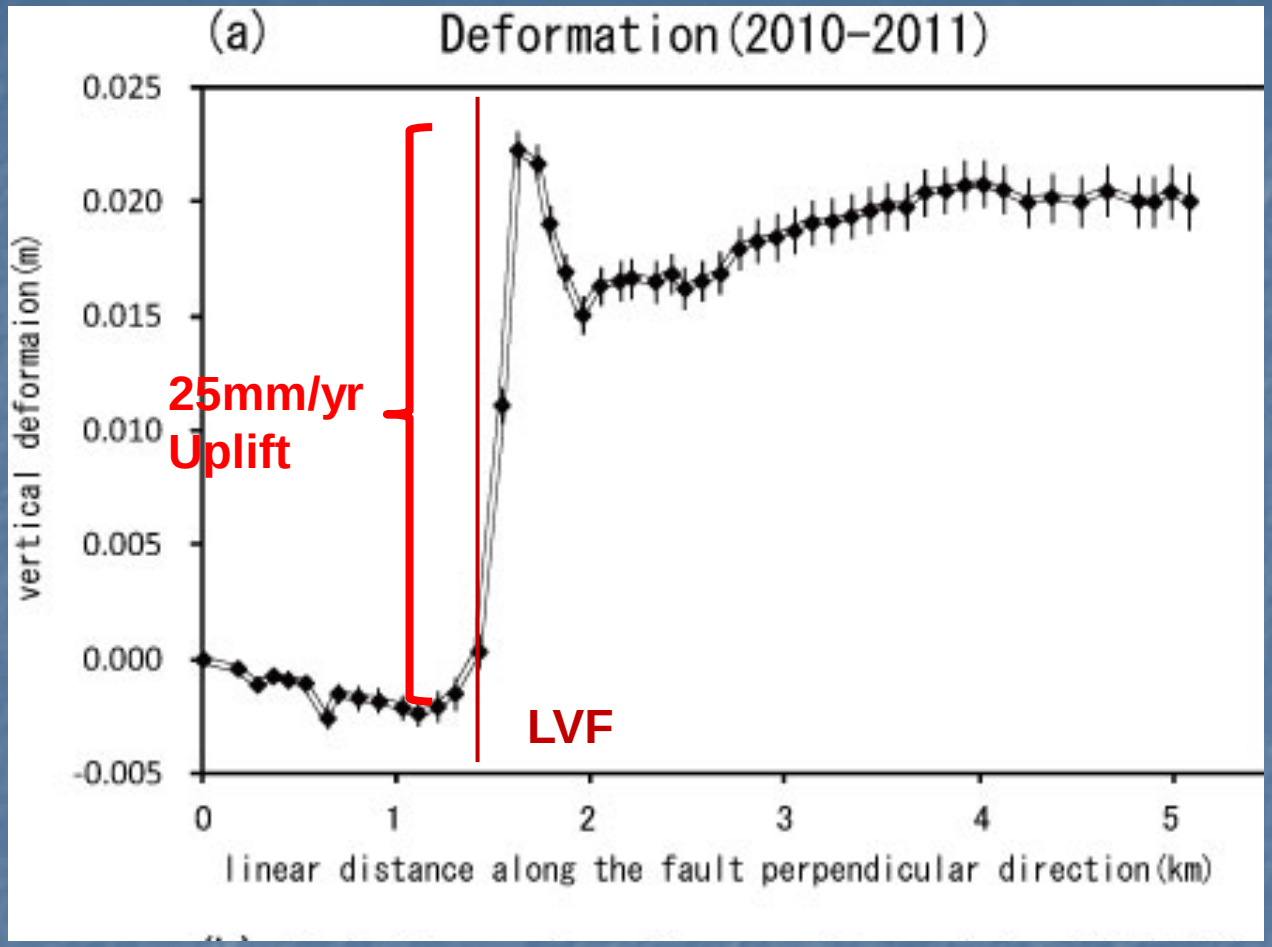


6 km leveling route.



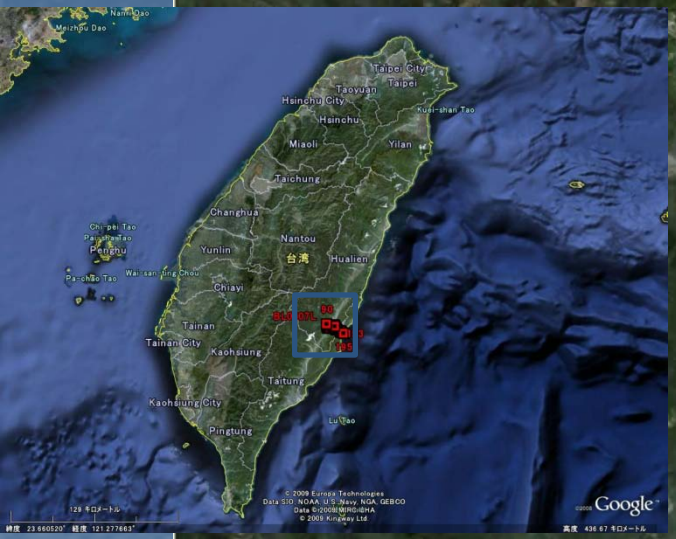
We surveyed in
Aug.2010 and Aug.2011

Deformation of the Fuli line



The vertical deformation of about 25mm/year Deformation rate is very larege and similar with that of the Yuli line.

Leveling lines in the central part of LVF



Reishuei line(since 2011)
瑞穂路線

Chike-shan line(since 2010)
赤科山路線

Yuli line(since 2008)
玉里路線

Dongli line(since 2010)
東里路線

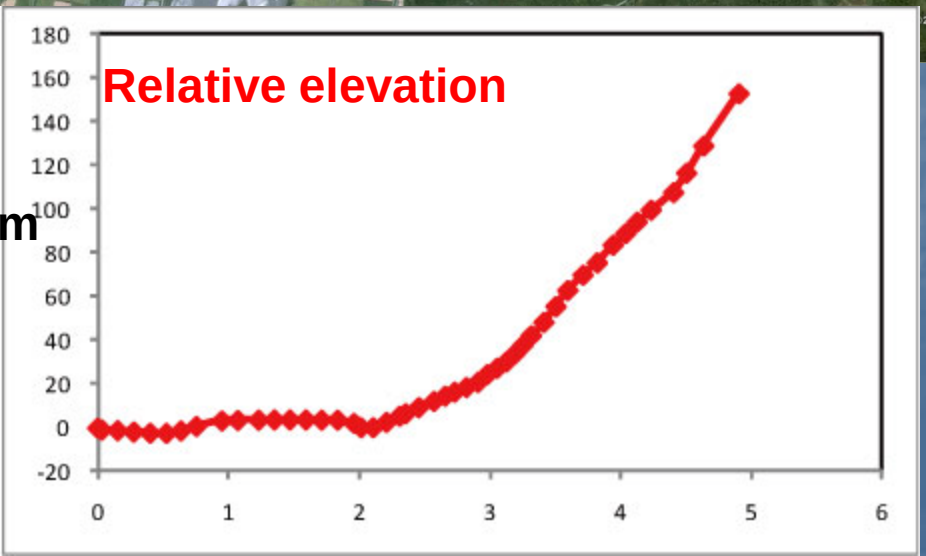
DongChu line(since 2011)
東竹路線

Fuli line(since 2010)
富里路線

10.2 km

Google

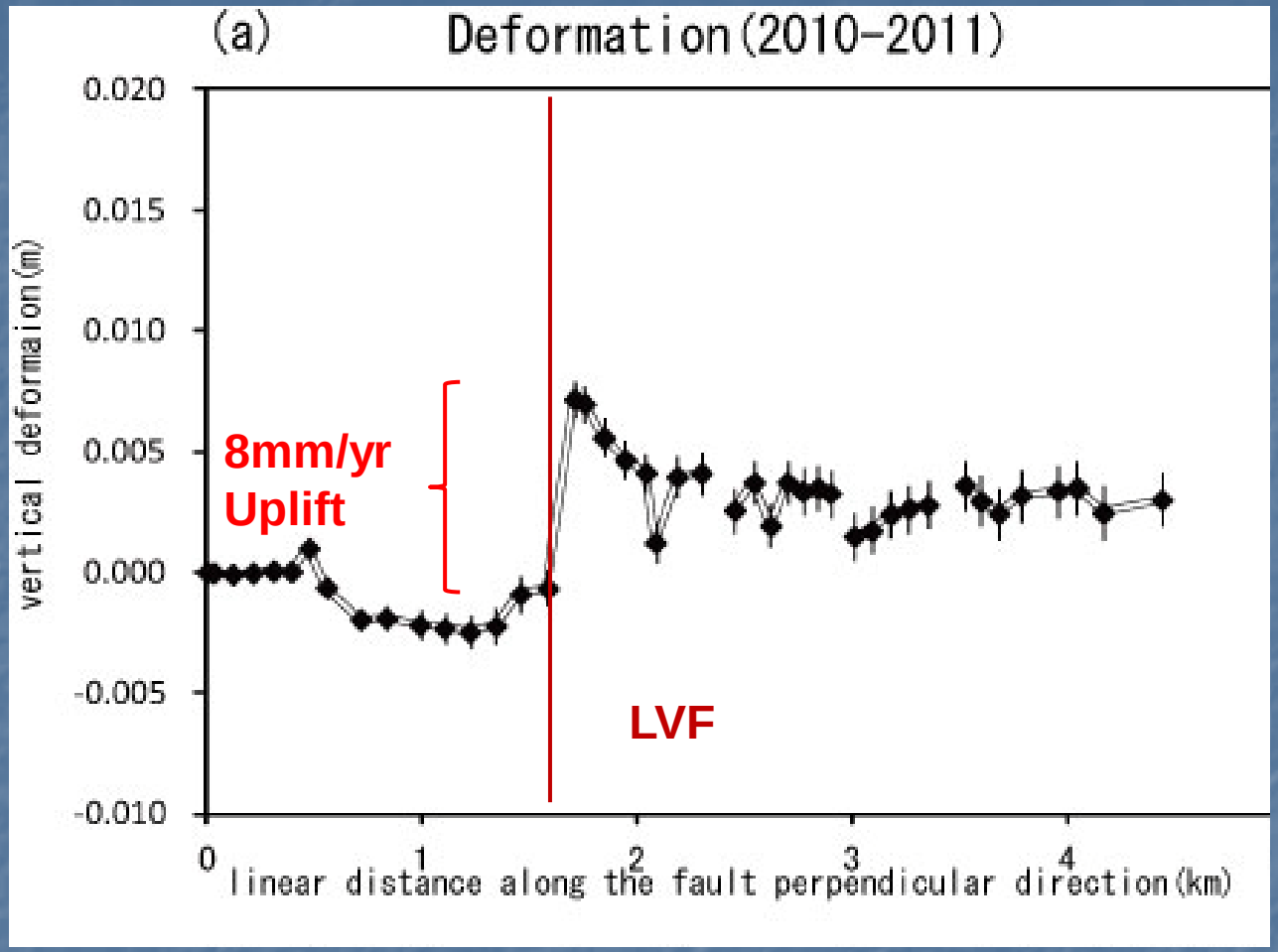
Leveling survey at Chike-shan line (赤科山線)



5 km leveling route.

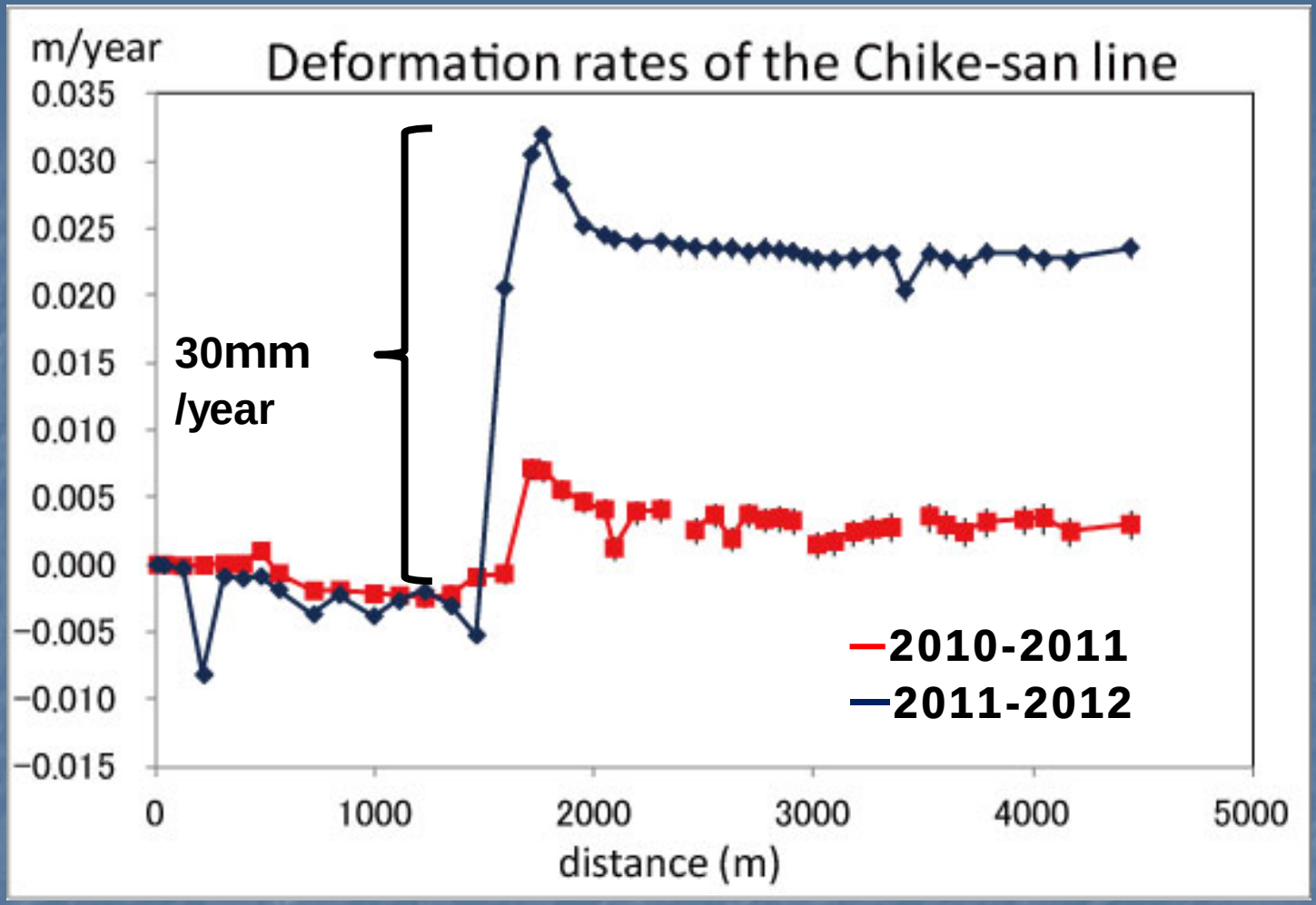
We surveyed in Aug.2010, Aug.2011, and Aug.2012.

Deformation of the Chike-shan line



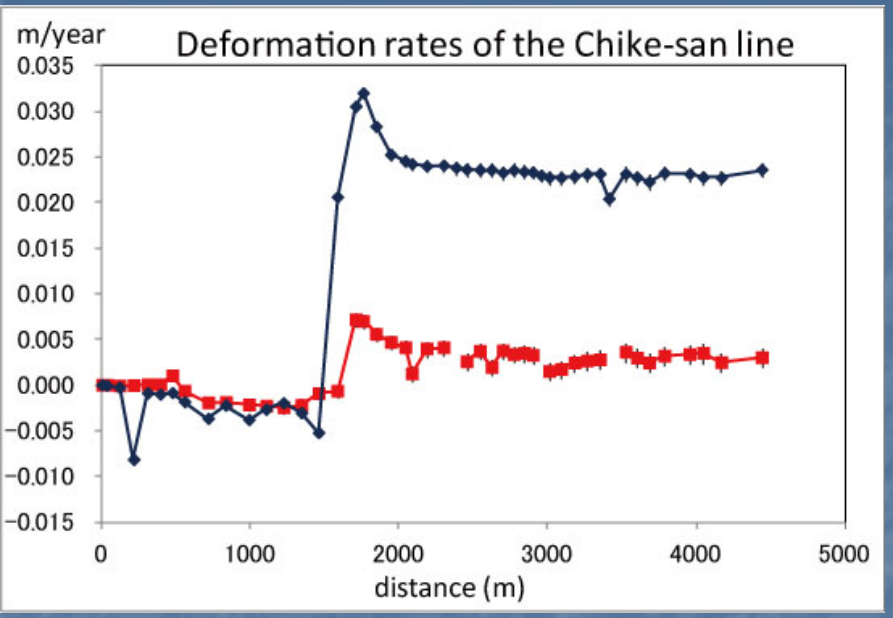
The vertical deformation of about 8mm/year during 2010-2011. The rate is smaller than that of Yuli and Fuli lines.

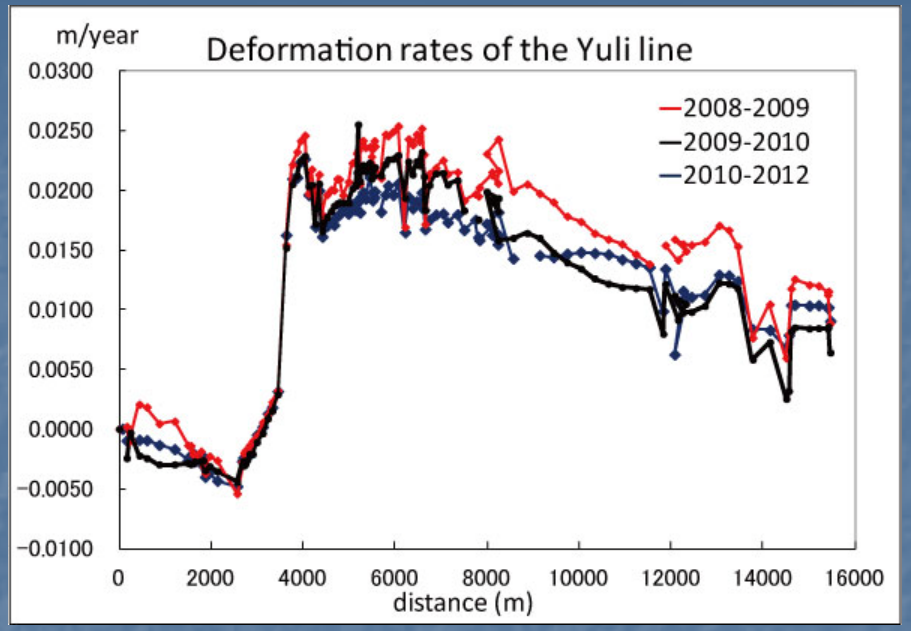
Deformation of the Chike-shan line



Deformation detected in 2011-2012 is about three times bigger than that in 2010-2011.

What is the change of deformation rate ?





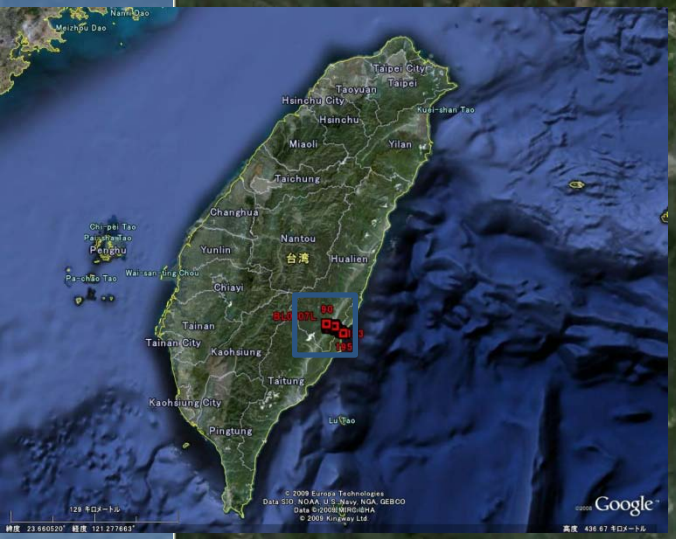
- **No large earthquake occurred near Cike-san last year.**
  → Not coseismic deformation
- **The deformation of Yuli (about 20 km south of Chike-san) didn't have a change of creeping rate.**
  → this change occurred just close to the Chike-san area.

↓

Small slow slip event might occur in Chike-san area.

GPS data and seismic data should be checked.

Leveling lines in the central part of LVF



Reishuei line(since 2011)
瑞穂路線

Chike-shan line(since 2010)
赤科山路線

Yuli line(since 2008)
玉里路線

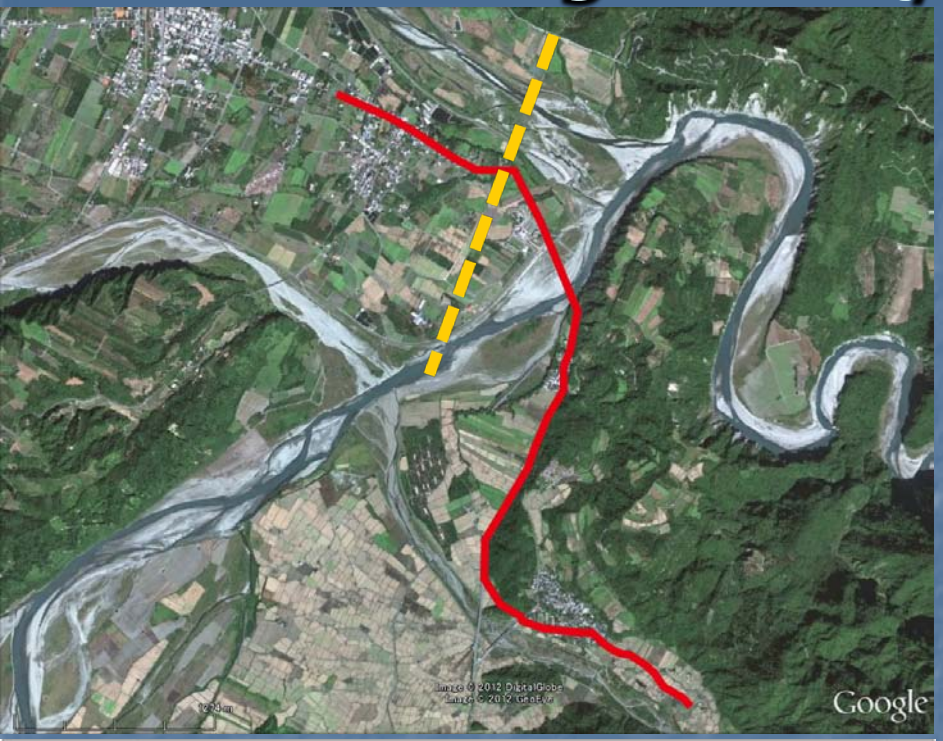
Dongli line(since 2010)
東里路線

DongChu line(since 2011)
東竹路線

Fuli line(since 2010)
富里路線

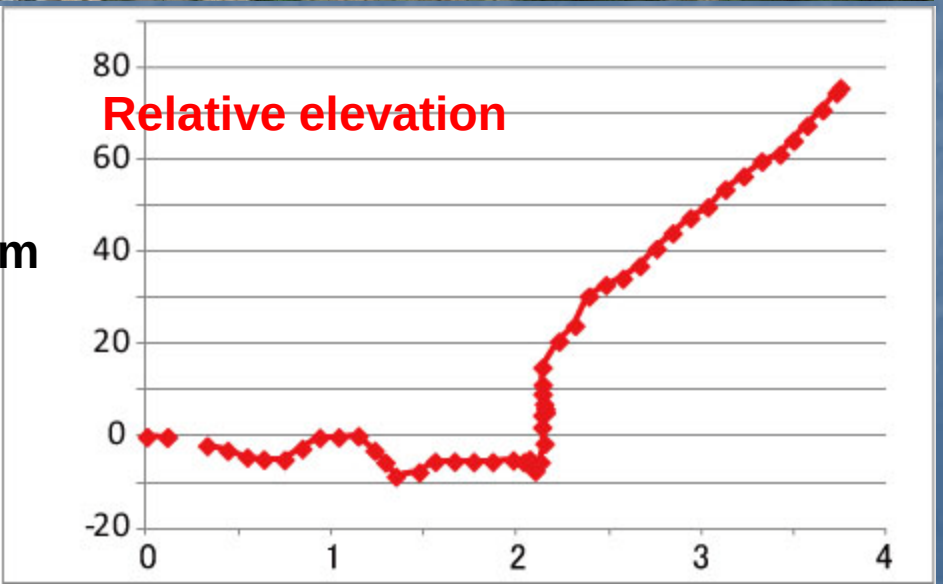
10.2 km

Leveling survey at Reishuei line (瑞穂路線)

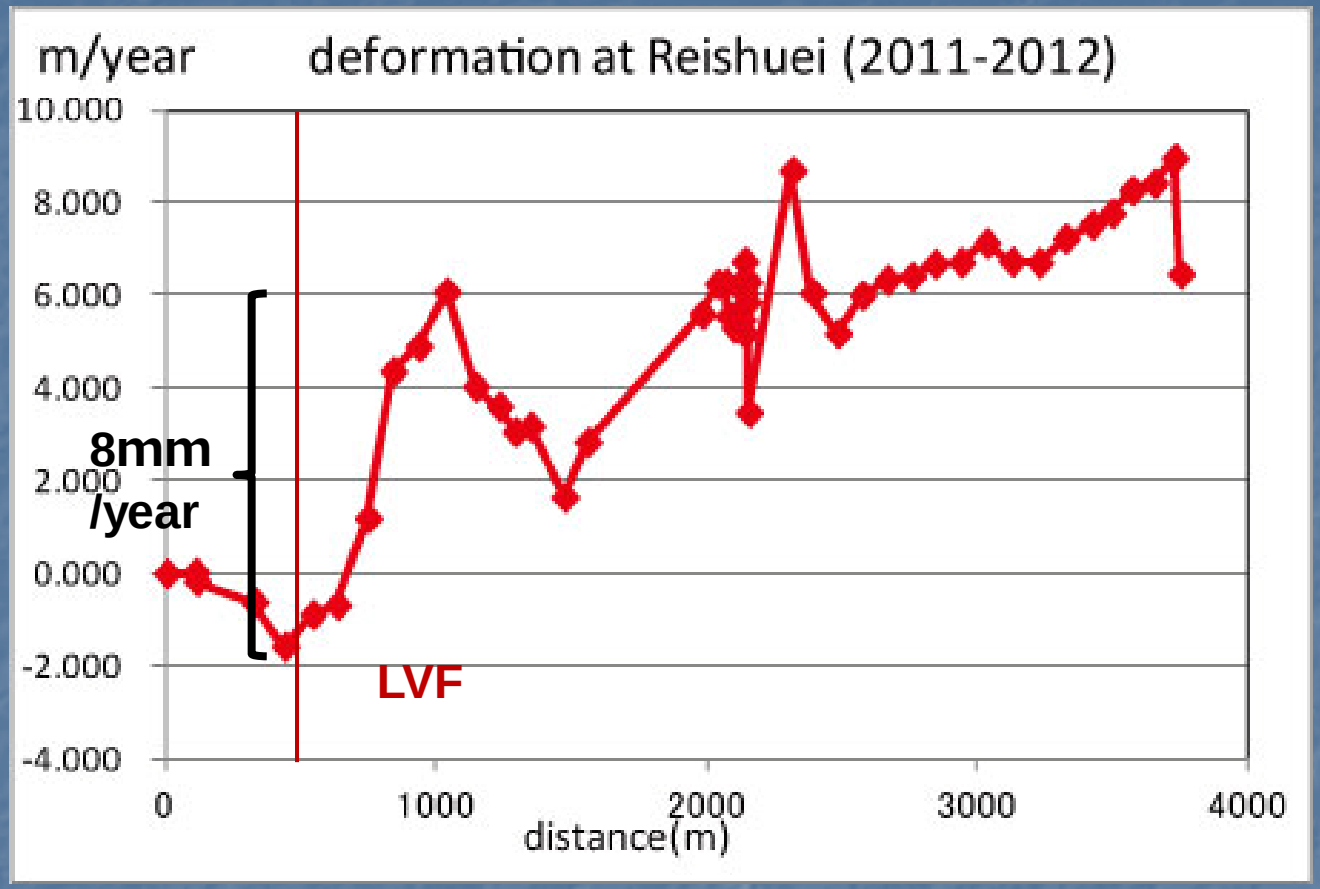


6 km leveling route.

We surveyed in Aug.2011 and Aug.2012



Deformation of the Reishuei line

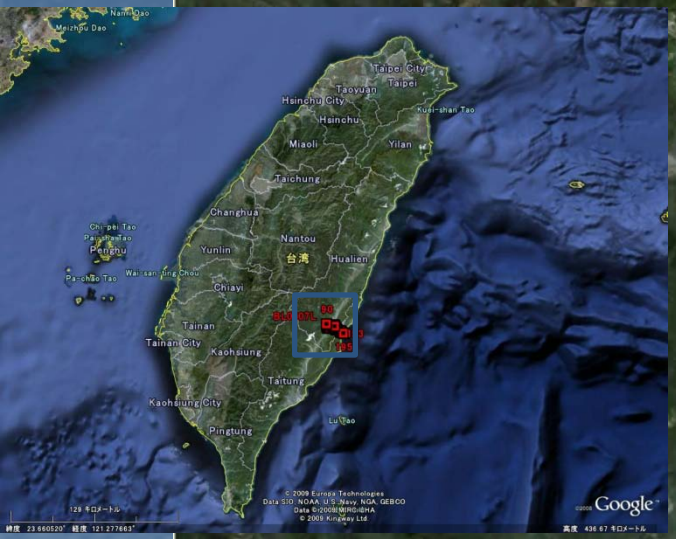


The vertical deformation of about 8mm/year during 2010-2011.

It is smaller than that of Yuli and Fuli lines.

It is almost as same as that of Chike-san in 2010-2011 .

Leveling results in the central part of LVF



Reishuei(瑞穂路線)

8mm/year

Small creeping rate
(with slow slip)

Chike-shan line(赤科山路線)

mm/year(2010-11)

30mm/year (2011-12)

Yuli line(玉里路線)

30mm/year

large creeping with
steady rate

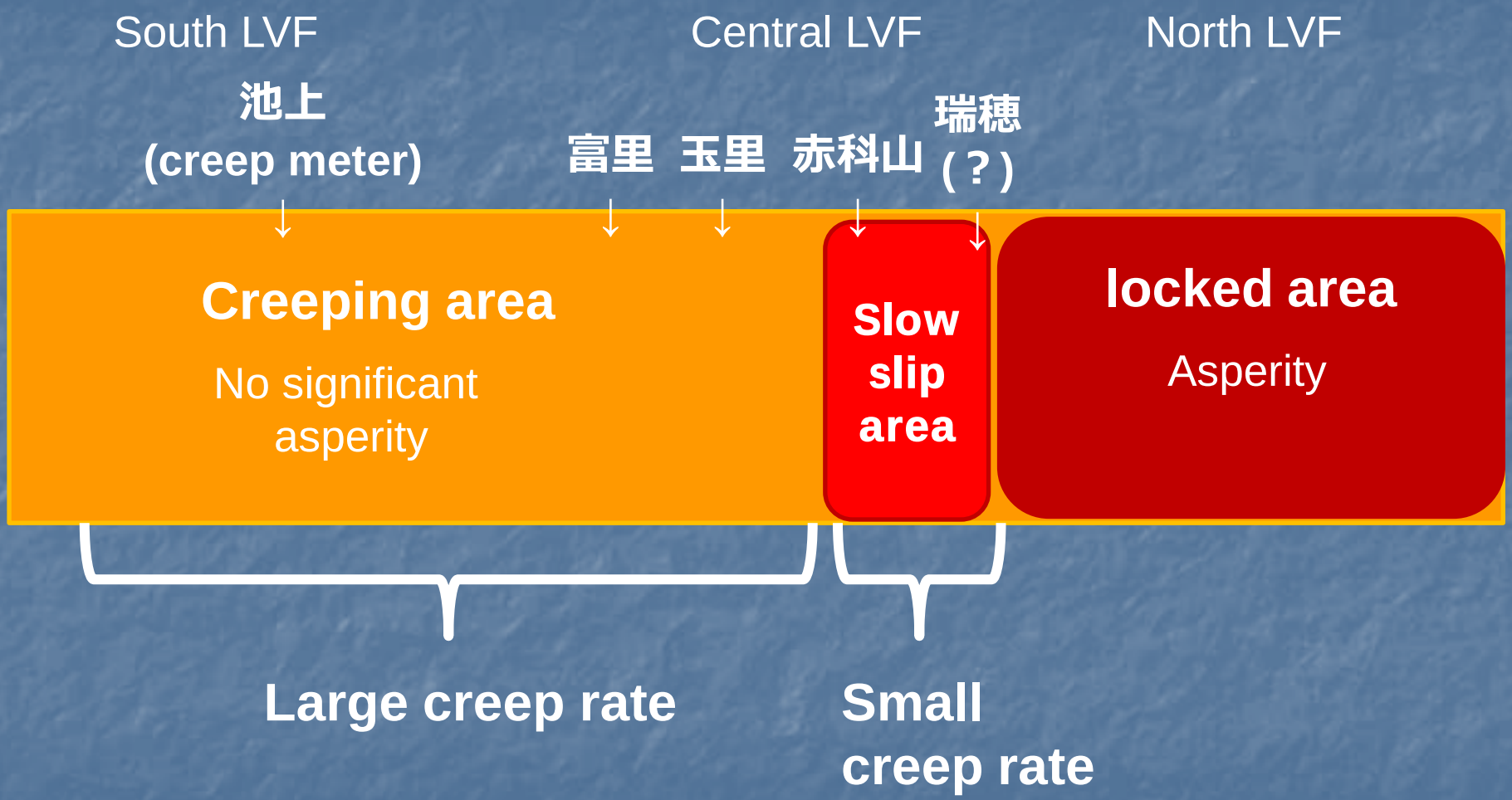
Fuli line(富里路線)

25mm/year

Image © 2012 GeoEye
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2012 DigitalGlobe

Google

Slow slip area in the Longitudinal valley fault



Based on the leveling data, the slow slip event is suggested in the central part of LVF. In order to discuss in detail, we should check other geodetic and seismic data.