

# 2016美濃地震同震地表變形 與台灣西南部地殼變形簡介

## Coseismic deformation of the 2016 Meinong Earthquake, and the interseismic crustal deformation of southwestern Taiwan

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Chung Huang, Postdoctoral Researcher,  
Department of Geosciences, National Taiwan University



# Outline

- Introduction
  - Education
  - Working experiences
  - Teaching experiences
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- Research
  - Preliminary results of coseismic deformation of Meinong Earthquake
  - Tectonic and crustal deformation of southern Central Range
  - Coseismic displacement of Chi-Chi earthquake in Fengyuan area and near surface fault geometry model construction
  - 3D structure of Western Foothills in central Taiwan
- Teaching plan
- Future projects



# Introduction

## Education

- Ph.D. University of Connecticut Jan. 2015
  - Geomorphic and Structural Evidence for an Active Tectonostratigraphic Boundary in an Accretionary Wedge: the Southern Central Range, Taiwan
  - Advisors: Timothy Byrne, William Ouimet
- M.S. National Taiwan University Jun. 2007
  - Graduate with Dean's award
  - The Fault Geometry and Co-seismic Surface Deformation Around the Northern Taichung Basin
  - Advisors: Jyr-Ching Hu, Yu-Chang Chan
- B.S. National Taiwan University Jun. 2005
  - Active Tectonic Geomorphology Study of the Chelungpu Fault system in Taichung-Fengyuan area based on LiDAR DEM
  - Advisors: Yu-Chang Chan, Jyr-Ching Hu



# Introduction

## Working experiences

- Postdoctoral Researcher, Department of Geosciences, NTU
  - Altyn-Tagh and Haiyuan Faults
  - Observation of Fault Activity
- Research Assistant, Center for Integrative Geosciences, UConn
  - Reactivation of Continental Margin Fracture Zones
- Mandatory National Serviceman (Geologist), CGS
  - Active fault mapping and investigation, active fault zone planning
- Research Assistant, Institute of Earth Sciences, Sinica
  - Airborne LiDAR Mapping and Tectonic Geomorphology Analysis



# Introduction

## Teaching experiences


- Teaching Assistant of University of Connecticut  
Outstanding Graduate Student Teaching Award (May 2015)
  - Structural Geology Fall 2011
  - Introduction to Geology Spring 2012, Spring 2014
  - Earth Surface Process Fall 2012
  - Geology and Geohazards in Taiwan Winter 2012-13, Winter 2014-15
- Teaching Assistant of National Taiwan University
  - Introduction to Geological Survey (I) Fall 2005, Spring 2006
  - Structural Geology Fall 2005, Fall 2006
  - Summer Geological Survey Summer 2005, Summer 2006
  - Geophysical Data Process Fall 2006, Spring 2006
  - Field Geology Spring 2006, Spring 2007



# Industrial connections

- Collaborate with Sinotech Consultants, Inc. on Central Geological Survey's active fault projects.
- Collaborate with Sinotech Engineering Consultants, Ltd. on using PSInSAR to monitor active faults near Taipower company's nuclear power plants.
- Collaborate with Exploration & Development Research Institute, CPC Corporation on the 3D geometry of Chinshui anticline.
- Consultant of Department of Geotechnical Engineering, CECI Engineering Consultants, Inc. for western Southern-Cross-Island-Highway improvement project and Anshuo-Caopu tunnel project.

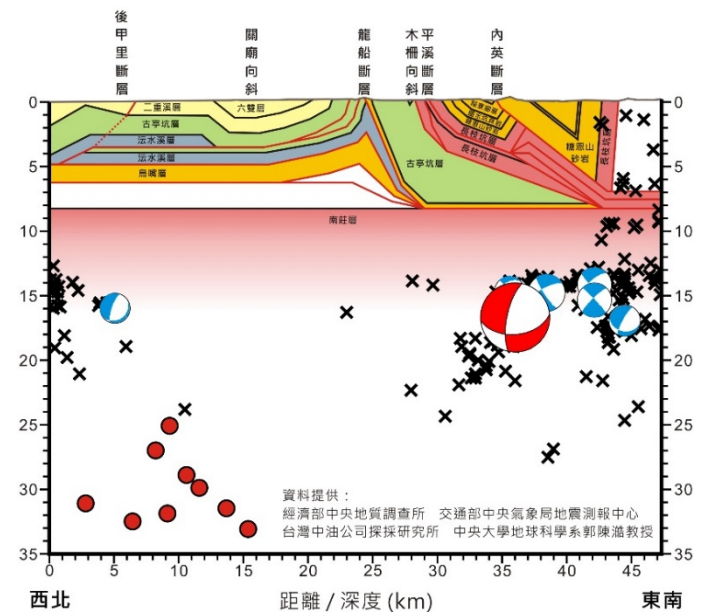
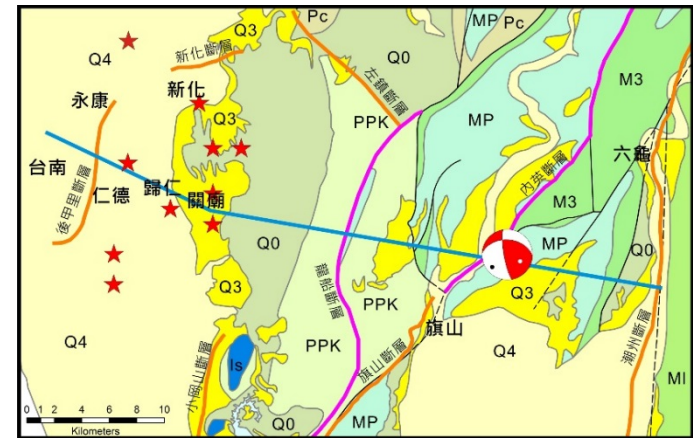
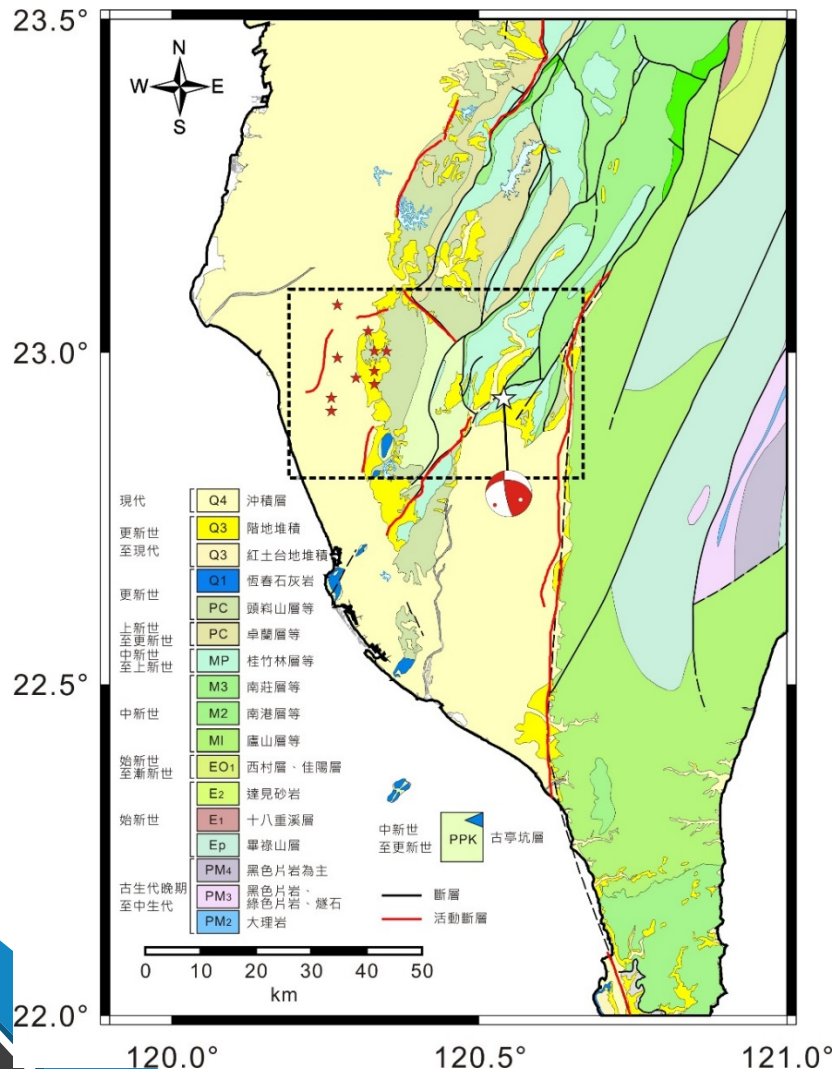




# Preliminary results of coseismic deformation of Meinong Earthquake

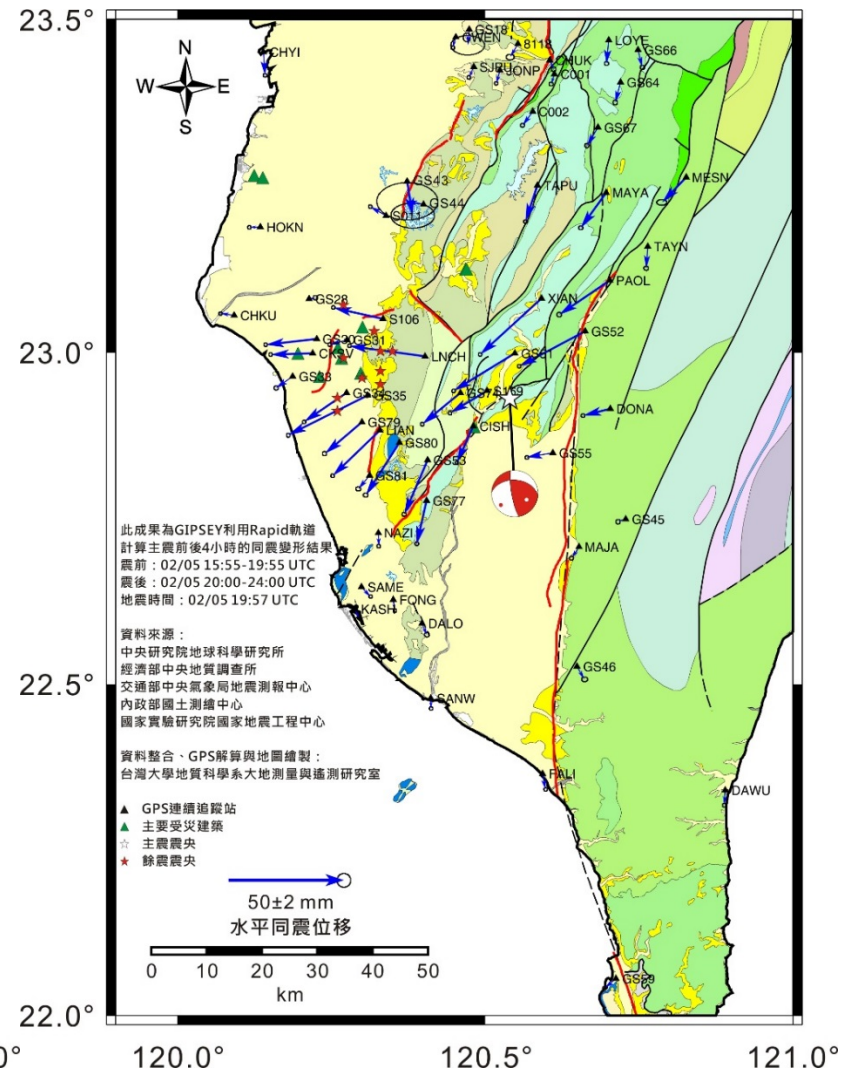
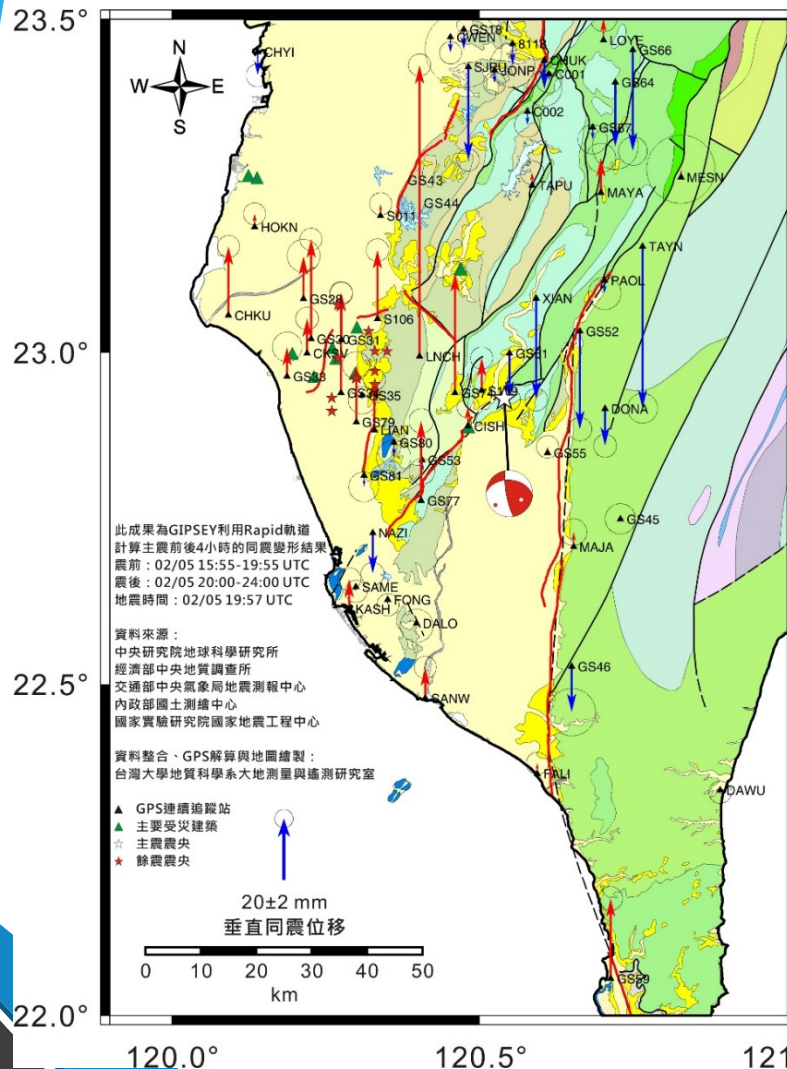


# Preliminary results of coseismic deformation of Meinong Earthquake



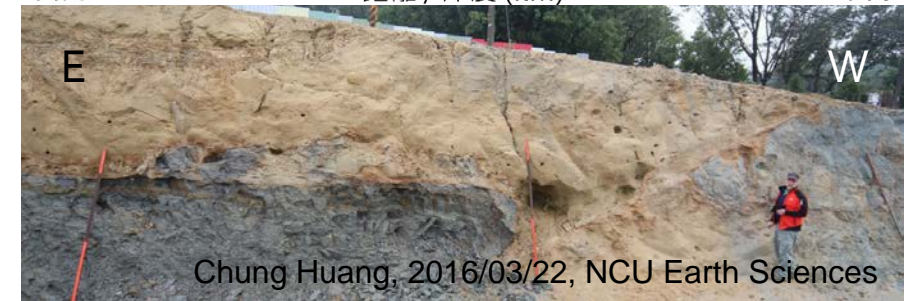
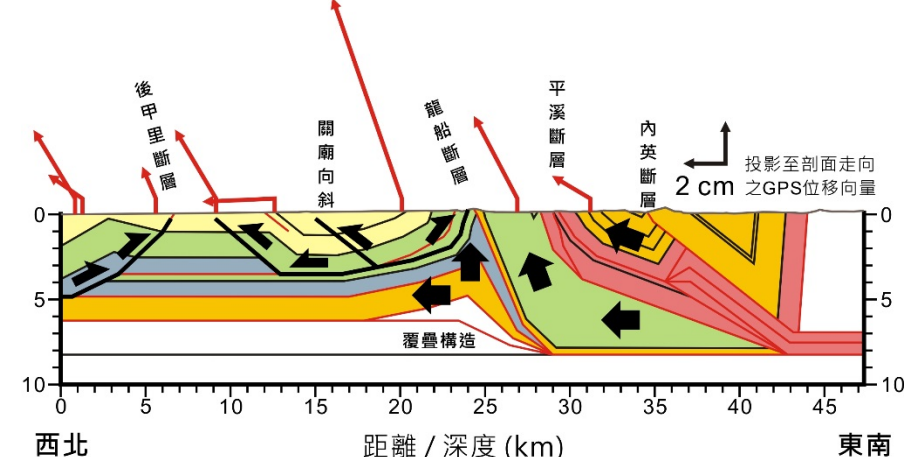
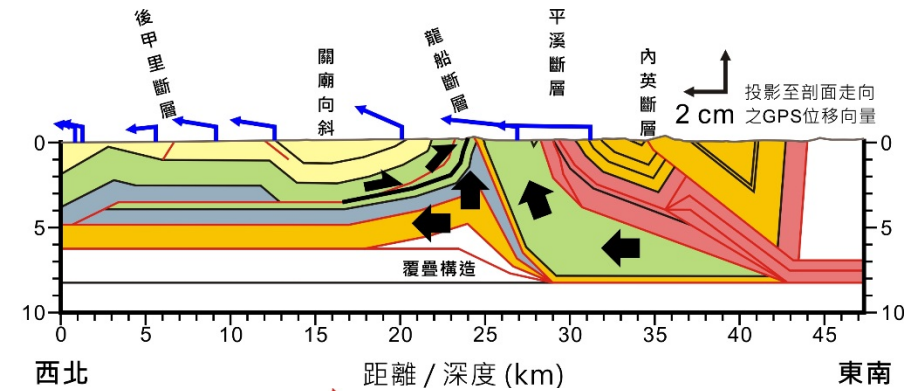
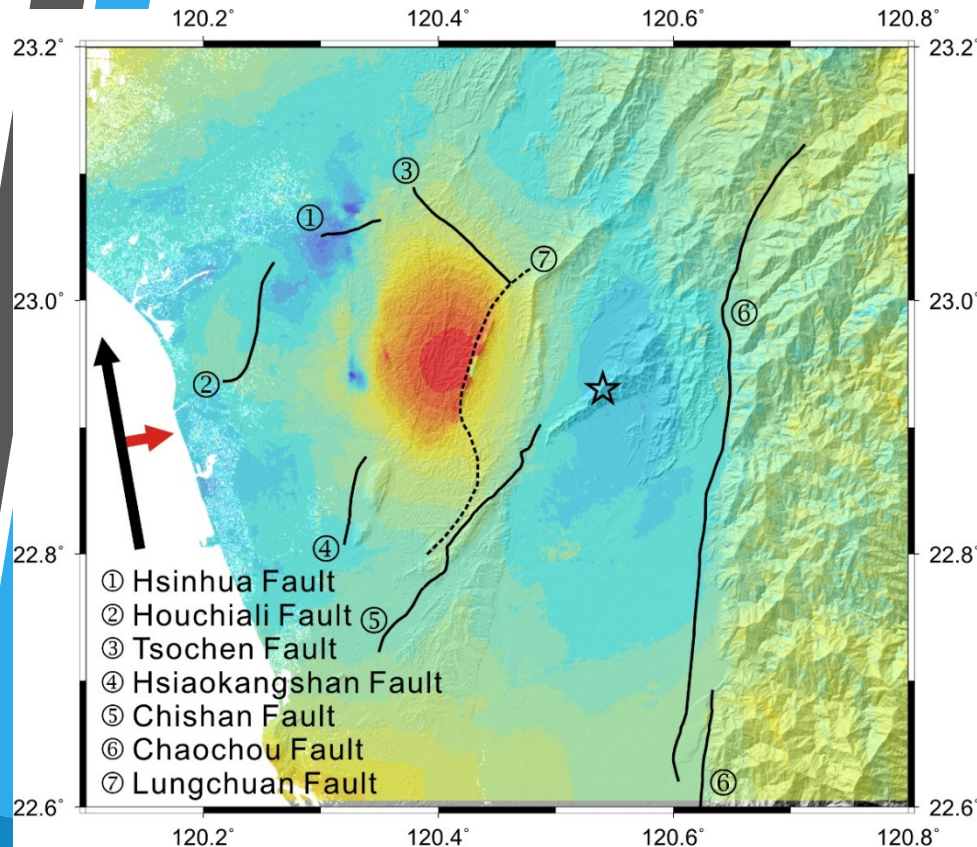


# Preliminary results of coseismic deformation of Meinong Earthquake






# Preliminary results of coseismic deformation of Meinong Earthquake





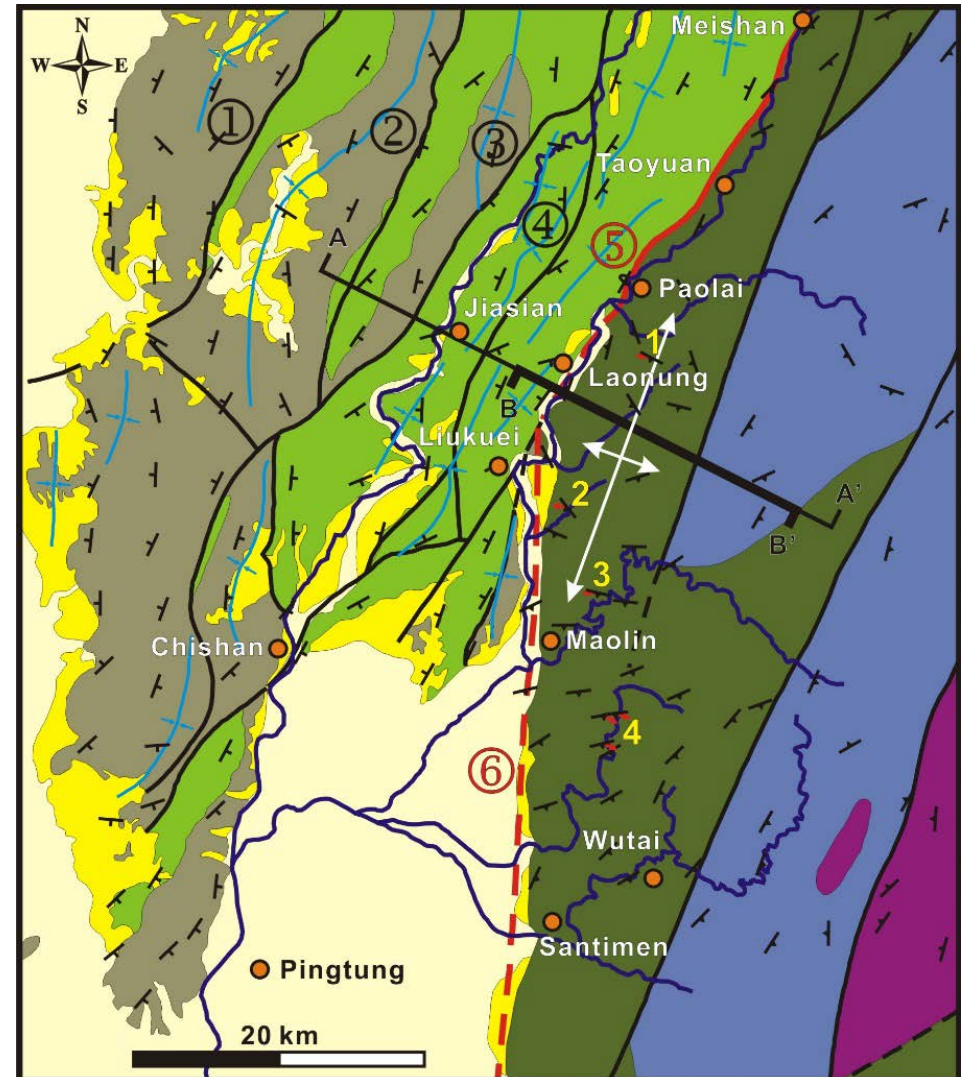
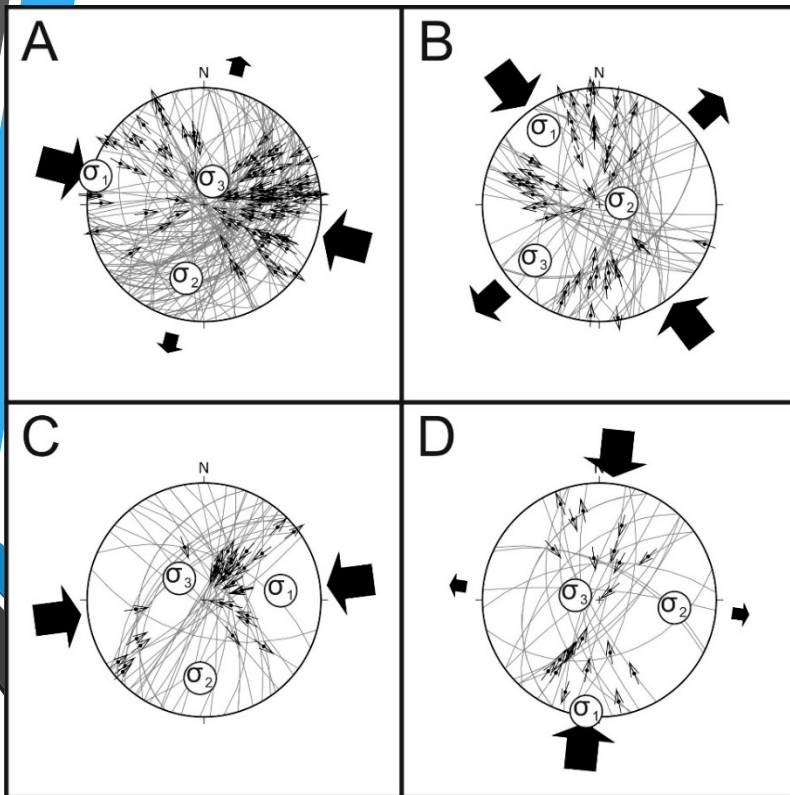


# Tectonic and crustal deformation of southern Central Range



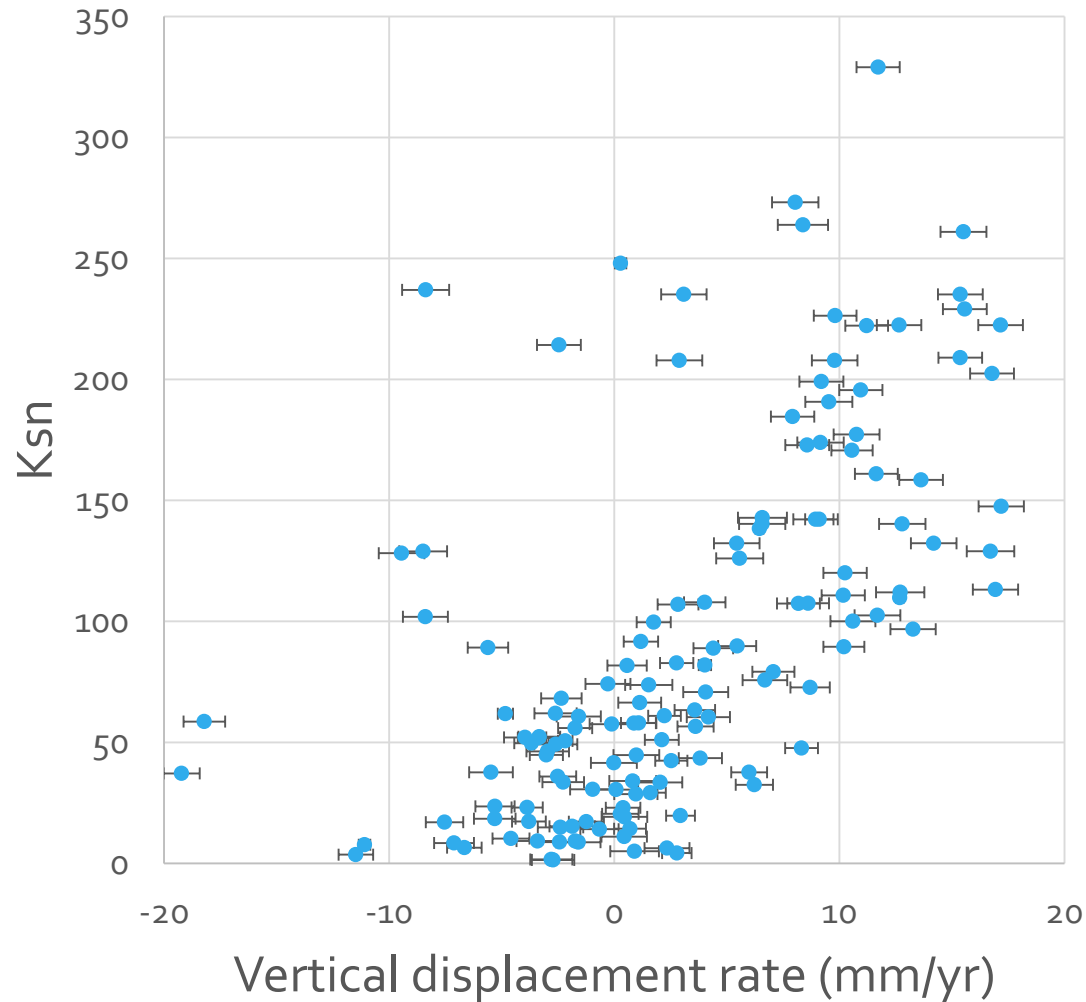
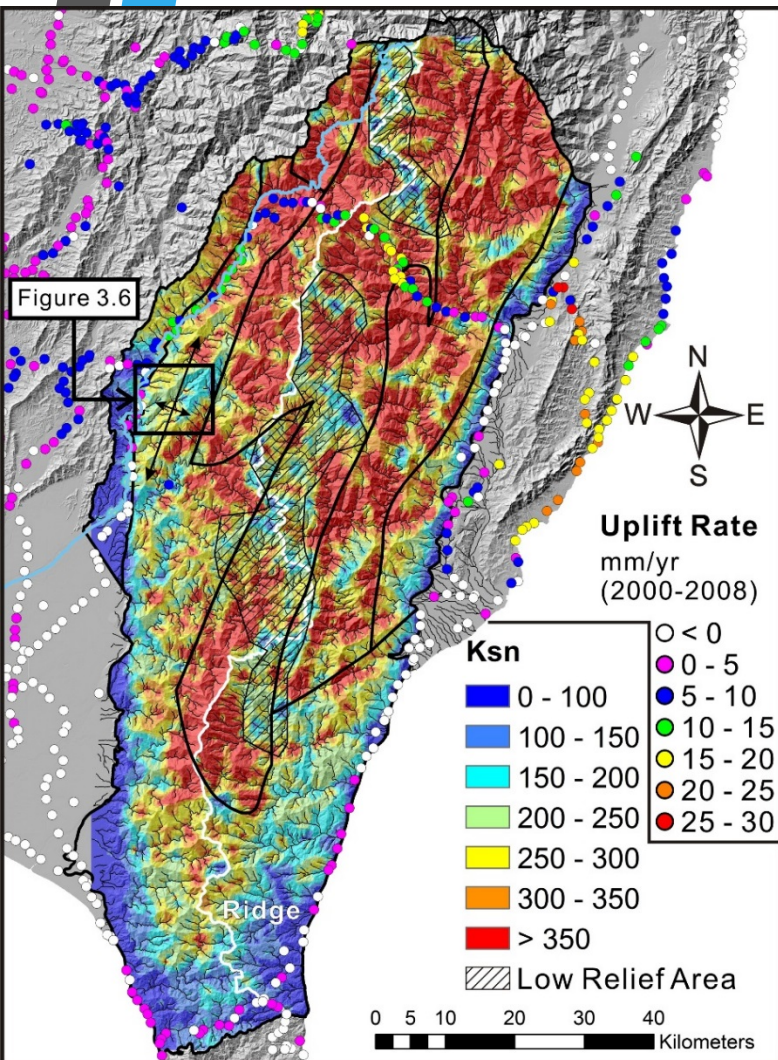
# Tectonic and crustal deformation of southern Central Range

Stress Inversion		
Phase	Max Orient.	Early / Late
1 (A)	285 / 02	17 / 22
2 (B)	323 / 13	12 / 6
3 (C)	083 / 23	5 / 5
4 (D)	187 / 02	1 / 7



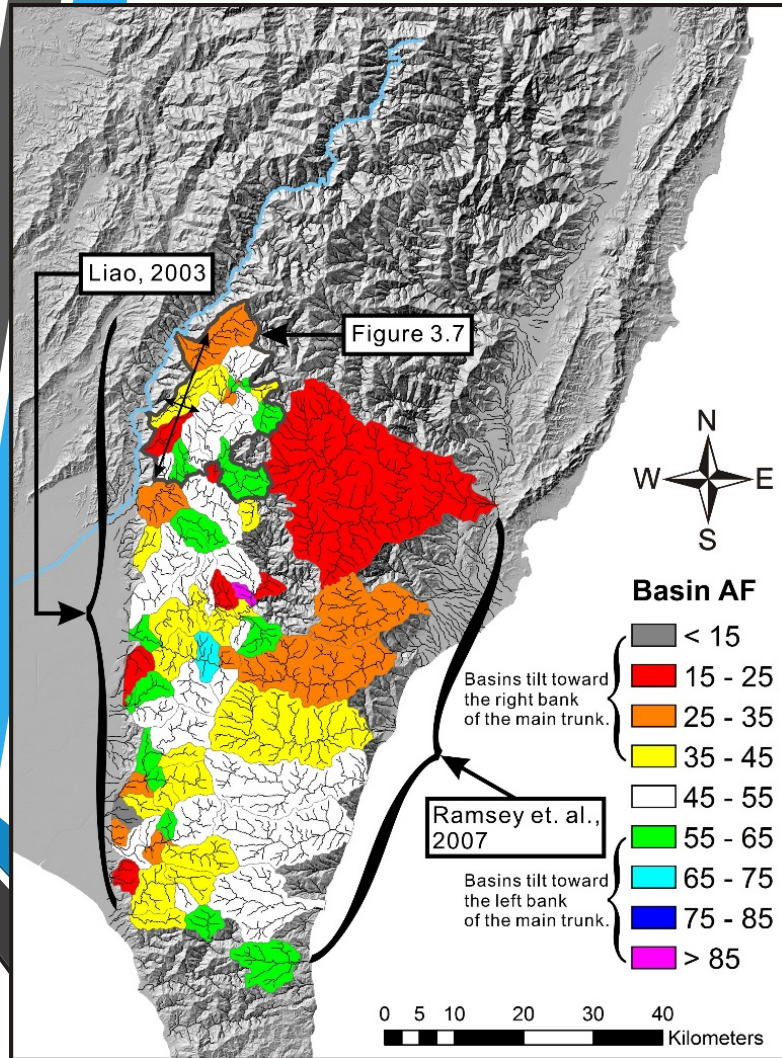


# Tectonic and crustal deformation of southern Central Range

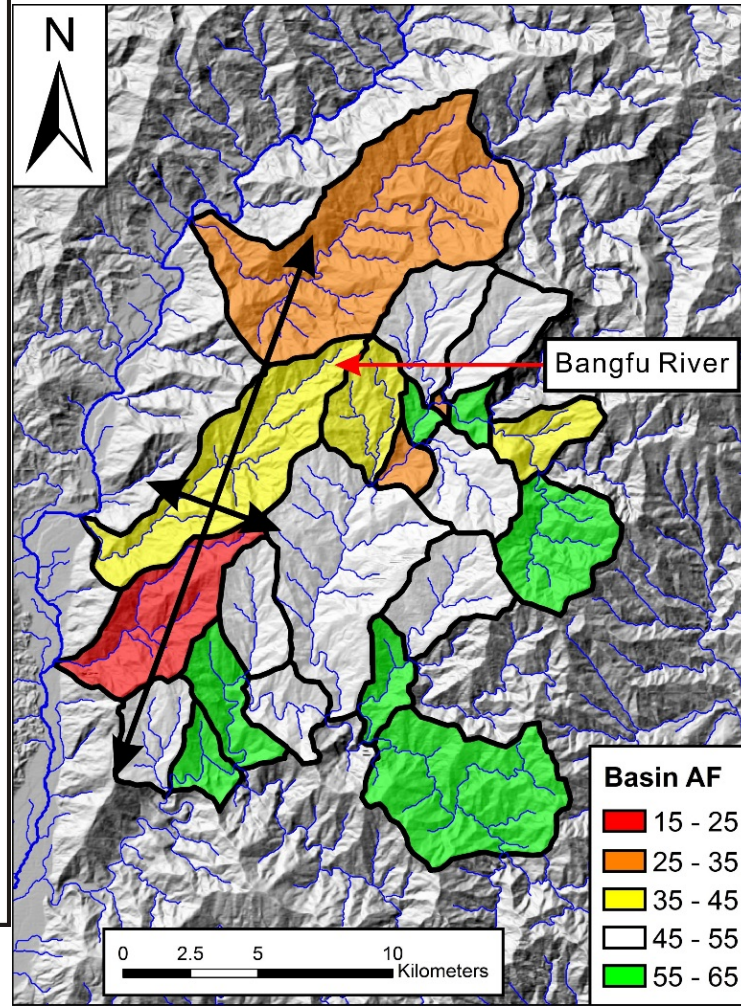




# Tectonic and crustal deformation of southern Central Range



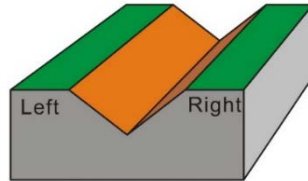
- Drainage basin tilts toward right bank:  $AF < 50$
- Drainage basin tilts toward left:  $AF > 50$



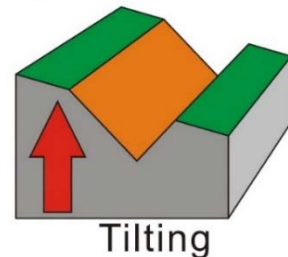
$$A_{\text{right}} = A_{\text{left}}$$

$$A_{\text{right}} / A_{\text{total}} = 0.5$$

$$AF = 50$$

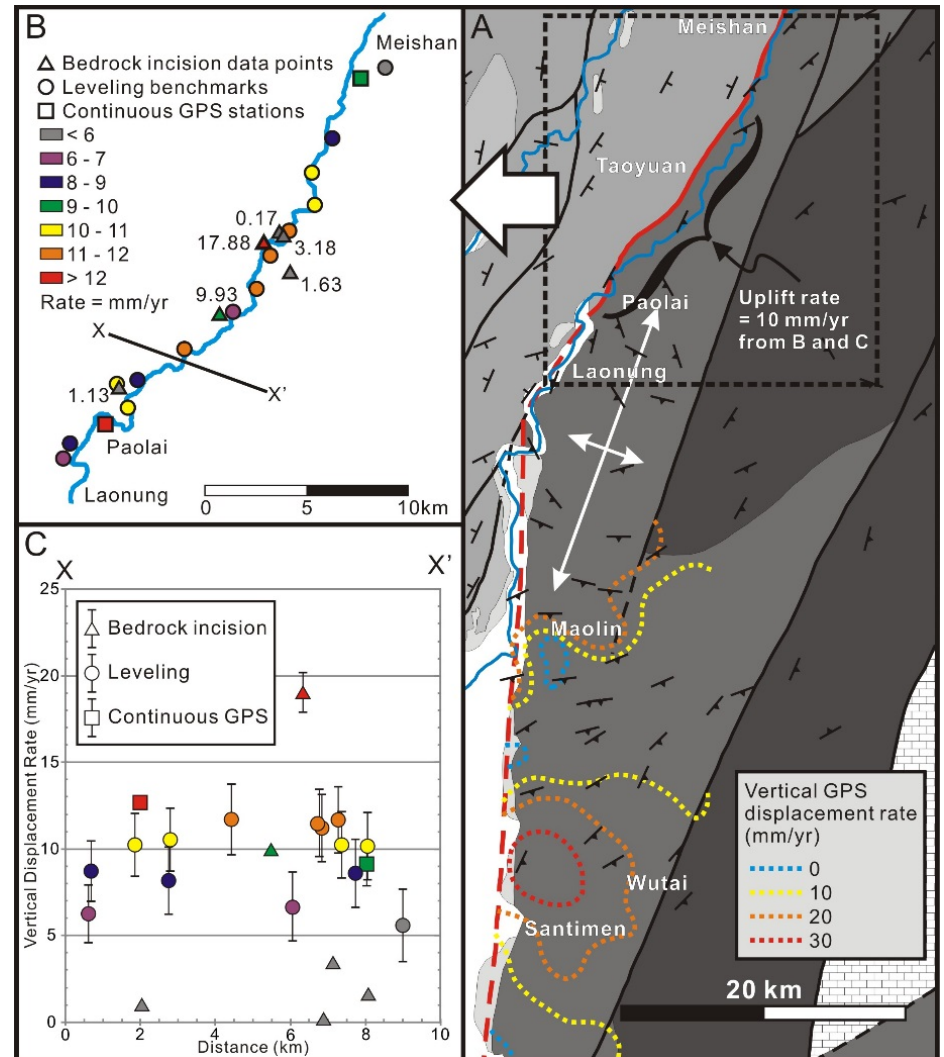
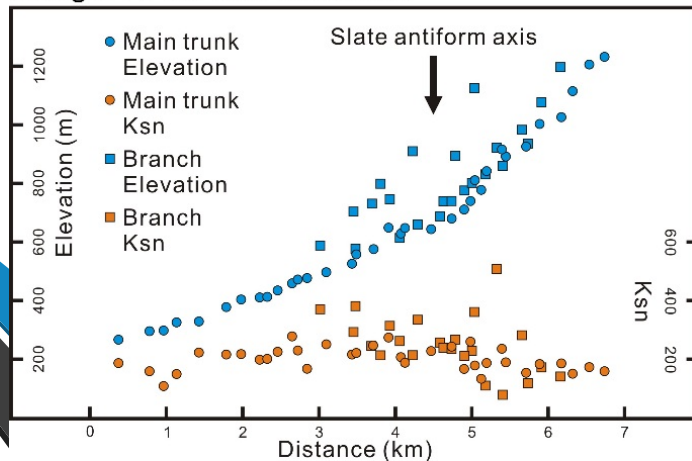
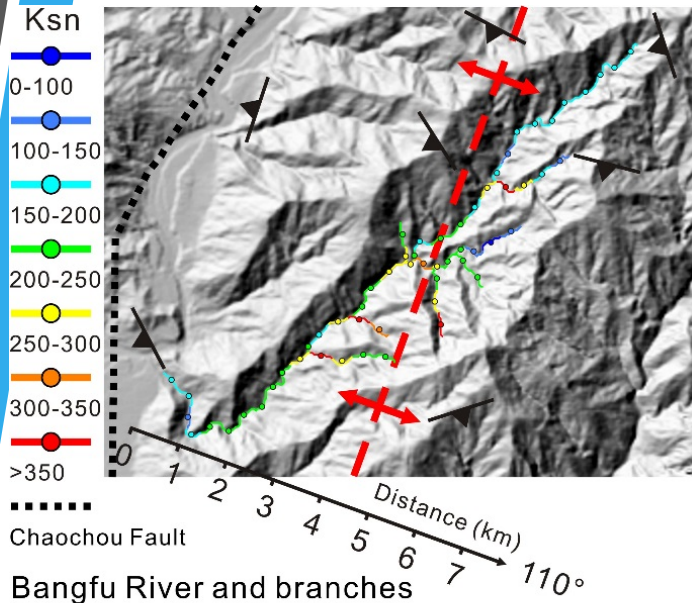


$$A_{\text{right}} < A_{\text{left}}, AF < 50$$



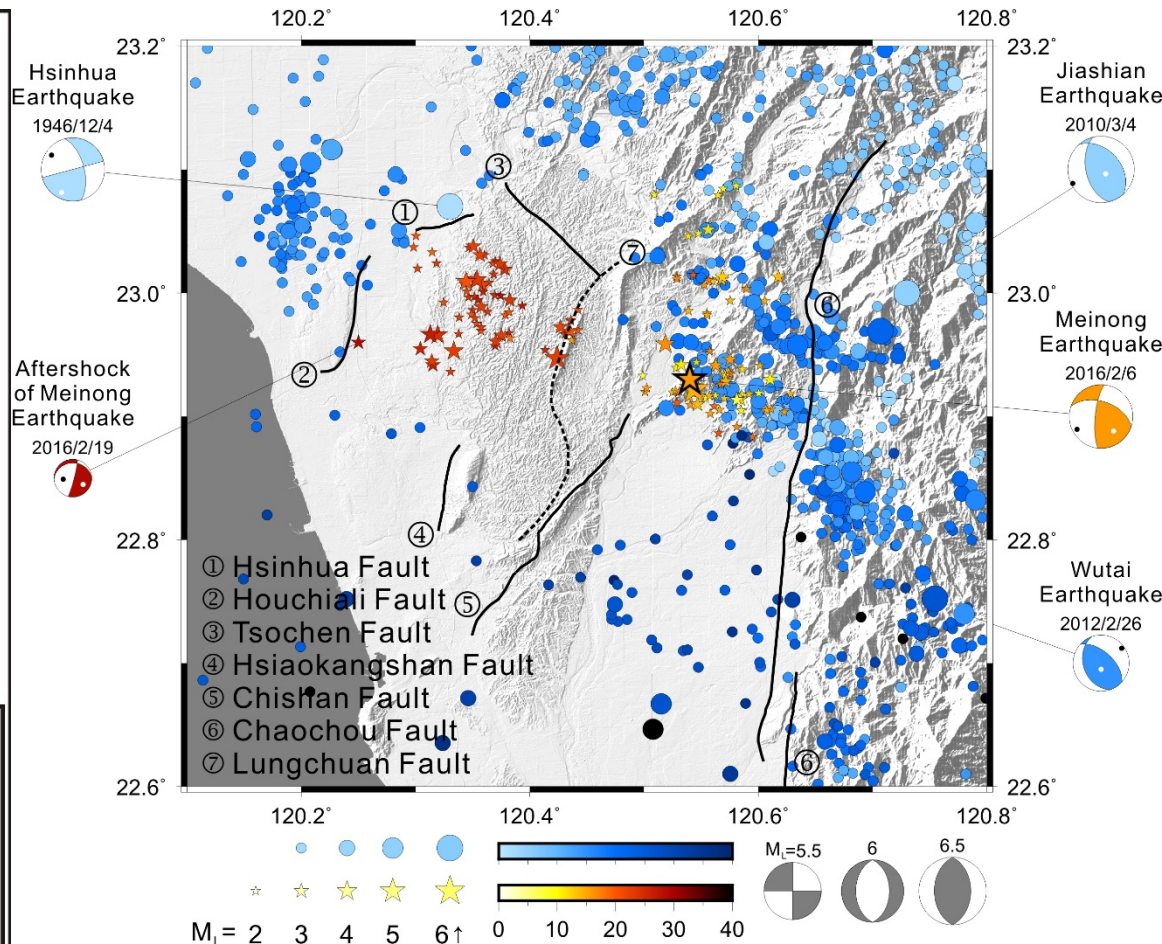
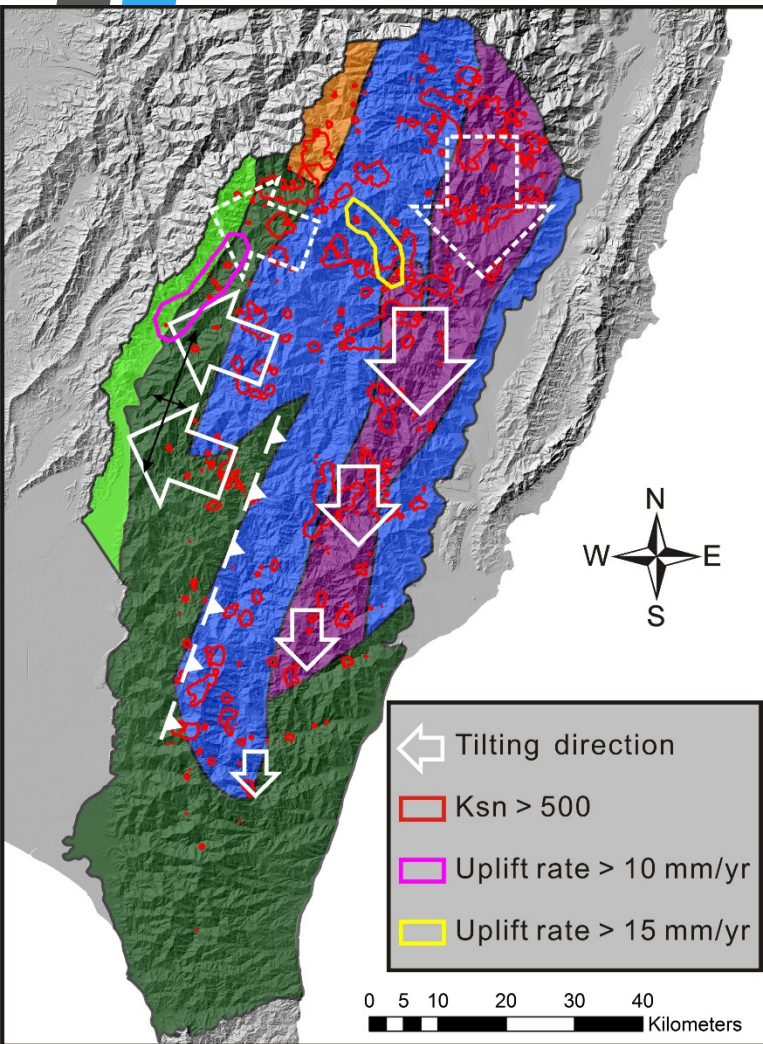


# Tectonic and crustal deformation of southern Central Range






# Tectonic and crustal deformation of southern Central Range



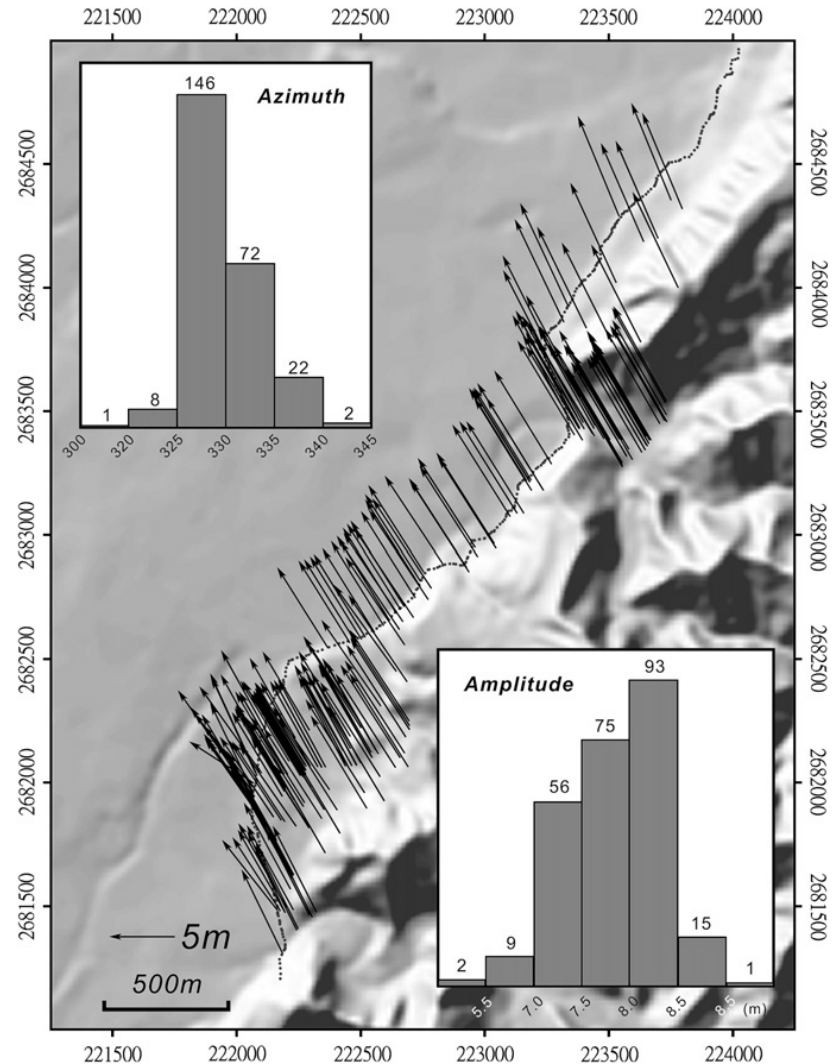
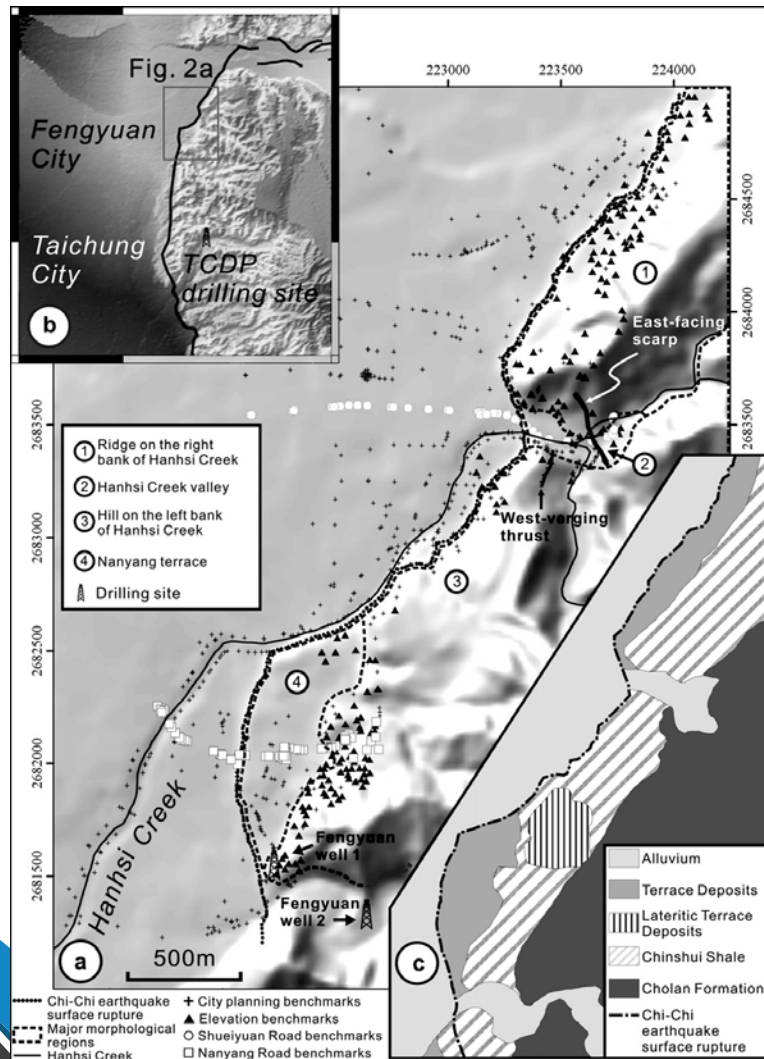




# Coseismic displacement of Chi-Chi earthquake in Fengyuan area and near surface fault geometry model construction

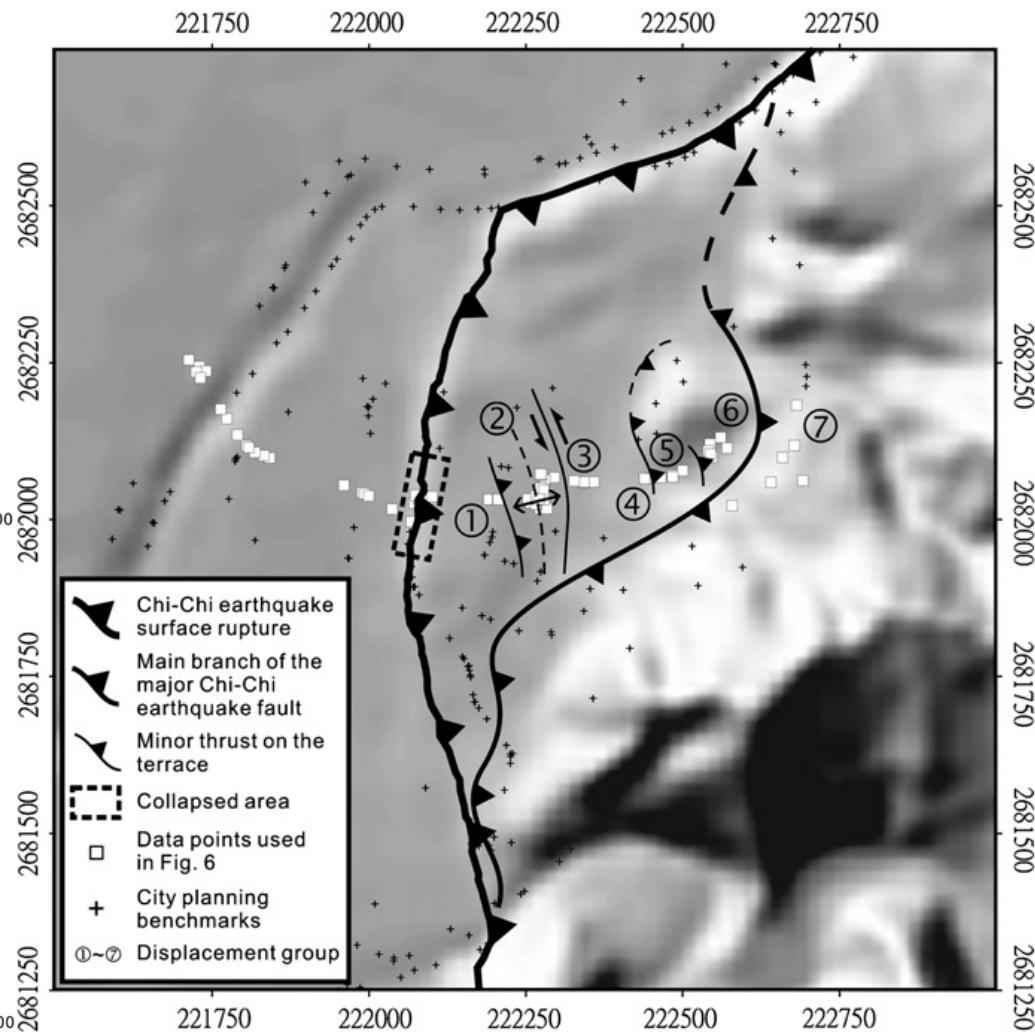
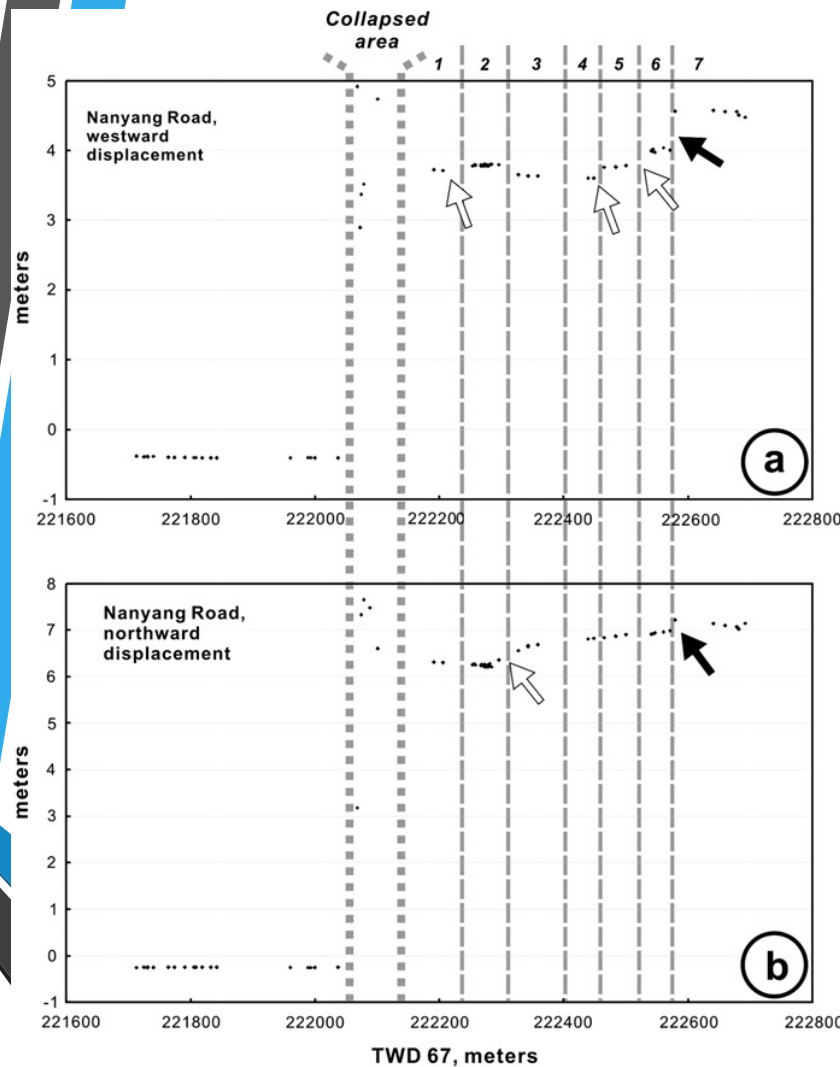


# Coseismic displacement of Chi-Chi earthquake in Fengyuan area



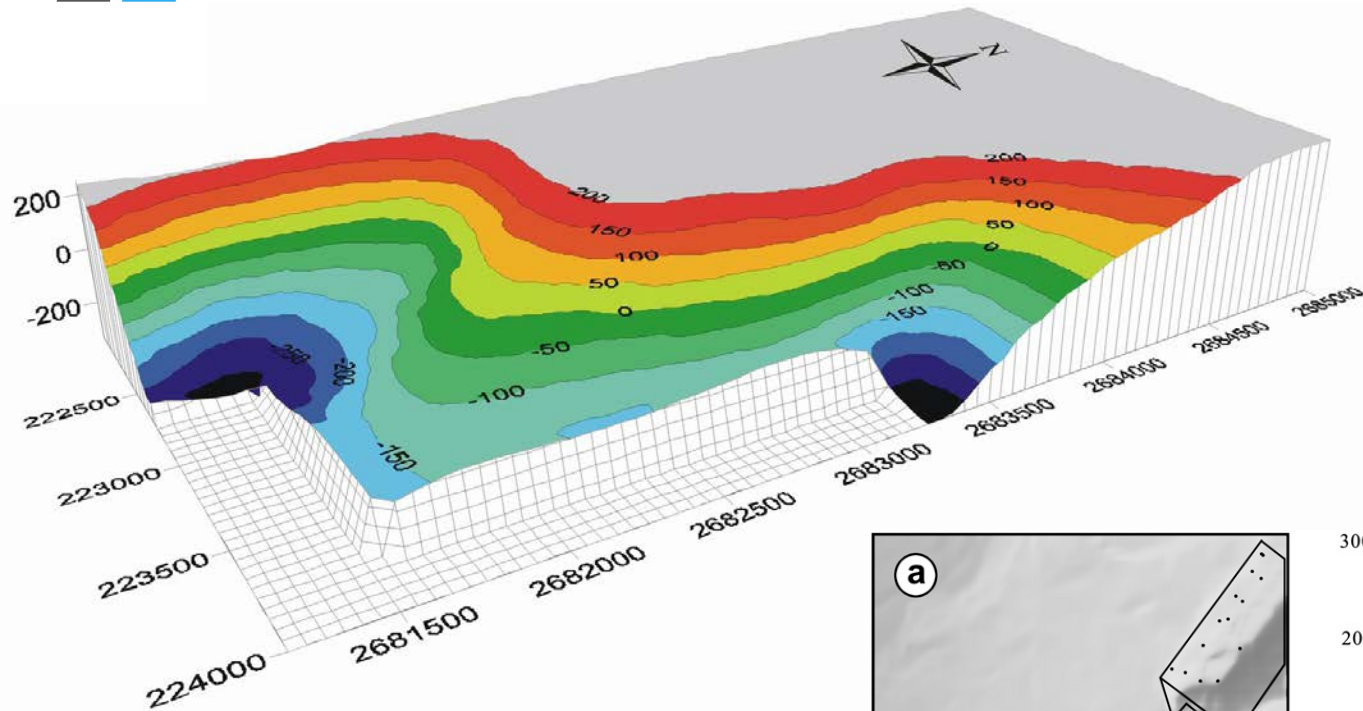


# Coseismic displacement of Chi-Chi earthquake in Fengyuan area

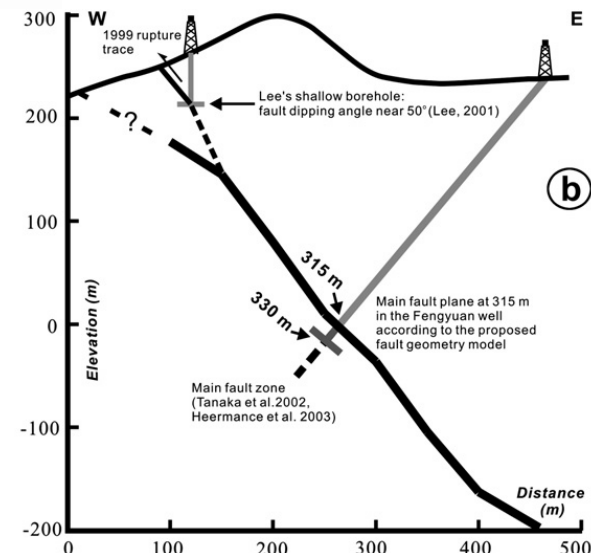
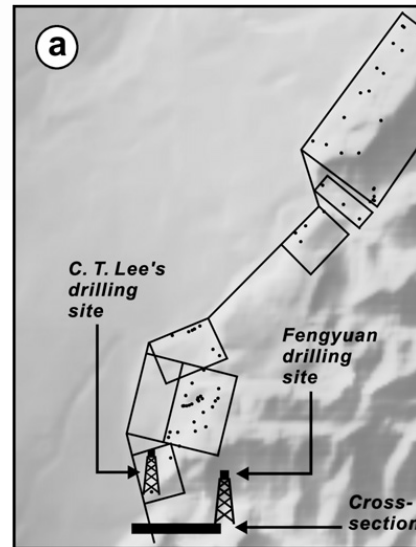





# Near surface fault geometry model construction



Huang et al., 2008, Journal of Structural Geology





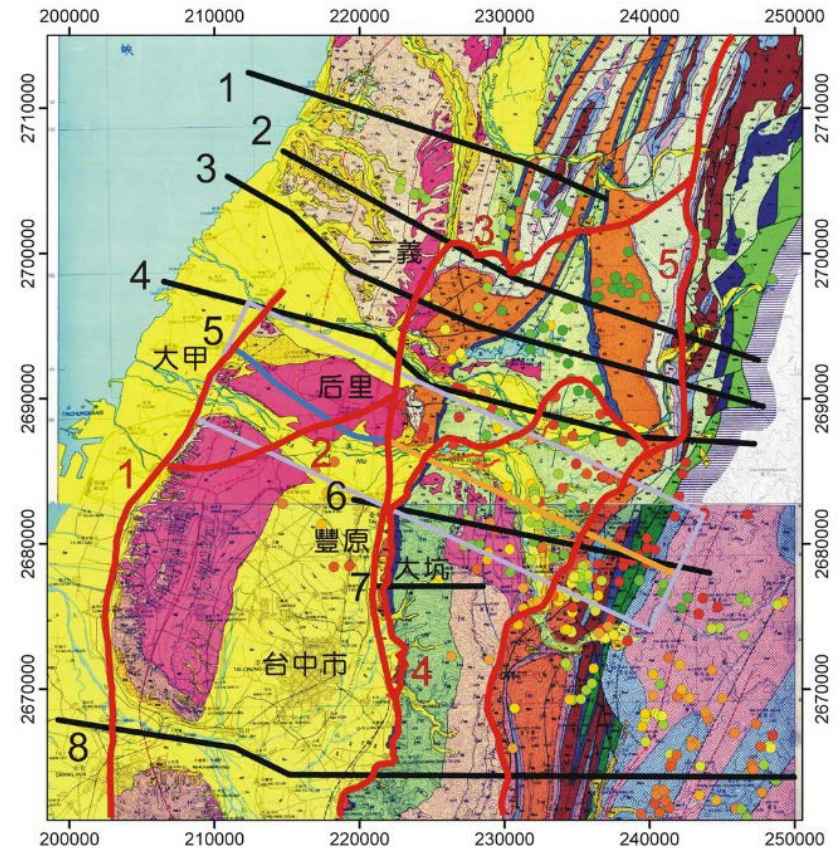
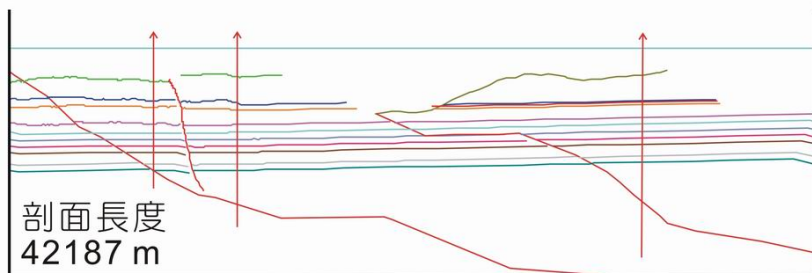
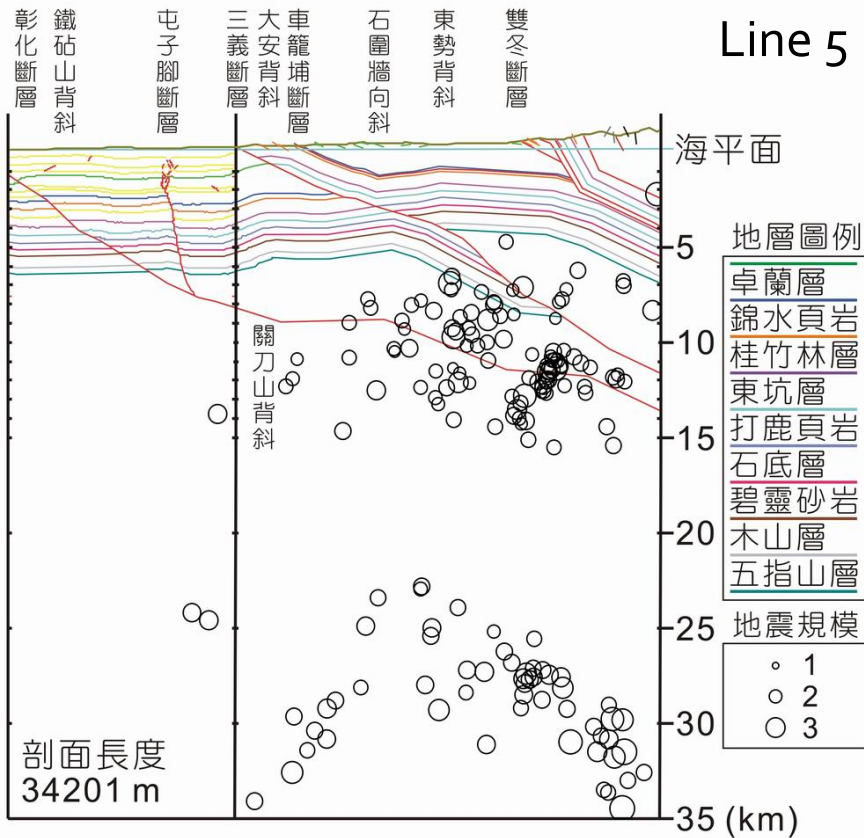


# 3D structure of Western Foothills in the central Taiwan



# 3D structure of Western Foothills in the central Taiwan

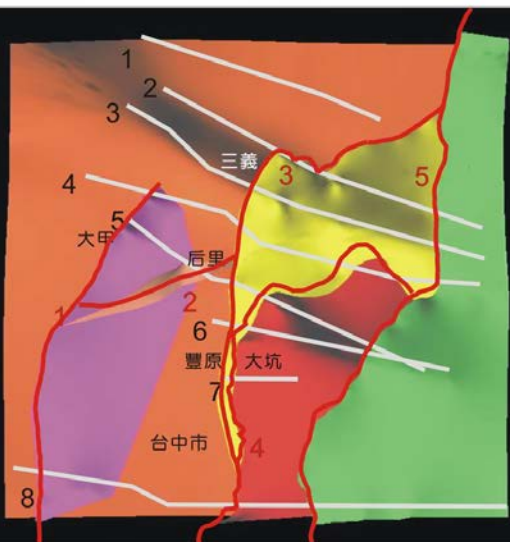
Line 5



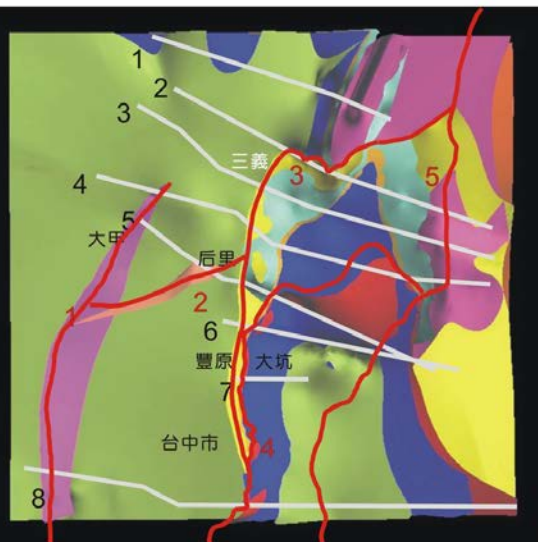


# 3D structure of Western Foothills in the central Taiwan

地下斷層模型

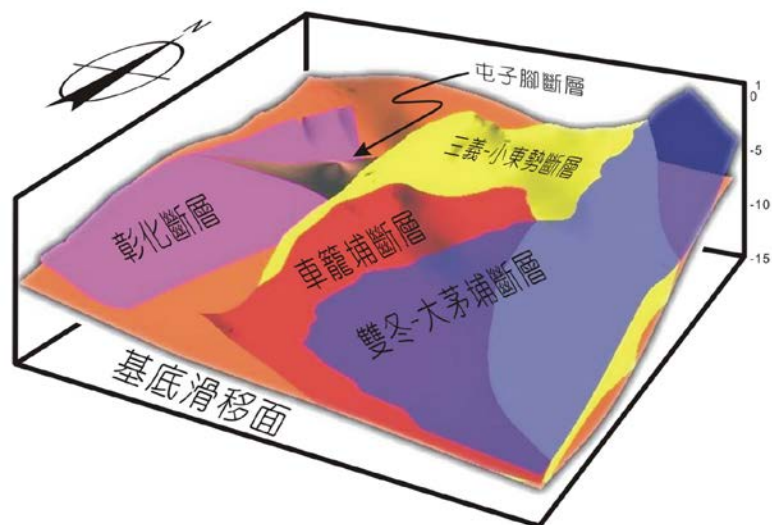


地下地層與構造模型



- 1 彰化斷層
- 2 屯子腳斷層
- 3 車籠埔斷層
- 4 三義-小東勢斷層
- 5 雙冬-大茅埔斷層

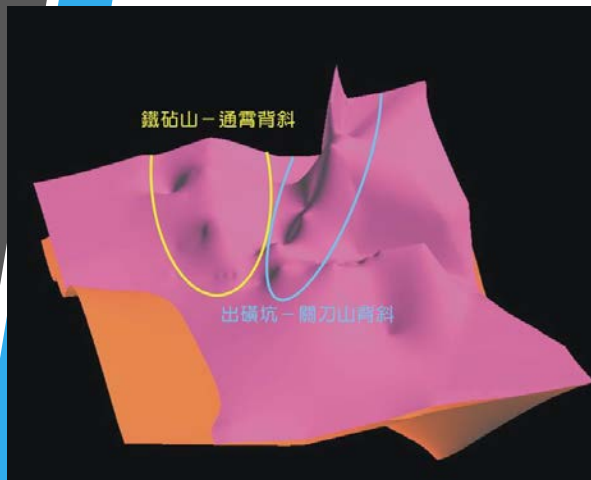
- 1 Namson, 1981, Line 1
- 2 CPC, 2003, Line 22
- 3 CPC, 2003, Line 21
- 4 CPC, 2003, Line 20
- 5 本研究自行製作之剖面
- 6 Hung, 2002
- 7 洪日豪, 未發表
- 8 CPC, 2003, Line 18



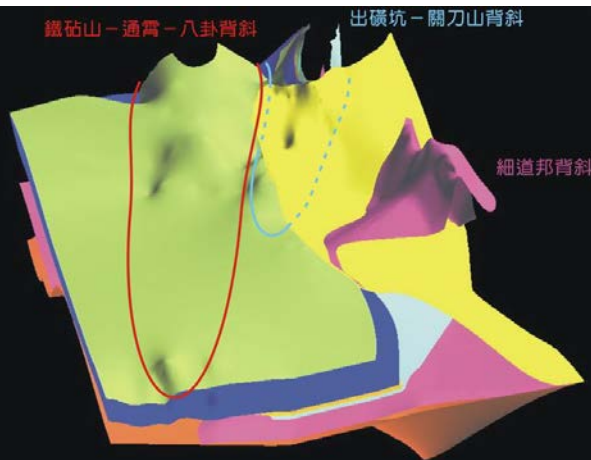


# 3D structure of Western Foothills in the central Taiwan

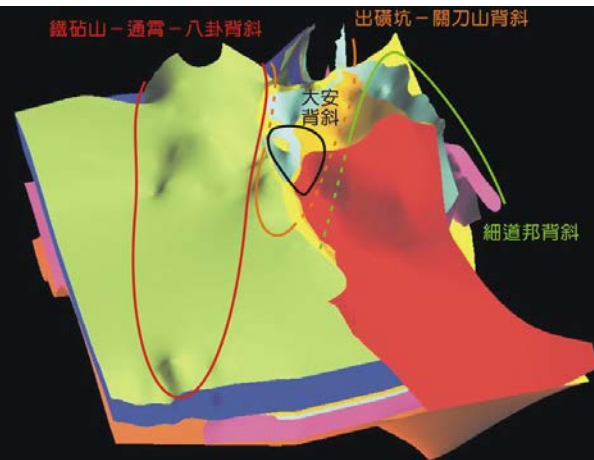
三義斷層下盤木山層



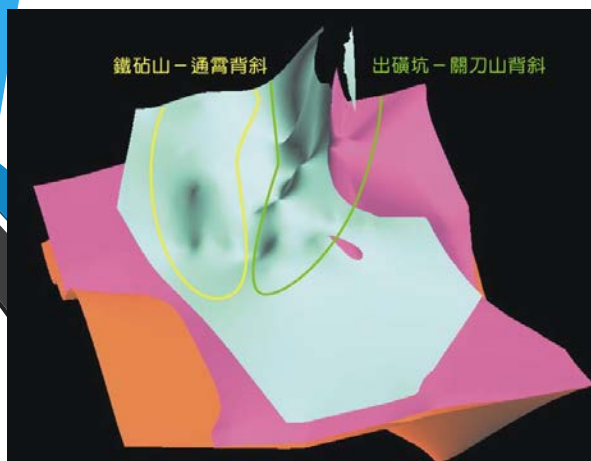
三義斷層上盤木山層



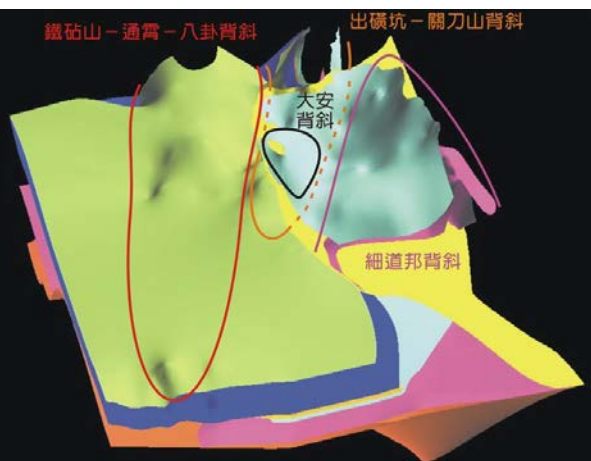
車籠埔斷層



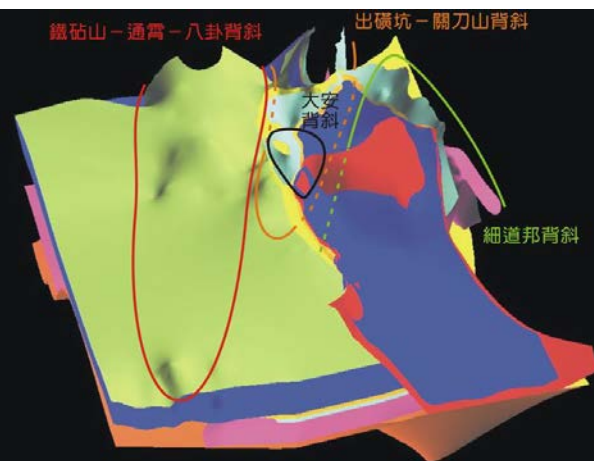
三義斷層下盤東坑層



三義斷層上盤東坑層



車籠埔斷層上盤錦水頁岩





# Teaching plan

- Introduction to geology and lab
- Field geology and lab
- Geological field trip
- Geomorphology and lab
- Active tectonics
- Metamorphic petrology
- Structural geology
- Engineering geology
- Geology of Taiwan





# Teaching plan

- Field trips for international students
  - University of Connecticut, CT USA
  - Indiana University of Pennsylvania, PA USA



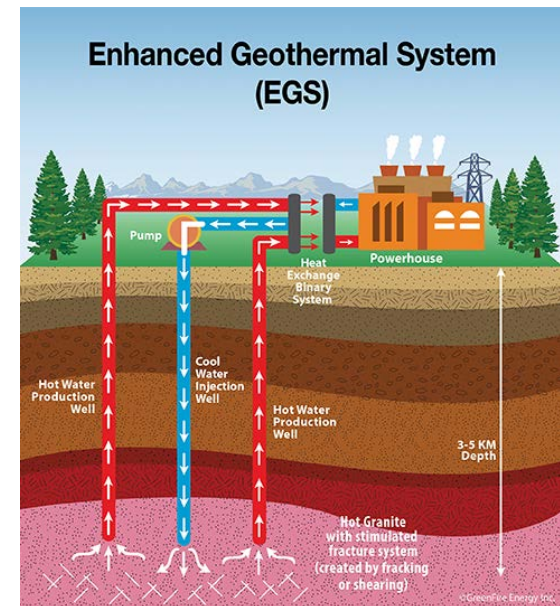
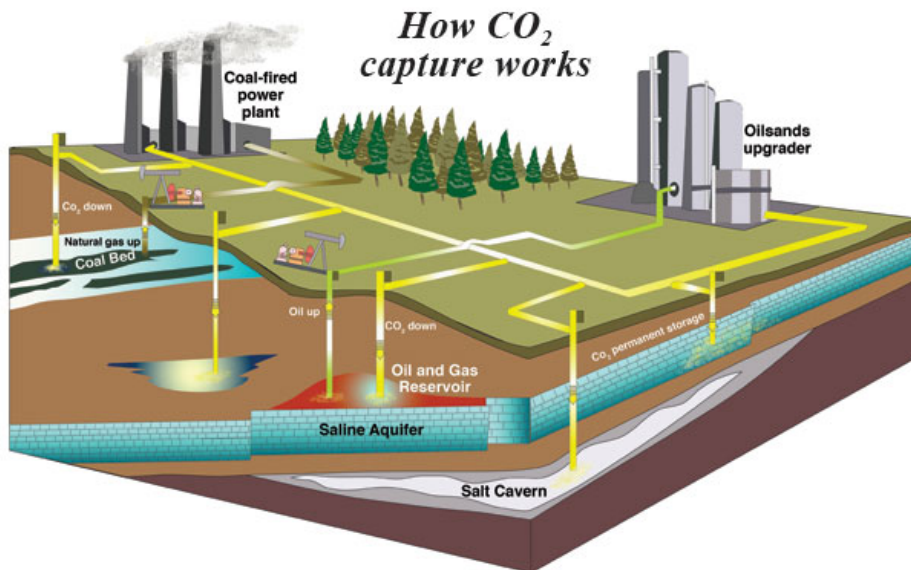


# Future projects

## Carbon Capture and Storage, Geothermal Power Plant

Dept. of Earth Sciences (NCU), TPC, ITRI, CPC, Sinotech Consultants, Inc.

- Construct a geological model with faults and shear zones in the injection field.
- Evaluate the possibility of earthquake caused by injection.
- Monitoring surface deformation and downhole strain for the early-warning of injection-related earthquake.



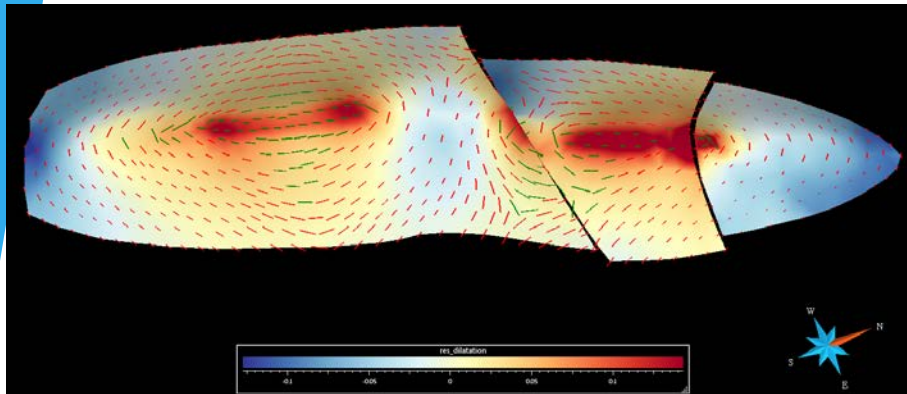


# Future projects

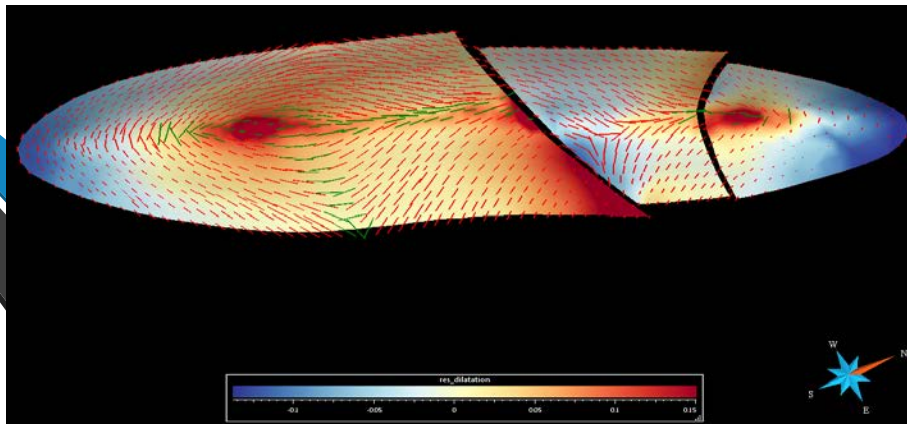
## Fracture distribution in the anticlines of Taiwan

Dept. of Earth Sciences (NCU), Jonny Wu (UH), 黃旭燦 (CPC)

錦水背斜內木山層



錦水背斜內五指山層



- The KINE3D module in GoCAD can restore any curved surface and calculate strain and shortening direction.
- Fracture distribution is crucial for oil and gas production, and also important for CCS



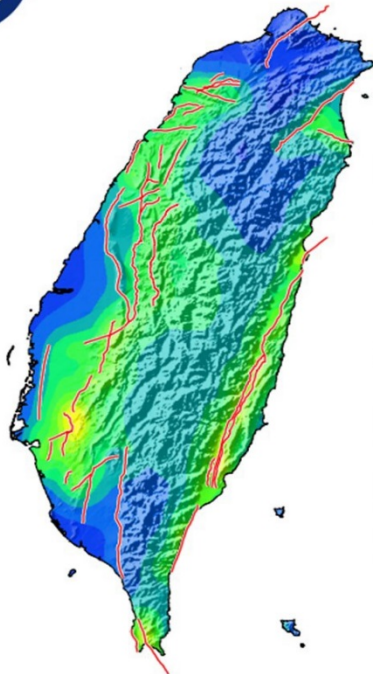
# Future projects

## Detailed fault geometry model and active fault sensitive areas

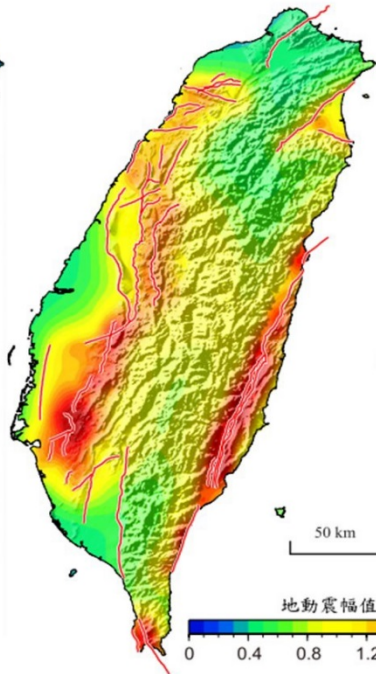
Dept. of Earth Sciences (NCU), CGS, CWB, AS-IES, TPC, CPC,  
Sinotech Consultants, Inc., Sinotech Engineering Consultants, Ltd.



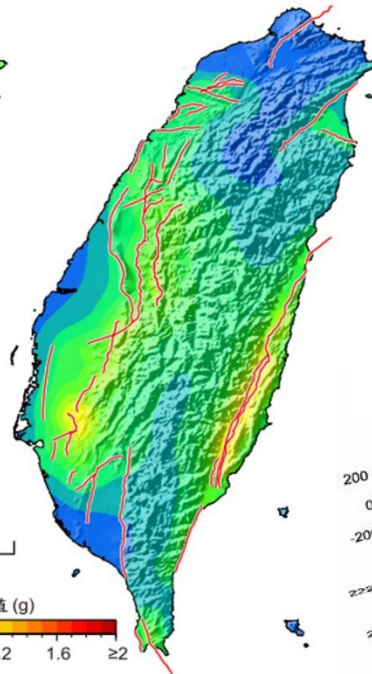
(1) 最大加速度震幅



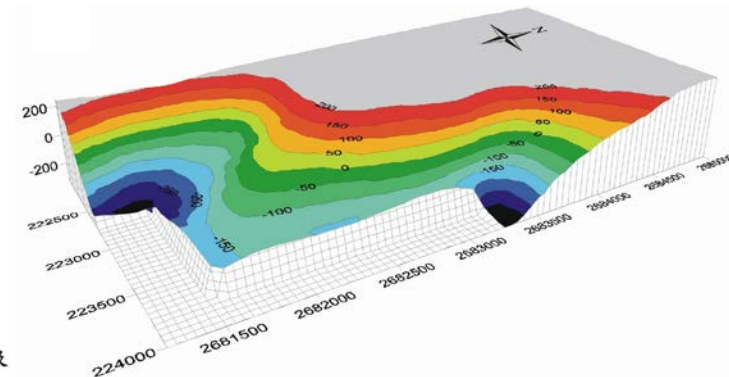
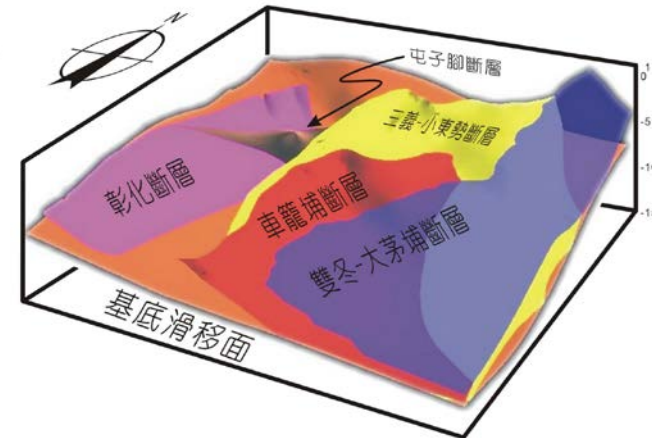
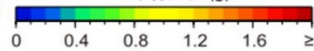
(2) 加速度反應頻譜0.3秒



(3) 加速度反應頻譜1.0秒



地動震幅值(g)



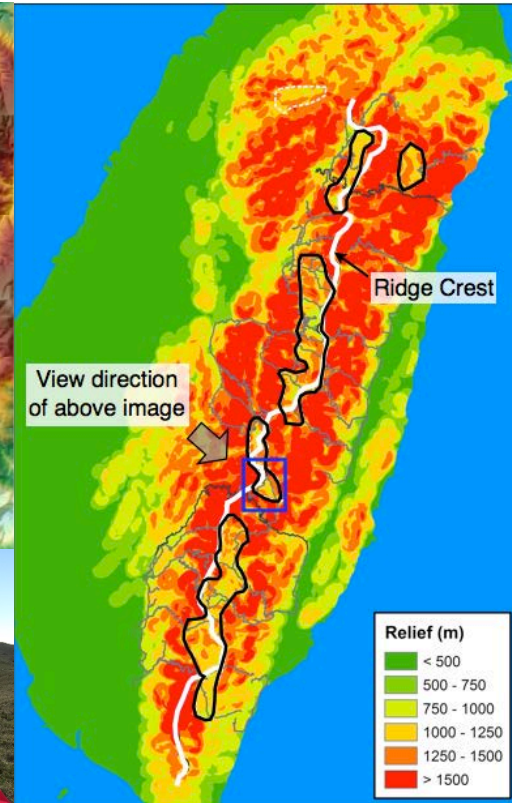
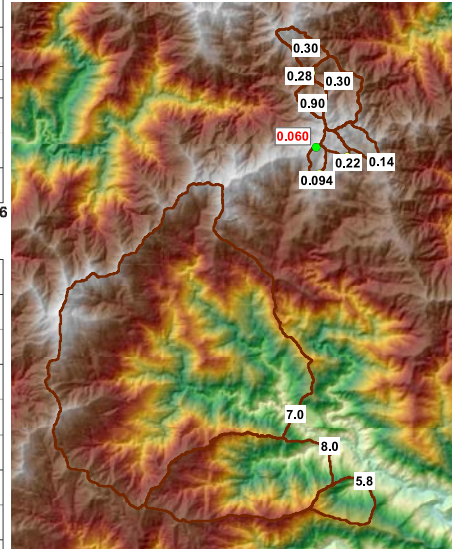
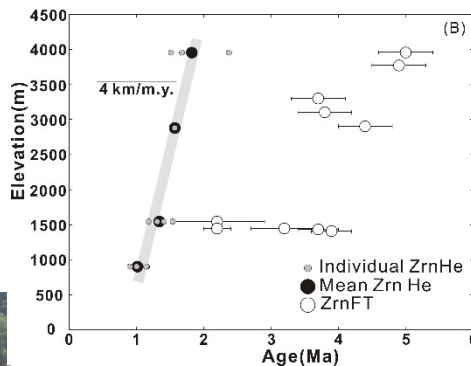
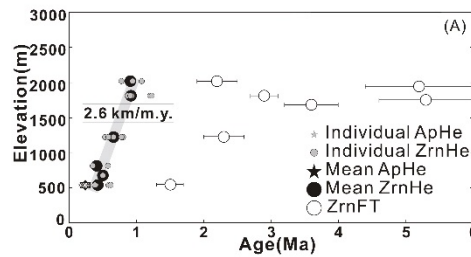
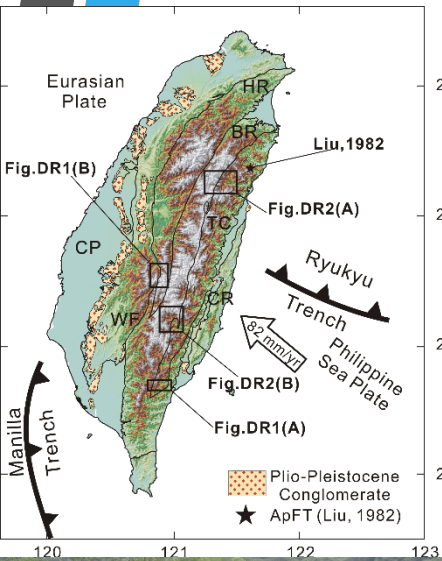
以台灣地震模型之孕震構造參數，評估台灣地區(1)最大加速度振幅、(2)加速度反應頻譜0.3秒，以及(3)加速度反應頻譜1.0秒，在50年內超越機率10%之可能地動震幅值分佈圖。



# Future projects

## Mountain building processes of Central Range

Tim Byrne, Will Ouimet, Michael Hren (UConn), Kip Hodges (ASU)  
In preparation, will be submitted to Geology



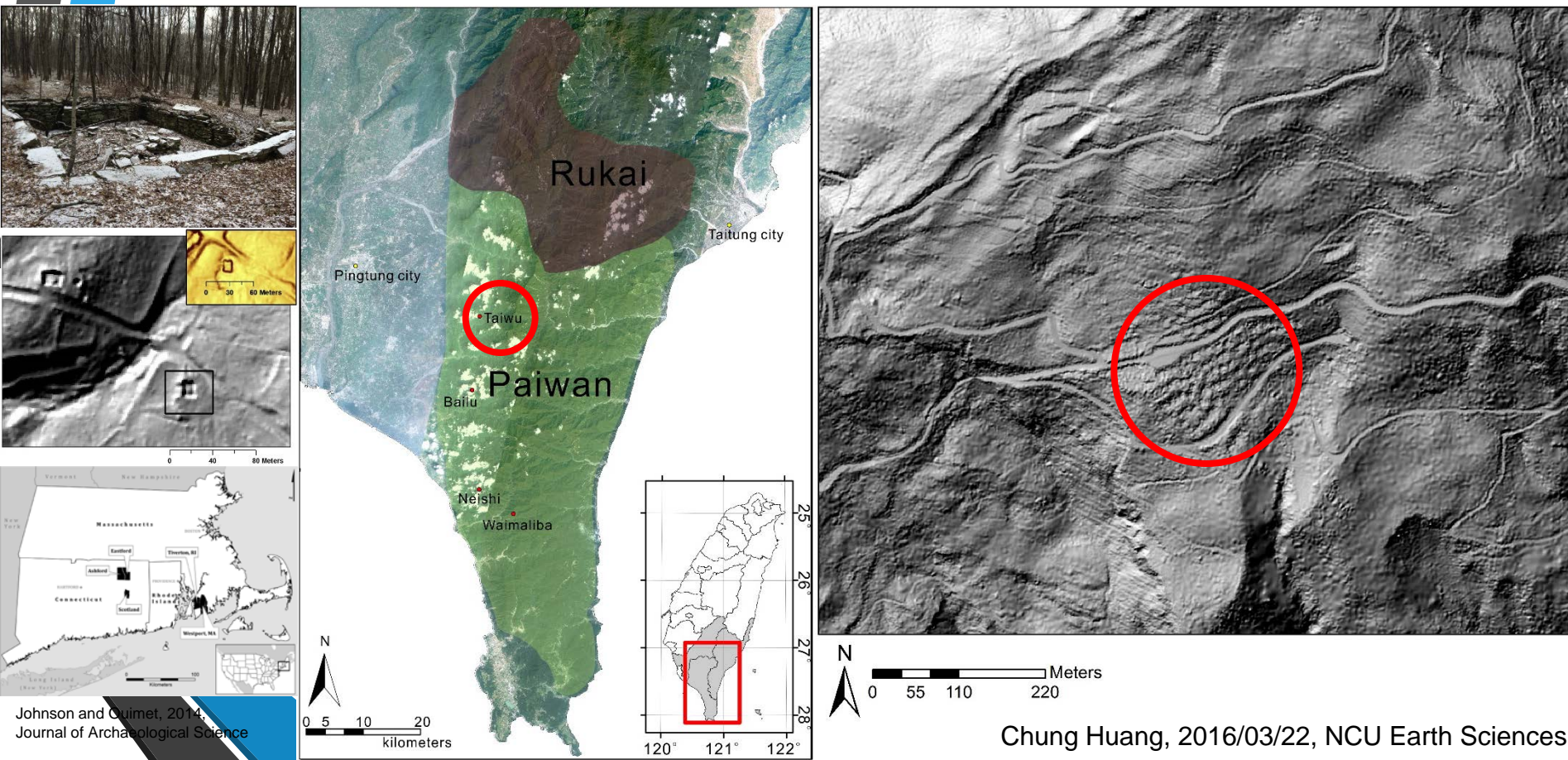


# Future projects

## Application of LiDAR on archaeological study of Taiwan

陳瑪玲 (NTU), 郭素秋 (Sinica), 謝有忠 (CGS), Will Ouimet (UConn)

In preparation, will be submitted to Journal of Archaeological Science

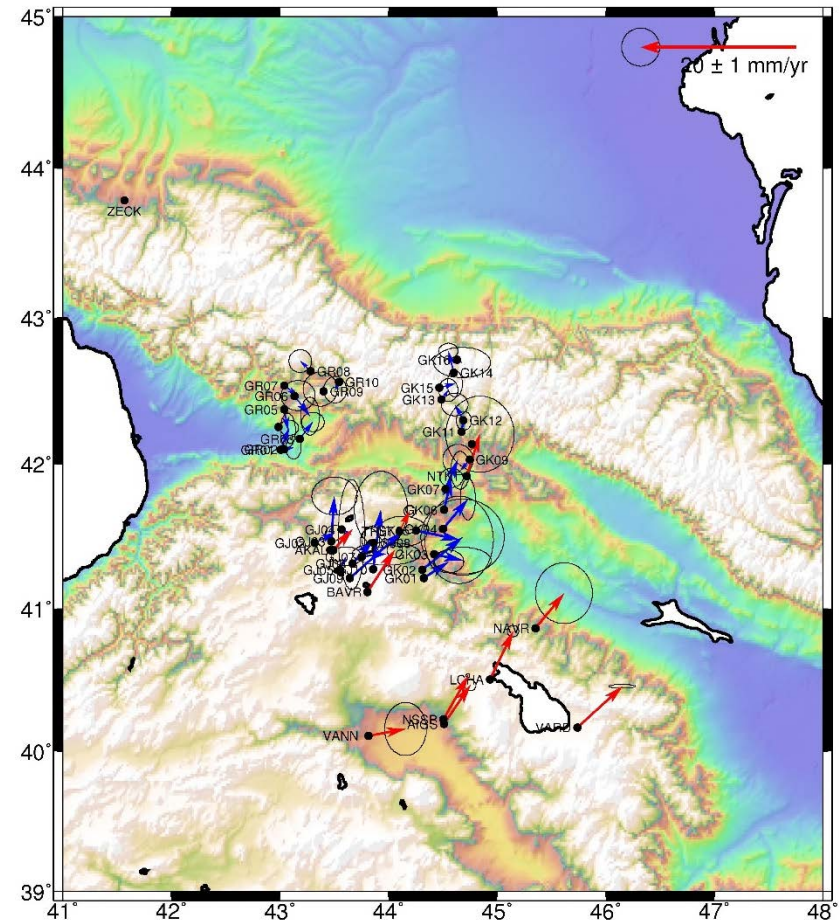
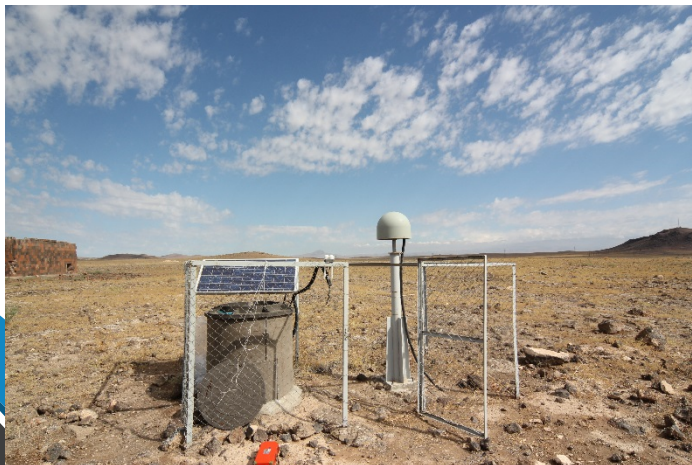




# Future projects

## Neotectonics of Caucasus Mountains

胡植慶、曾泰琳 (NTU), 黃柏壽、陳宏宇 (Sinica), Rob Reilinger, Michael Floyd (MIT)



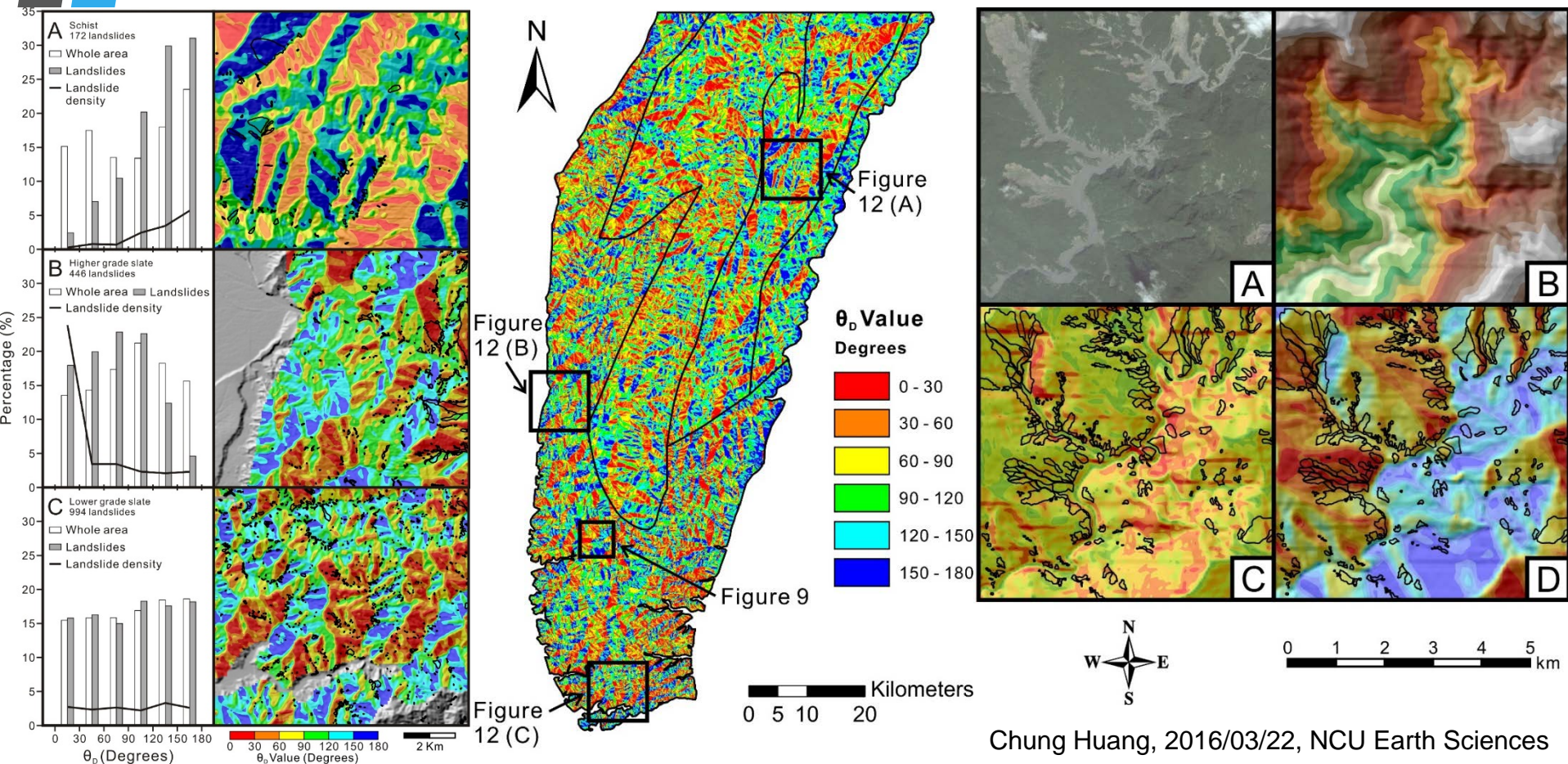


# Future projects

## Landslide properties of southern Central Range, Taiwan

Tim Byrne, Will Ouimet (UConn)

In review, submitted to Tectonophysics







Thank you for your attention!