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Determination of Structural Characteristics of the Chusiang Active Fault Using Geological Cross-Sections
利用地質剖面探討初鄉活動斷層構造特性

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Data : 2023/03/10

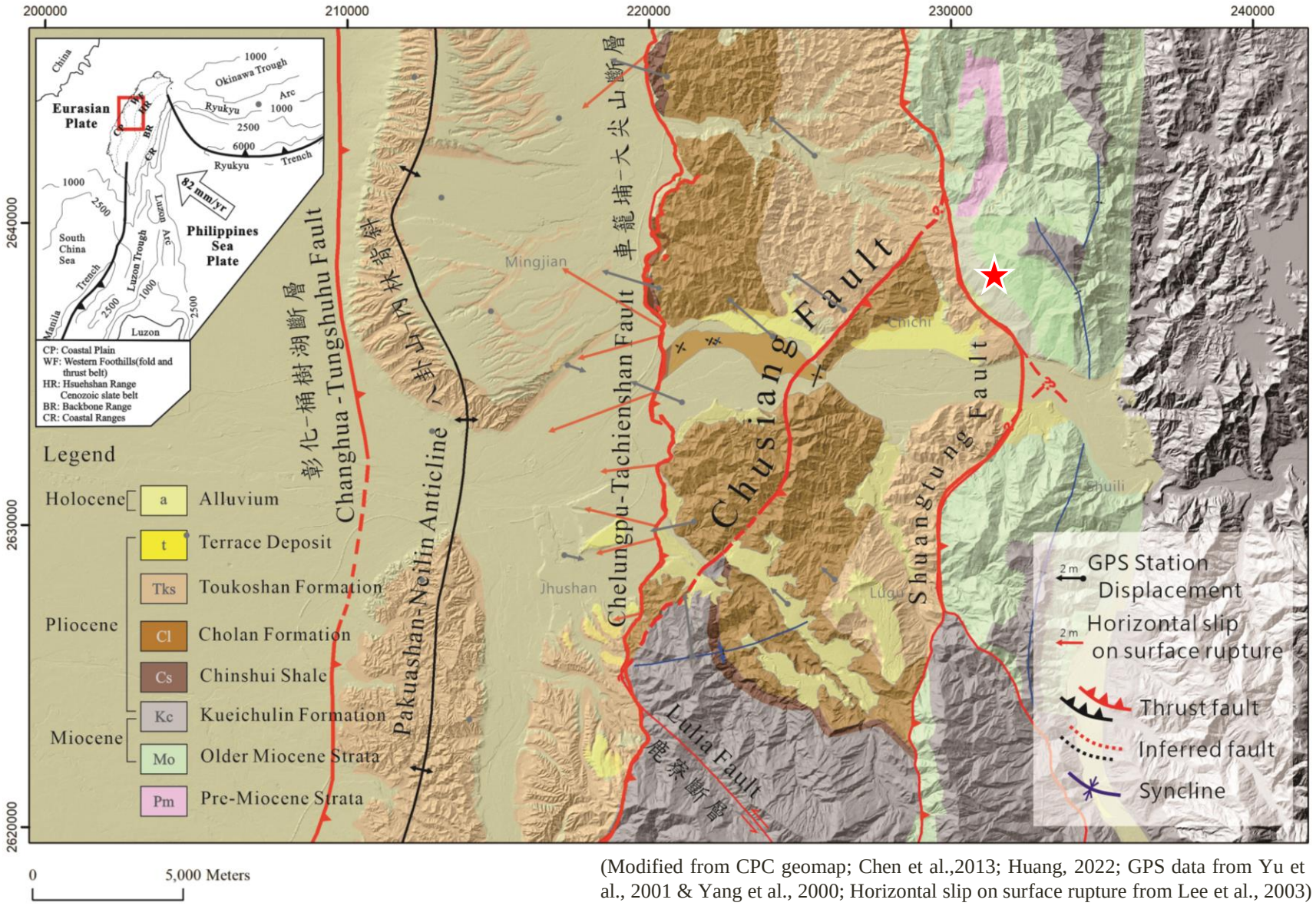
OUTLINE

- Introduction
  - 1999 ChiChi Earthquake & Geological setting
  - Motivation & Purpose
- Structural Cross-Sections
- Results
- Discussion
- Conclusions

INTRODUCTION

1999 Chi-Chi earthquake

- The block between the Shuangtung fault and the Chelungpu fault has the largest displacement (CGS, 1999).
- The GPS horizontal displacements have changed significantly across the Chusiang fault (Lee et al., 2003).
- No relative uplift and surface ruptures along the Chusiang fault (Lin et al., 2000).

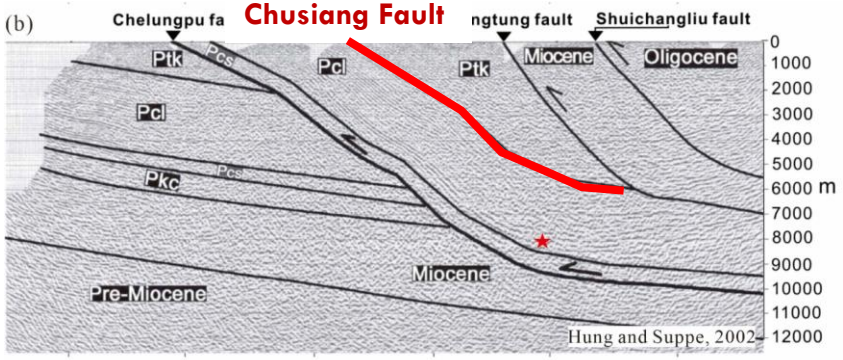


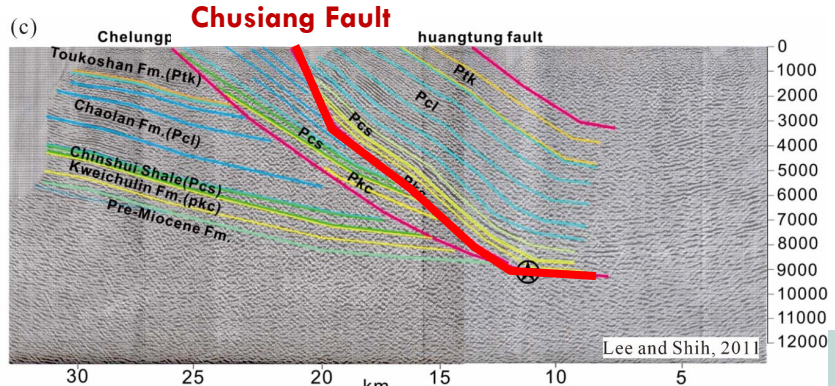
(Modified from CPC geomap; Chen et al.,2013; Huang, 2022; GPS data from Yu et al., 2001 & Yang et al., 2000; Horizontal slip on surface rupture from Lee et al., 2003)

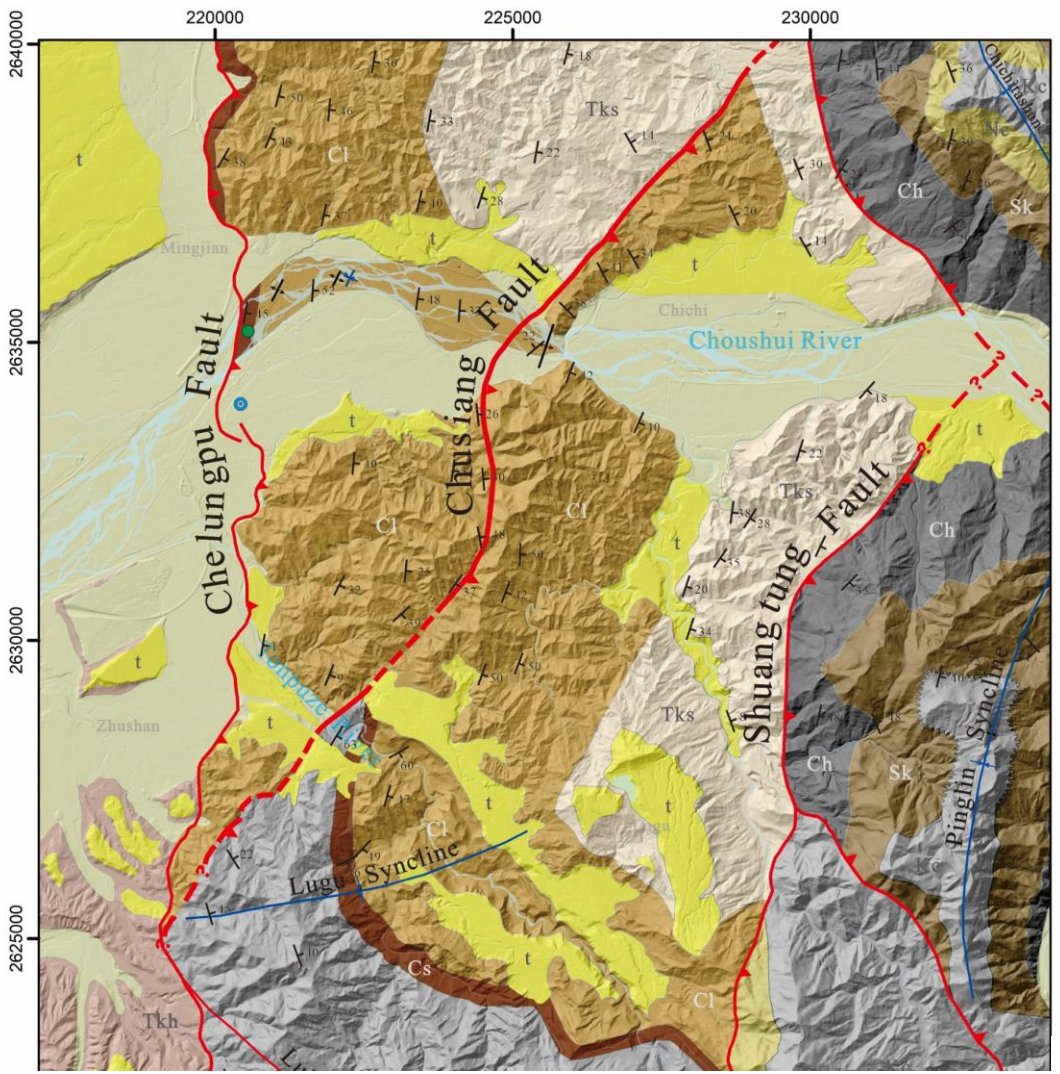
INTRODUCTION

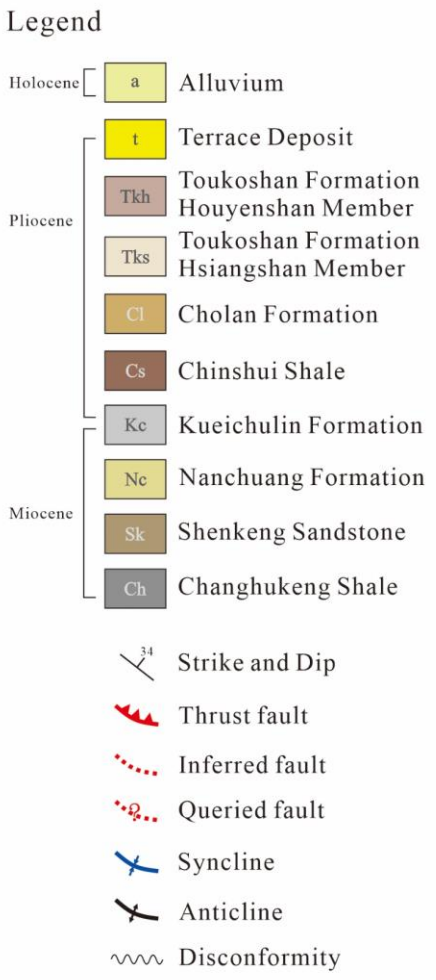
Motivation & Purpose

- In the next 50 years, the Chusiang fault has a 37% chance of causing a magnitude 6.0 earthquake. (TEM, 2022)
- Debate for the interpretation of the seismic reflection profile along the Choushui River.









(Modified from CPC geomap; Chen et al.,2013)

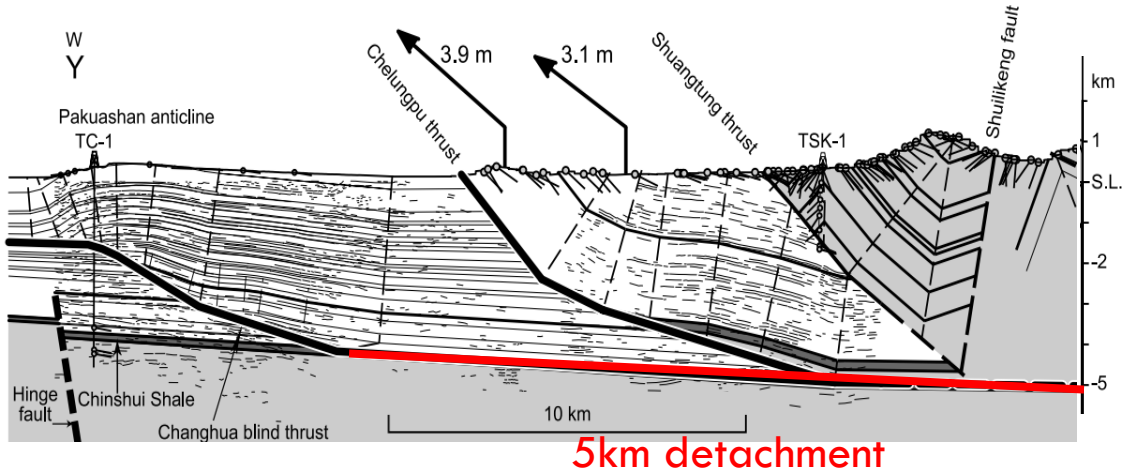
- To understand the geometric relationship between the Chusiang fault and the surrounding structures
- Activation of the Chusiang fault (during the 1999 ChiChi earthquake)

→ **Construct Plausible Structural Cross-Sections**

INTRODUCTION

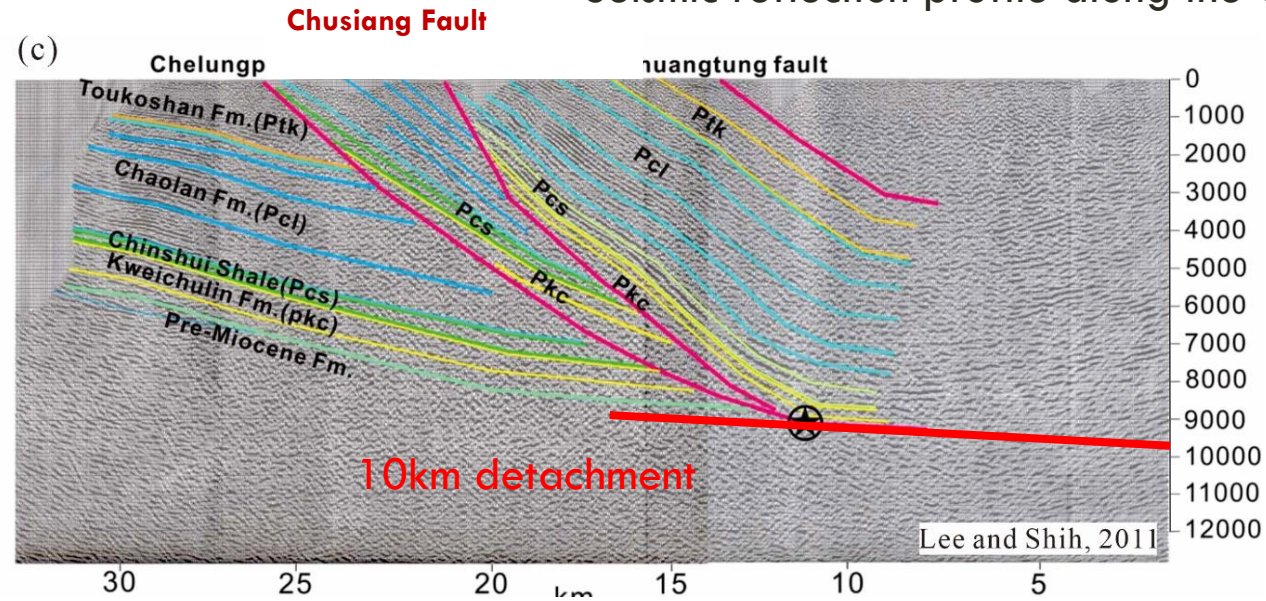
Previous Structural Cross-sections

- North of Choushui River
  - Detachment 5-6 km (Much shallow than the south)



- Include the Chusiang Fault

Seismic reflection profile along the Choushui River



- The interpretation is hard to connect to the north.

(Yu et al.,2005; Yang et al., 2007;Lee and Shih, 2011; Detal et al., 2012)

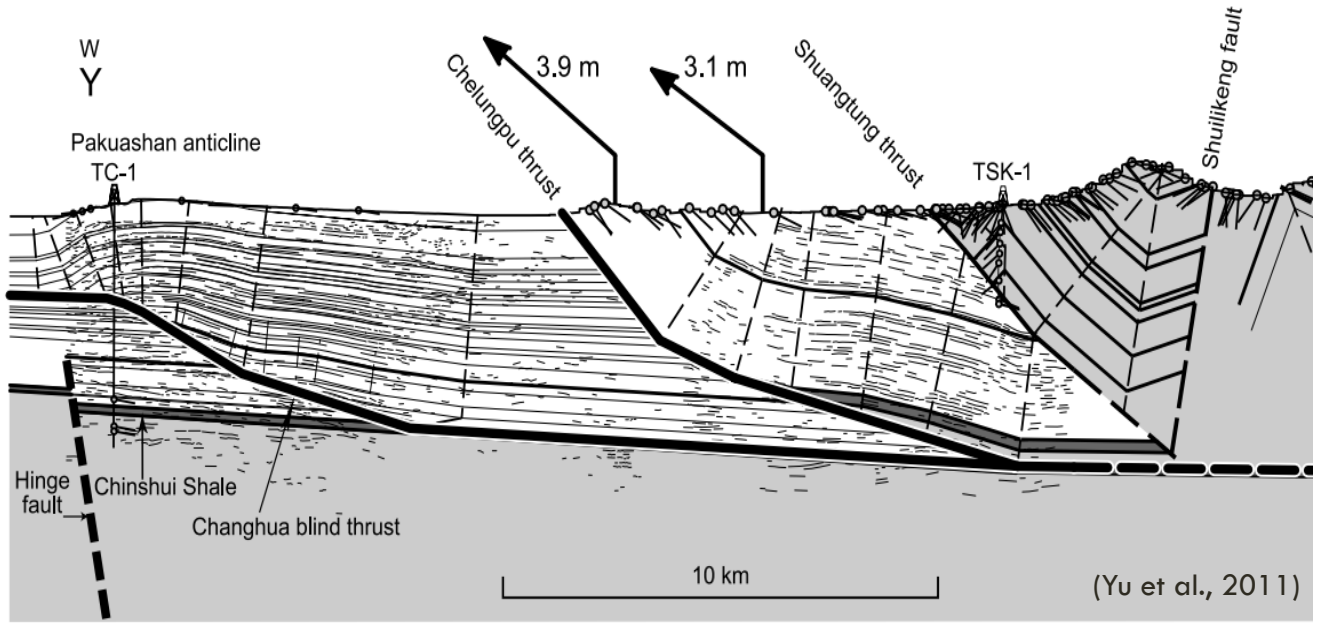
STRUCTURAL CROSS-SECTIONS

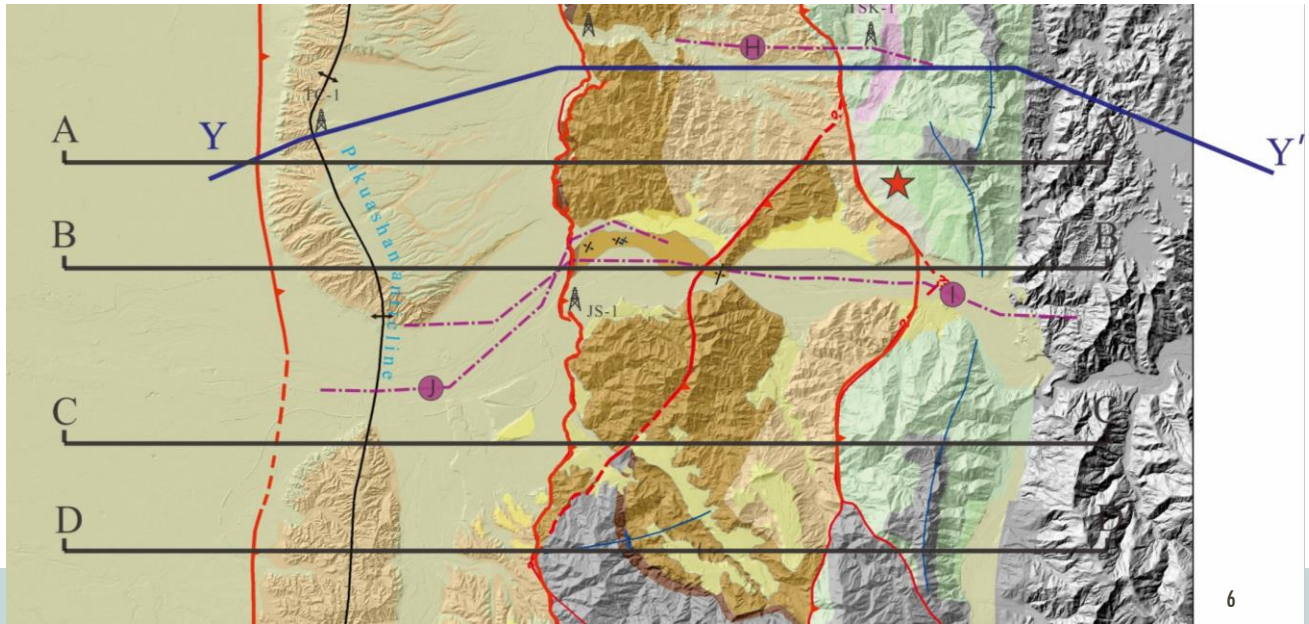
Structural Cross-Sections

- Strata :
  - The changing thickness of the formations
- Structures :
  - The geometry of the faults
  - The angle of detachment

→ Geological map & Boreholes & Seismic reflection profiles & Coseismic GPS displacements

- Method :
  - Kink method
  - Balancing cross-sections

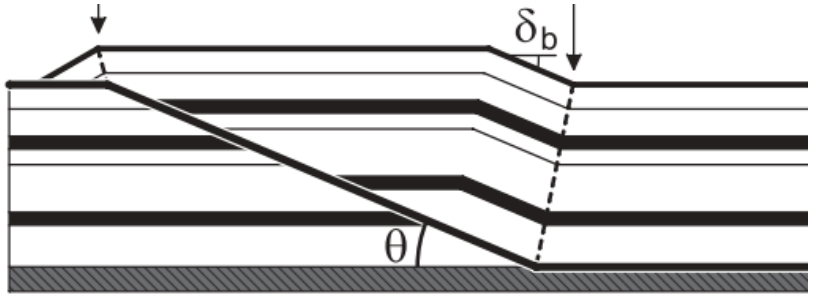




STRUCTURAL CROSS-SECTIONS

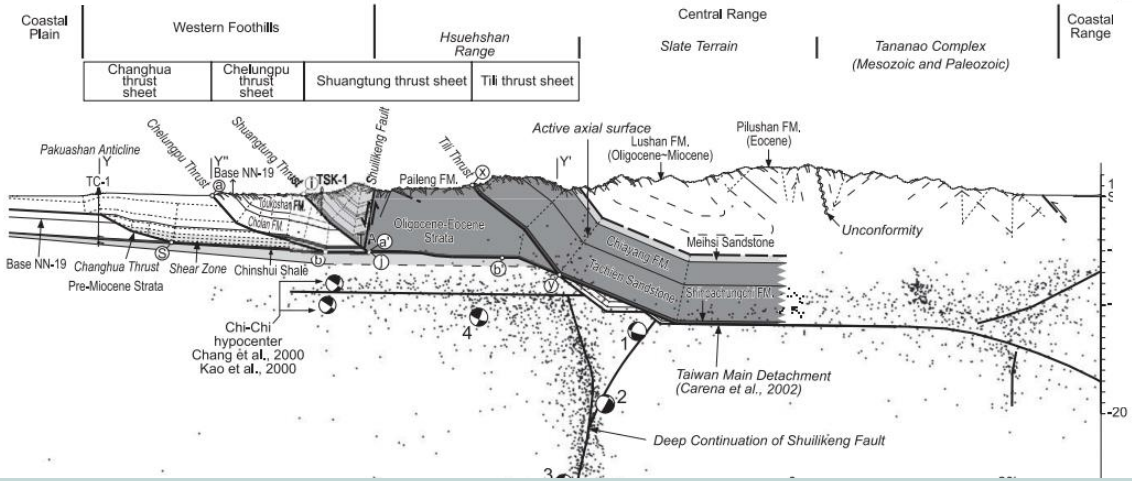
Method

- Kink method
  - The Chelungpu thrust shows a classic fault-bend folding geometry. The bending of the fault plane at depth results in a monoclinal kink-shape in the strata of the hanging wall (Yu et al., 2011; Lai et al., 2006).
  - Suitable for areas where the state changes rapidly in a short distance (Marshak & Mitra, 1988).
- Restoring and Balancing cross-sections

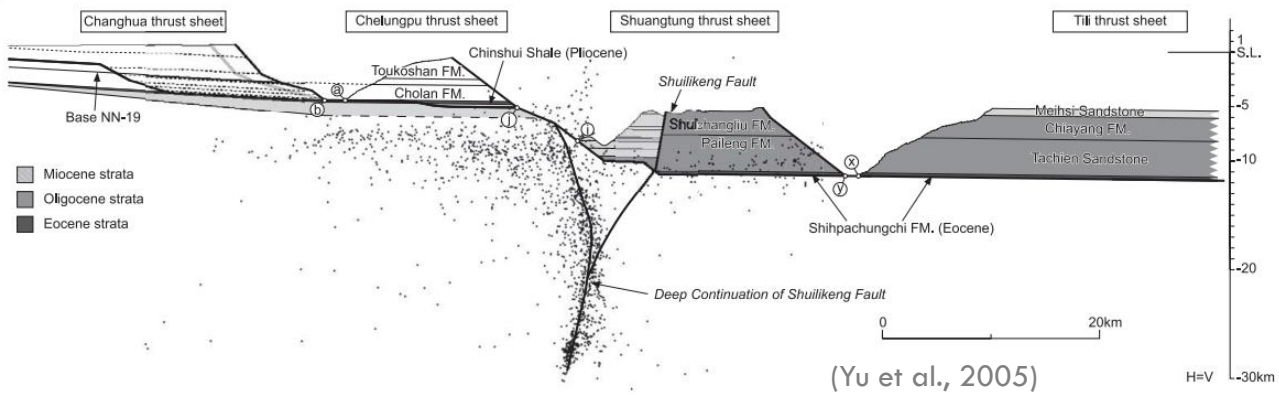


Classical fault-bend fold (Suppe, 1983)

Cross-sections



Restoring

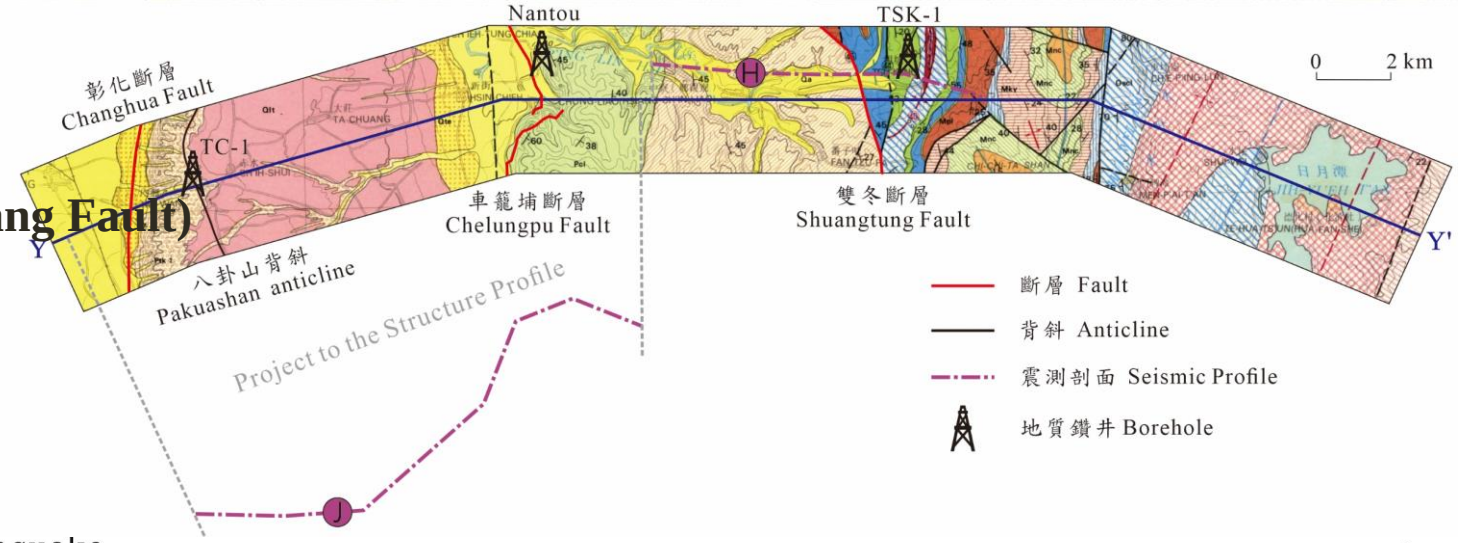


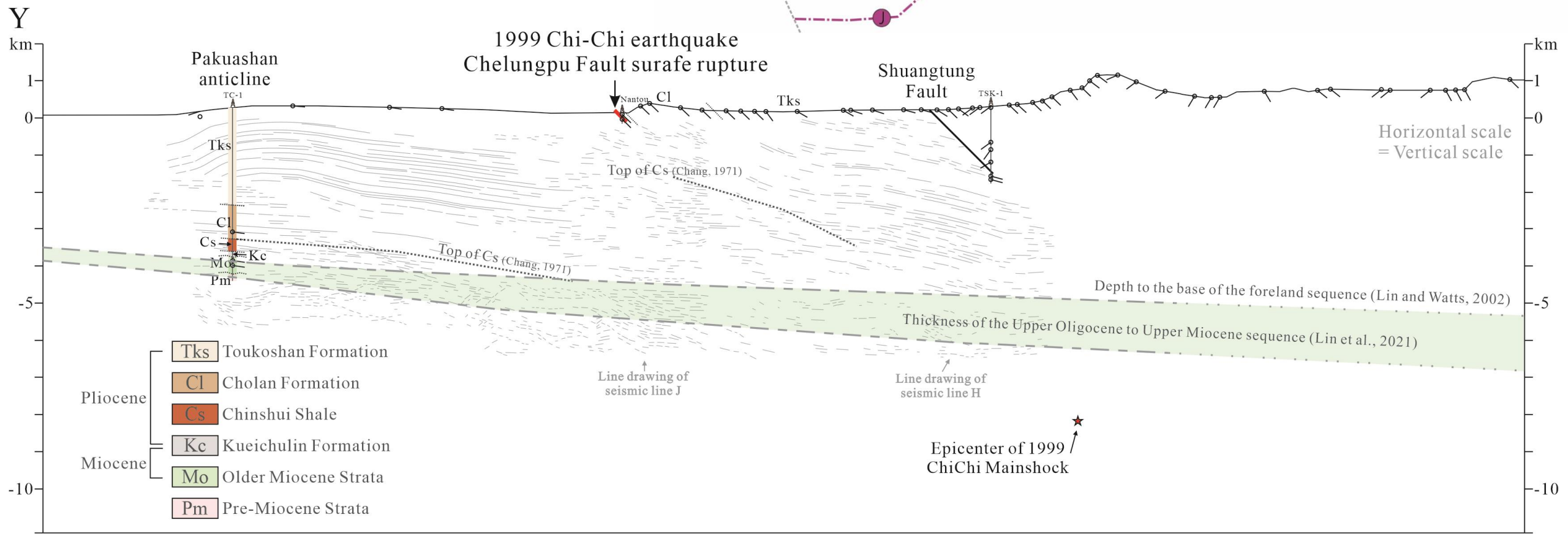
(Yu et al., 2005)

STRUCTURAL CROSS-SECTIONS

Structural Cross-Sections – YY' (North of Chusiang Fault)

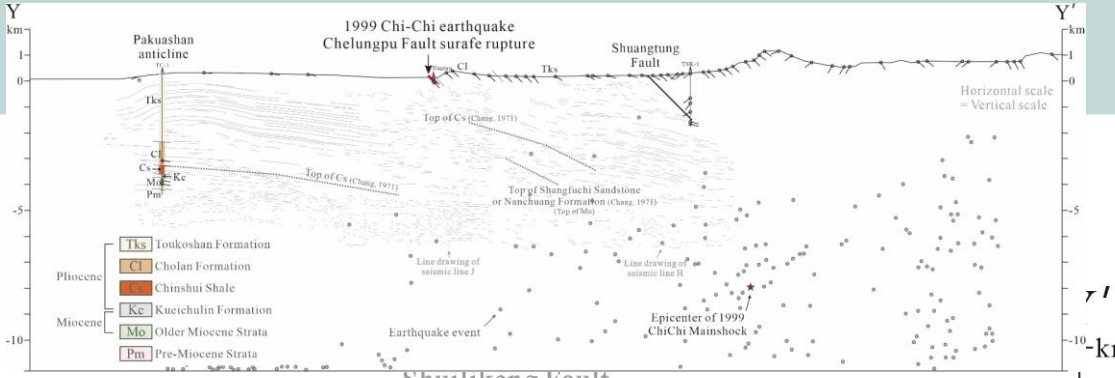
- Constrained - YY
  - Surface/2 Seismic Profiles/3 Boreholes

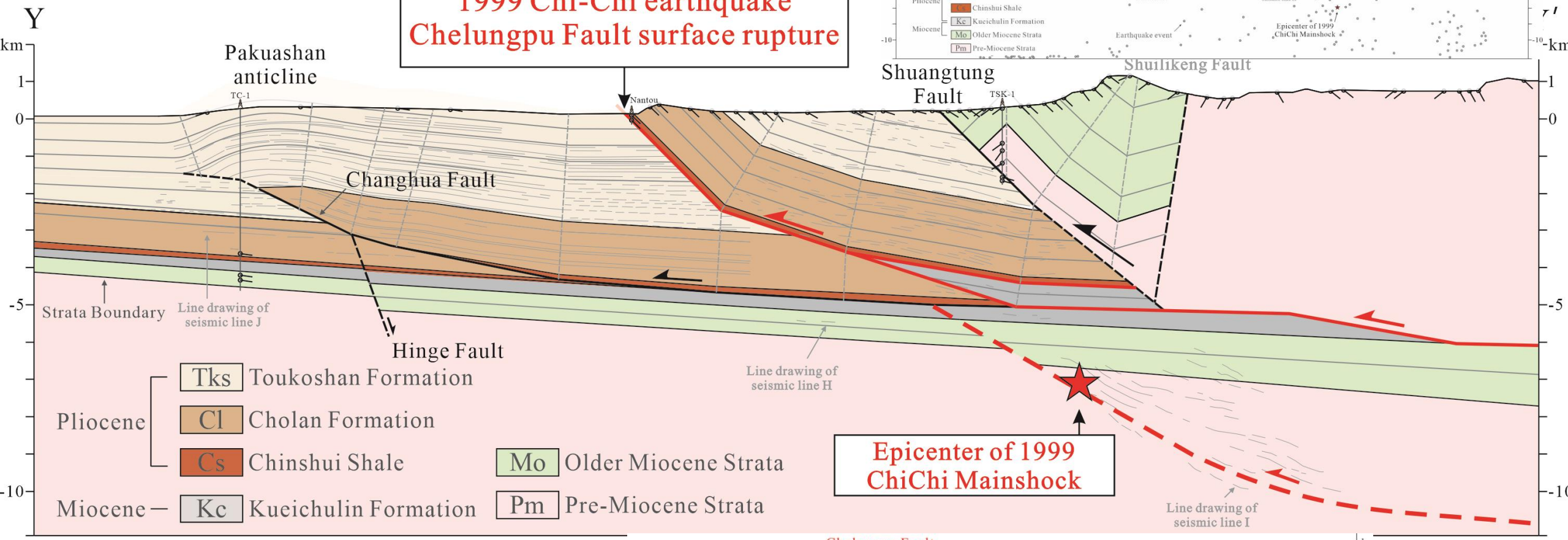




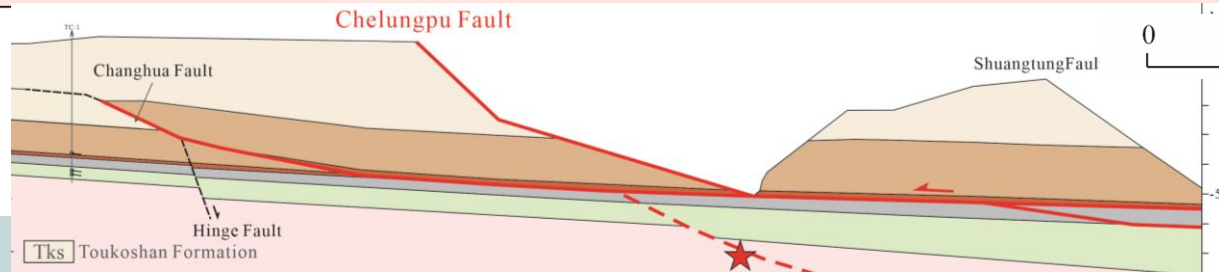
RESULTS

Structural Cross-Sections – YY'





Modified from Yu et al., 2005 YY' Profile

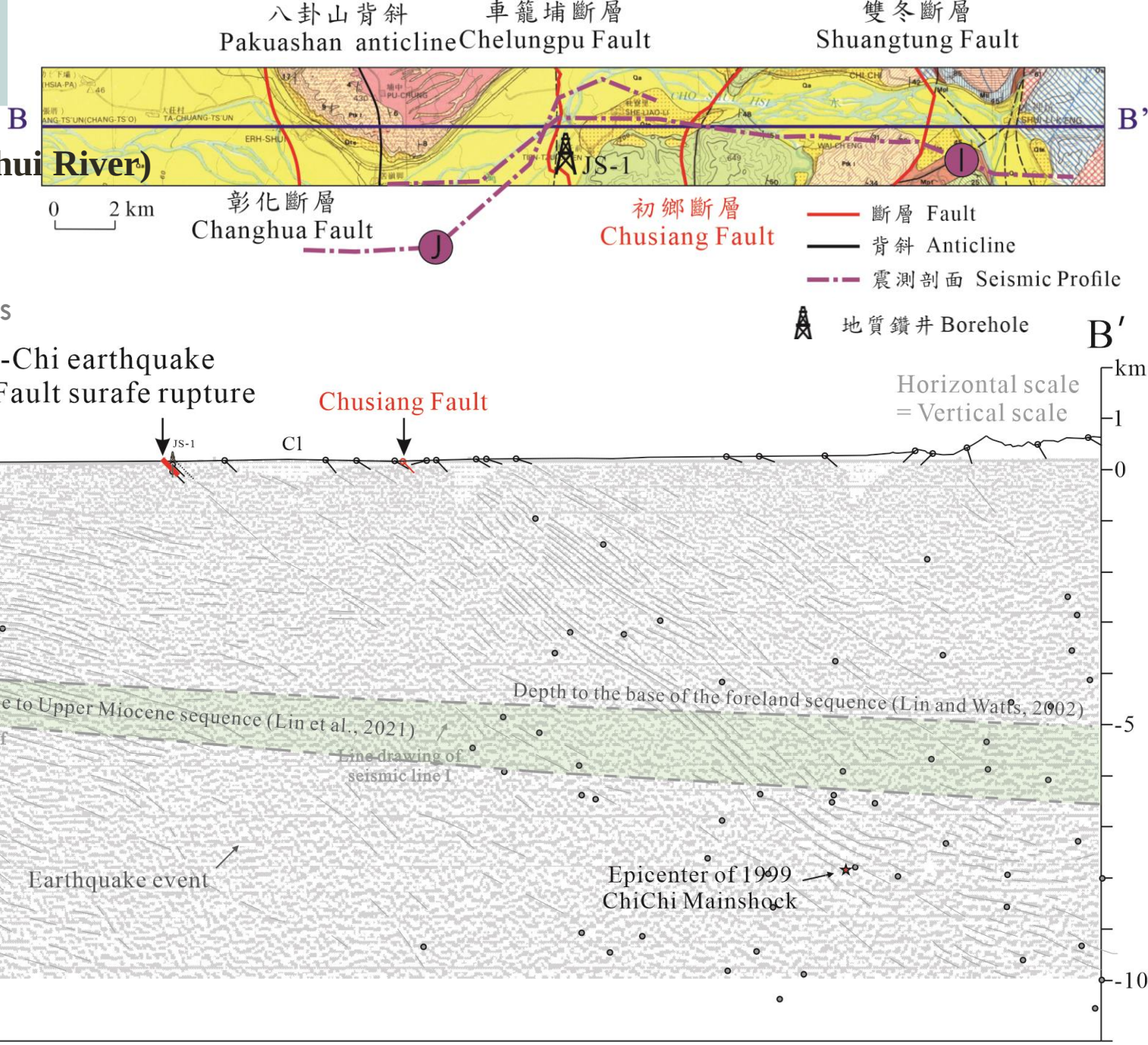


- Total shortening of the Chelungpu Fault : About 25.6km

GEOLOGICAL SETTING

Structural Cross-Sections – BB' (Along Choushui River)

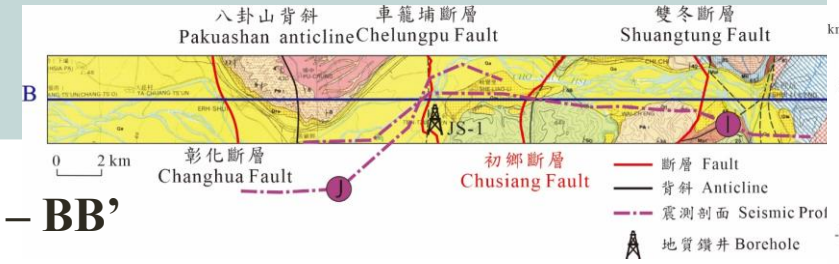
- Constrained - BB
  - Surface/2 Seismic Profiles/3 Boreholes

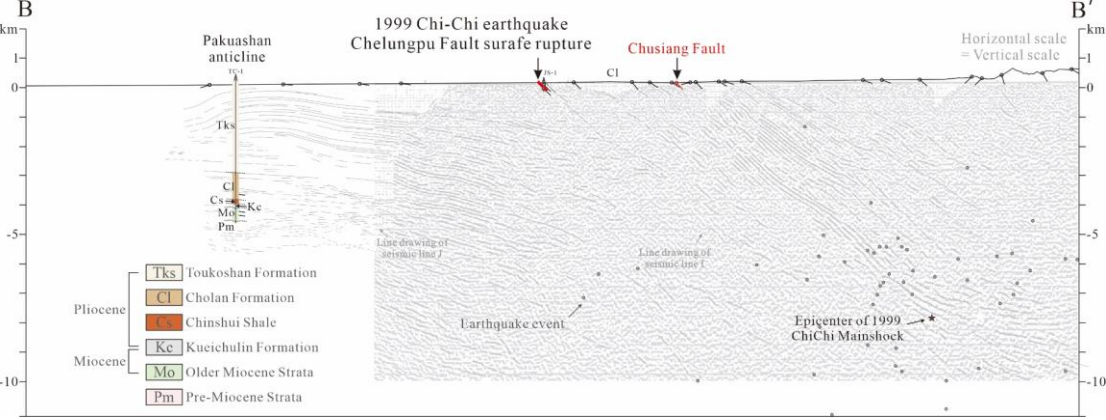


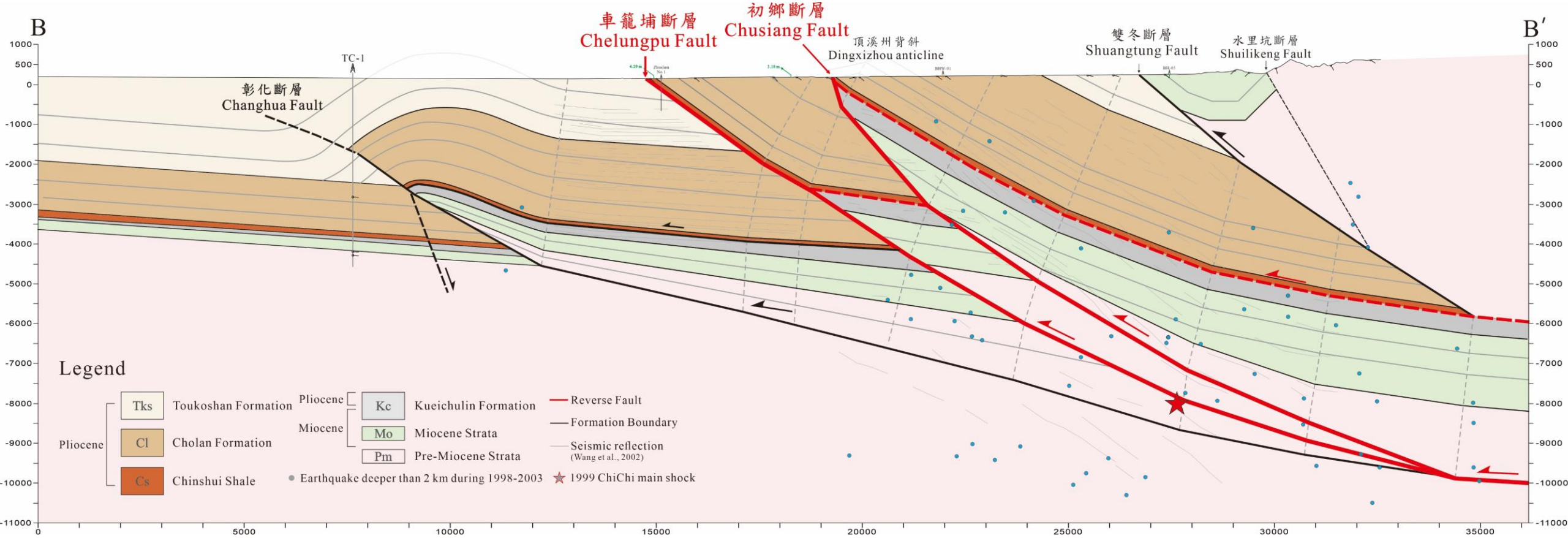
RESULTS

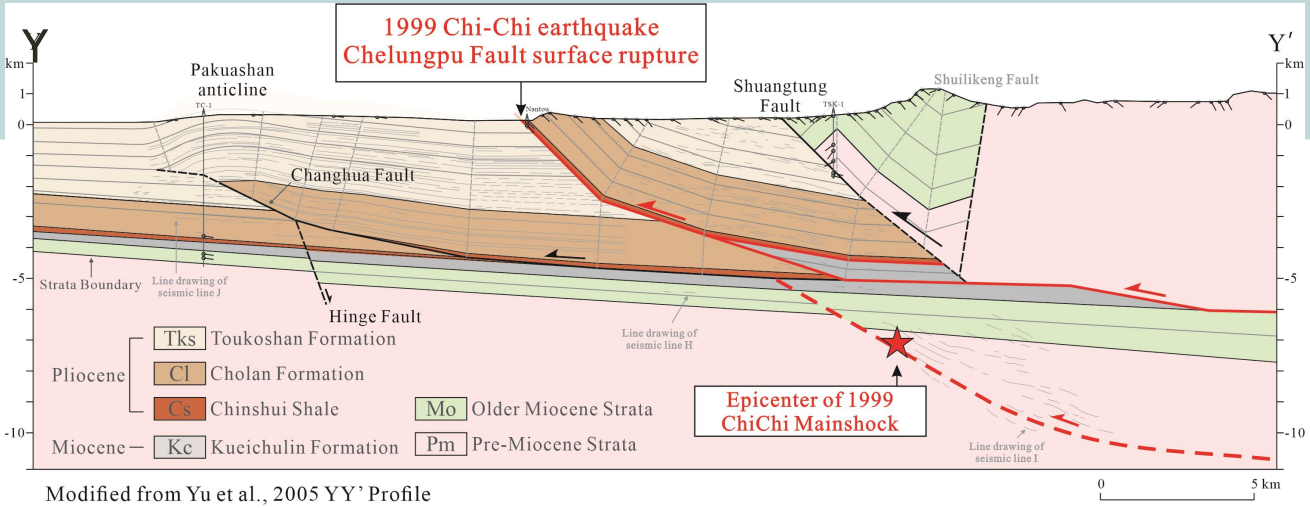
Structural Cross-Sections – BB’

- Constrained - Surface/Seismic Profiles(I,J)/Boreholes(TC-1,JS-1)



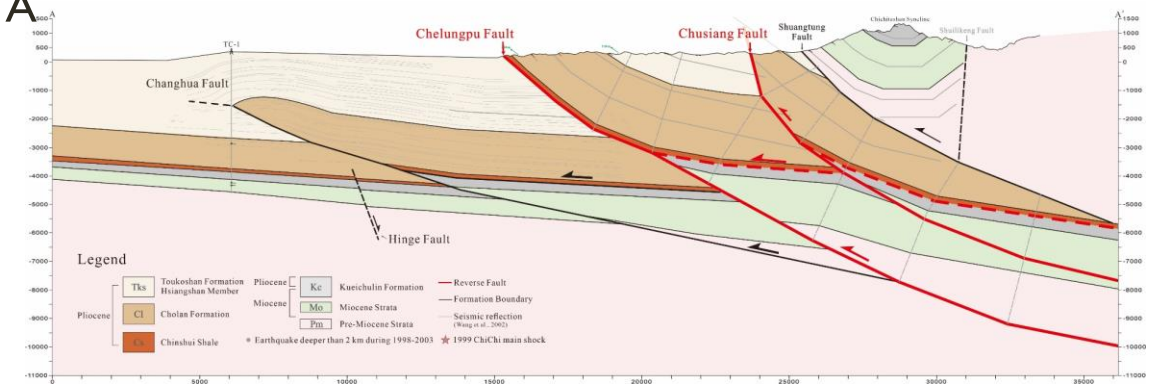




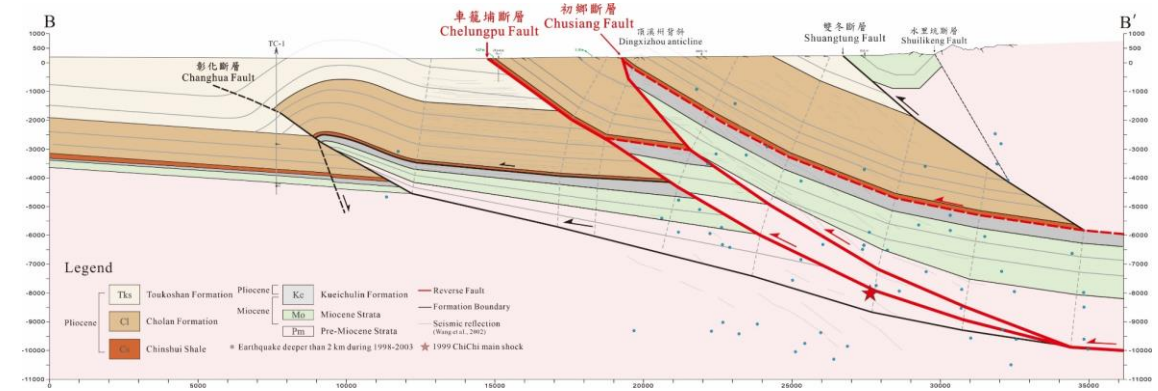


Modified from Yu et al., 2005 YY' Profile

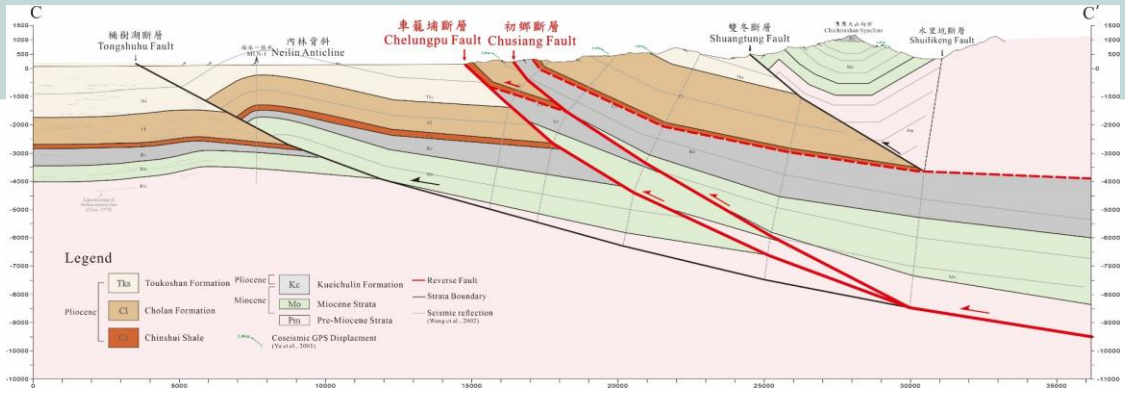
A



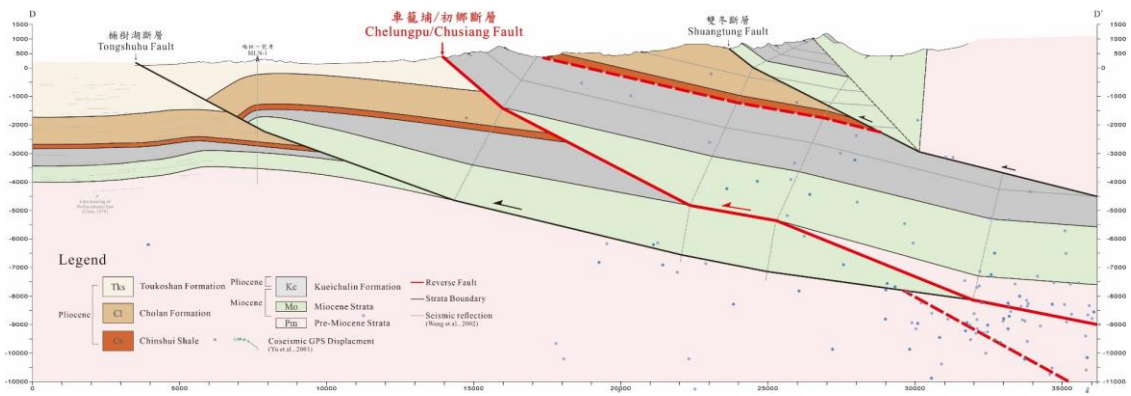
B



C



D



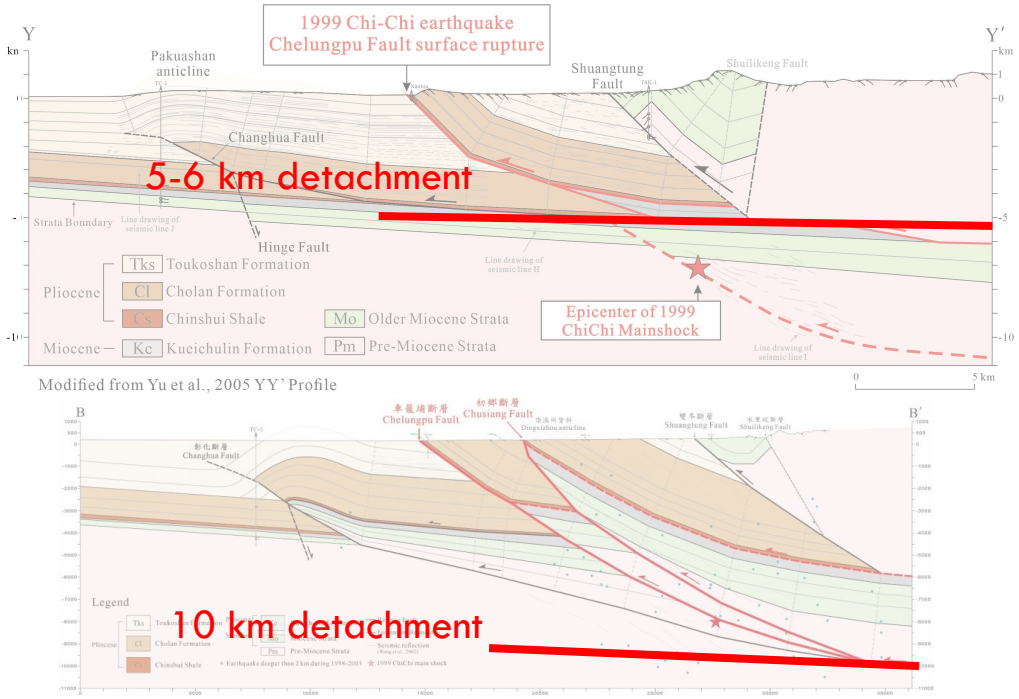
- From North to South : YY' AA' BB' CC' and DD'
- The Chusiang Fault in the south has larger displacement and cuts deeper than it in the north.
- The thickness of Kueichulin Formation in the south is much thicker than the thickness in the north.

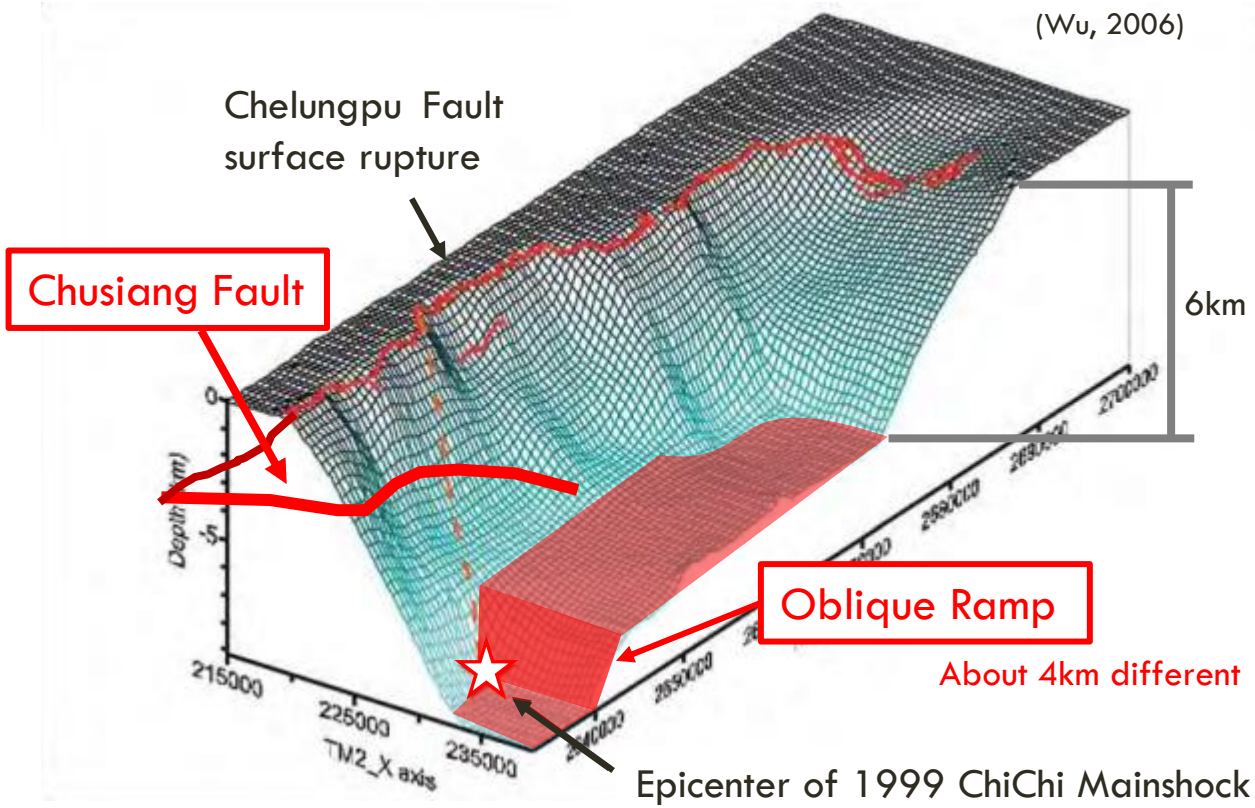
DISCUSSION

Chelungpu detachment model

- YY' profile and BB' profile have the detachment in different depth. (5-6km and 10km)

→ How to connect the YY' profile and BB' profile ?



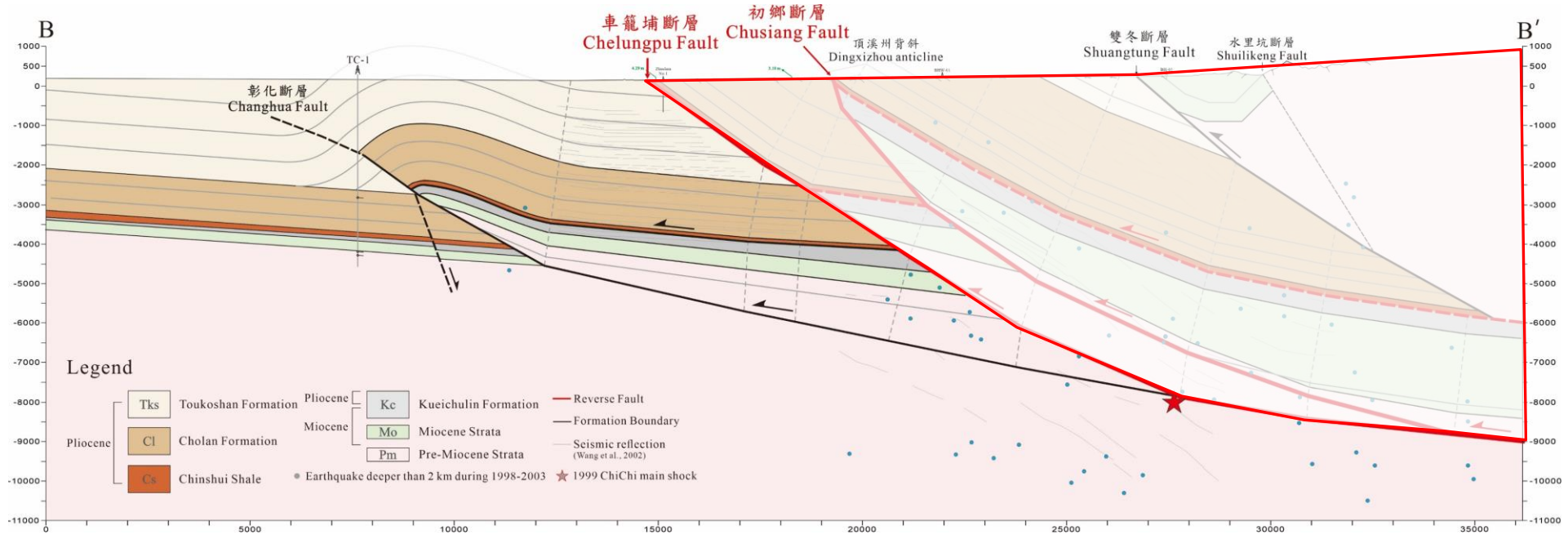


The two segments of the detachment may have different behavior.

→ The Chusiang Fault adjusts the different offsets between the Chelungpu Fault and the Tachienshan Fault in two segments of the detachment.

CONCLUSIONS

- Based on the geological map and the cross-sections, the Chusiang fault merges with the Chelungpu fault at the deep detachment.
- The Chusiang Fault adjusts the different offsets between the Chelungpu Fault and the Tachienshan Fault in two segments of the detachment.
- During the 1999 Chichi earthquake, the Chelungpu fault brought up the hanging wall and the Chusiang Fault. (Non-relative deformation on both sides of the Chusiang Fault)



Thanks for your attention