New evidences for active folding in SW Taiwan from Sentinel-1 InSAR.

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Introduction

- Taiwan is located at the junction of the Philippine and Eurasian tectonic plates converging at a rate of about 8 cm per year (Figure 1 and 2)
- The western foothills of Taiwan are a West-verging active fold-and-thrust belt that accommodates about one third of the convergence Plate. The deformation front is located in the western coastal plain and continue offshore toward the south-west near the city of Tainan.
- East of this front, in South-Western Taiwan, high strain rate are measured by geodesy reaching up to one µstrain/year. Previous InSAR time-series analysis using ERS, ENVISAT and ALOS-1 data allowed us to precisely identify the geological structures on which strain concentrates, like the Tainan anticline, the Lungchuan ridge, or along the Gutingkeng fault.
- In this study we performed a InSAR time-serie analysis of Sentinel-1 data from 2014 to 2018, and focused our tectonic interpretation on the deformations observed in the coastal plain located South of the city of Tainan.

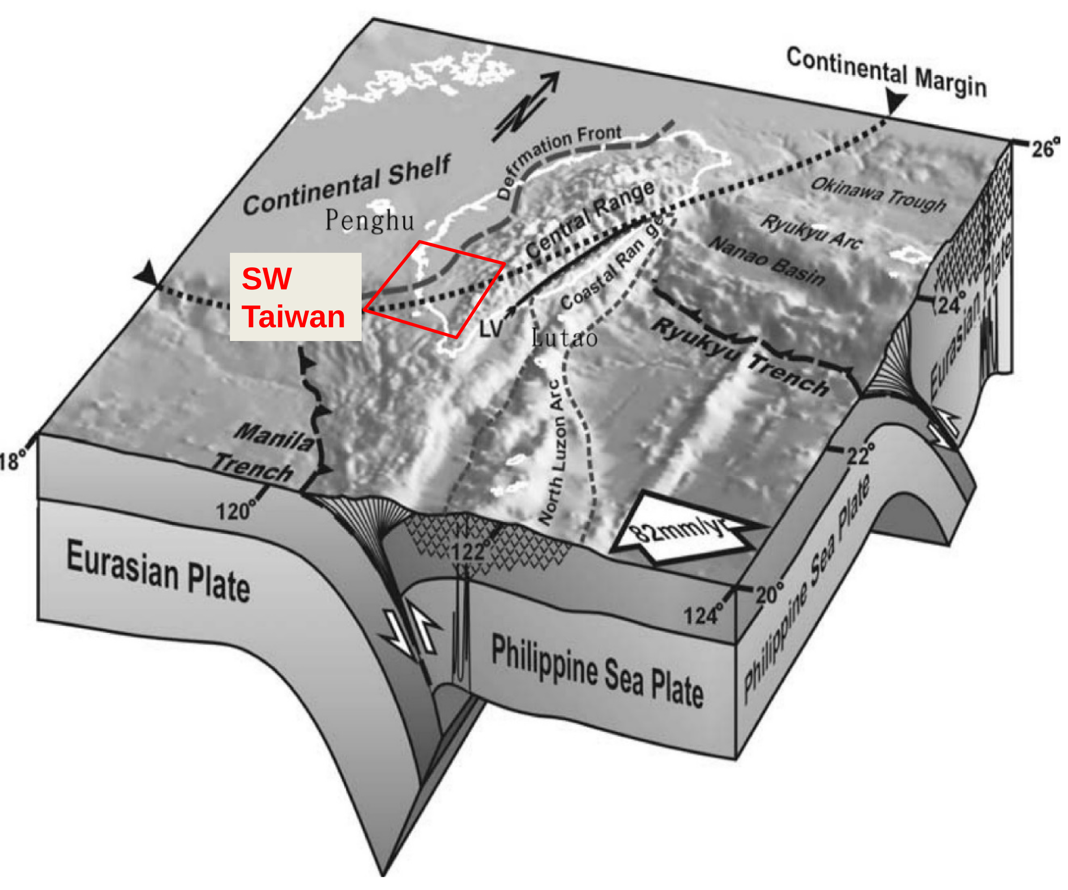

Figure 1 : Taiwan geodynamical settings (from *Chang T.-Y. 2002).*

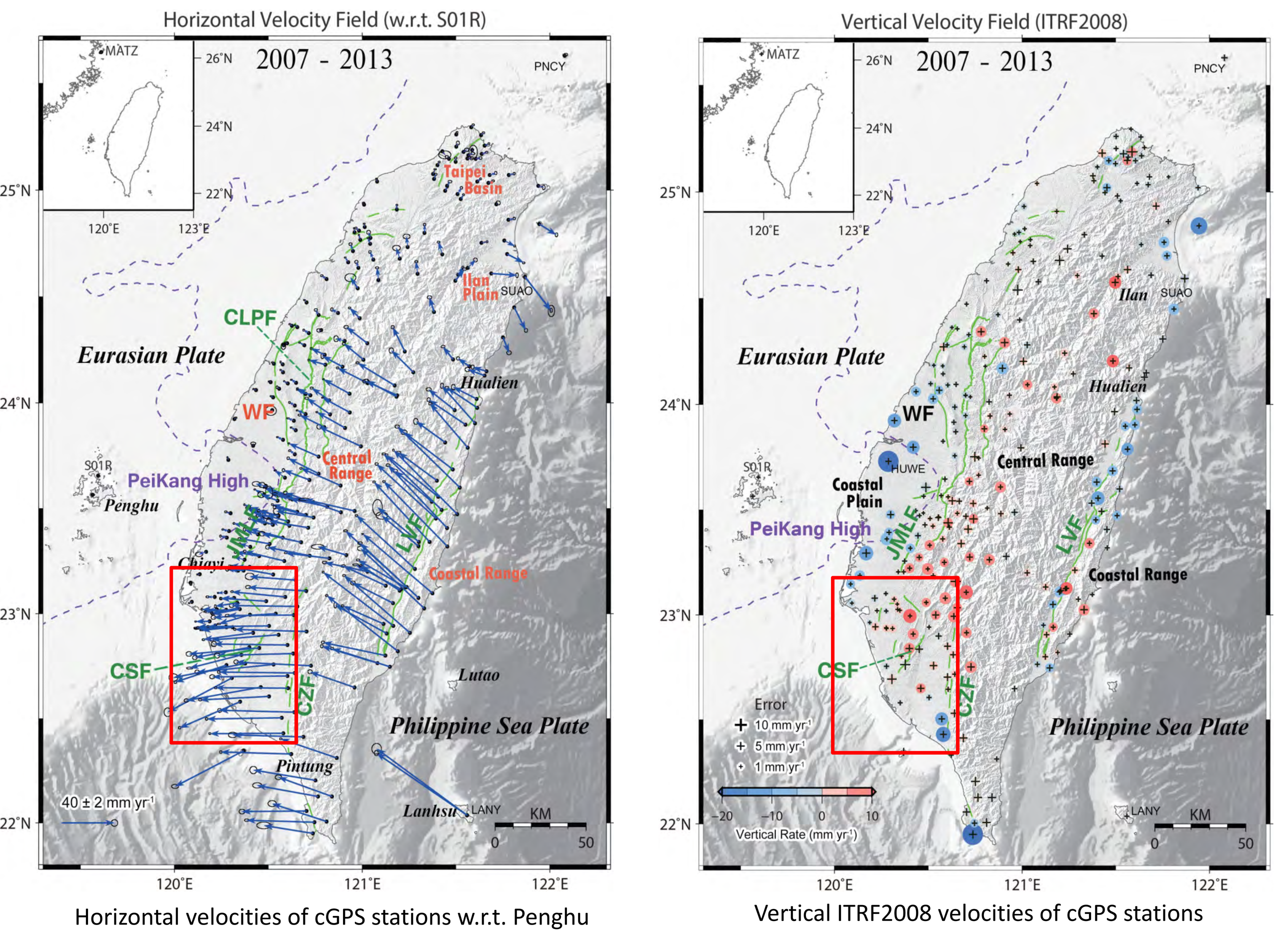

Figure 2 : GPS velocity field of Taiwan (from *Tsai et al 2002).*

Sentinel-1 InSAR analysis

- We used Sentinel-1 Level-1 (SLC) images in TopSAR mode (IW) provided by ESA. We processed descending data, on subswath IW2 (figure 3) using 20 consecutive bursts of data (figure 4).
- 63 acquisition dates have been used to form a network of interferograms with small baselines (figure 5)

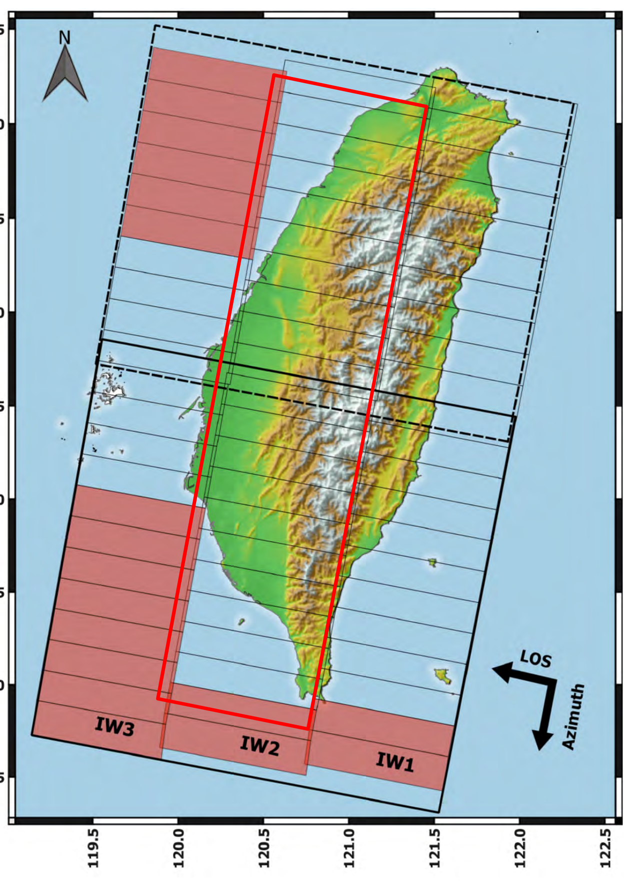

Figure 3: Location of Sentinel-1 data used in this study (in red)

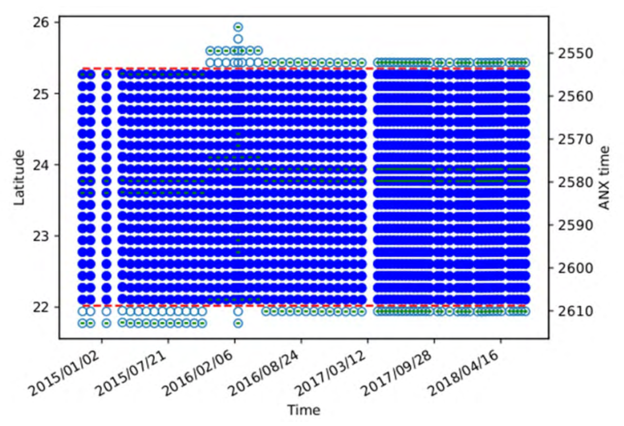

Figure 4: bursts completude

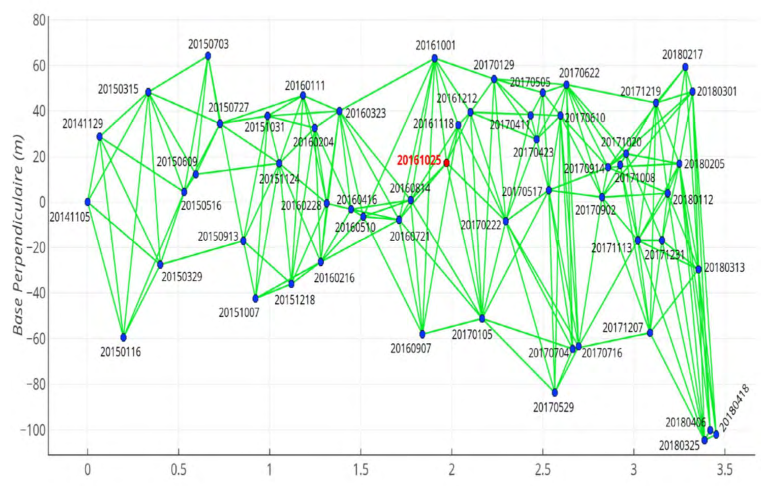

Figure 5: Perpendicular baseline vs. Time (in year) showing the network of interferograms (green lines)

SAR images are processed through a small baseline approach using the **NSBAS chain,** developed at ISTerre (Doin et al., 2011) and based on ROI_PAC (Rosen et al., 2004).

- Several corrections have been applied before unwrapping : in particular correction of atmospheric delays predicted from the global atmospheric re-analysis ERA-Interim model (Doin et al., 2009; Jolivet et al., 2011),
- GPS data are used to correct LOS velocity map from a residual large scale quadratic ramp that could remain on InSAR results.
- The time series and LOS mean velocity map (figure 6, 7 and 8) are impacted by the 2016 Meinong earthquake (Mw = 6.4).
- The mean velocity map show in figure 10 has been corrected from the coseismic step.

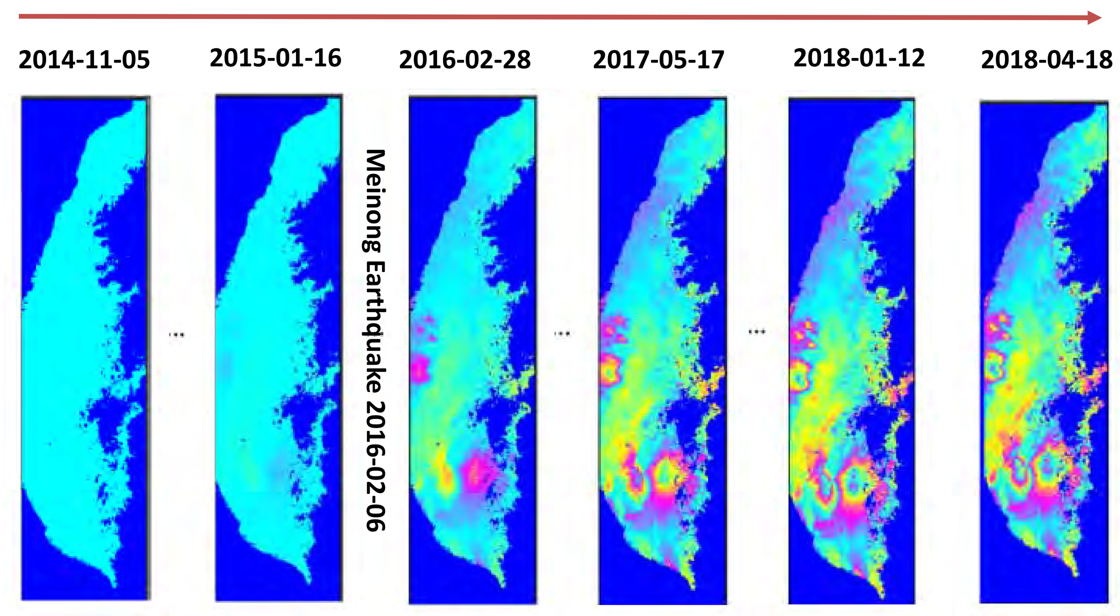

Figure 6: Time serie reconstruction including the deformation of the Meinong Earthquake

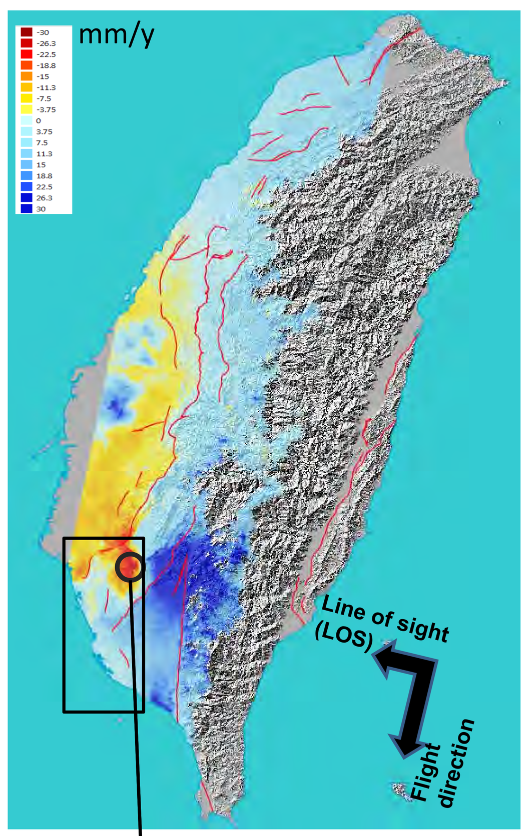

Figure 7: LOS mean velocity map

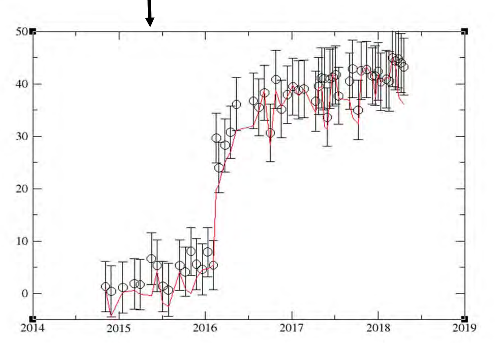

Figure 8 : displacement time series for selected pixel

Tectonic analysis

Figure 9: 40m resolution Digital Elevation Model

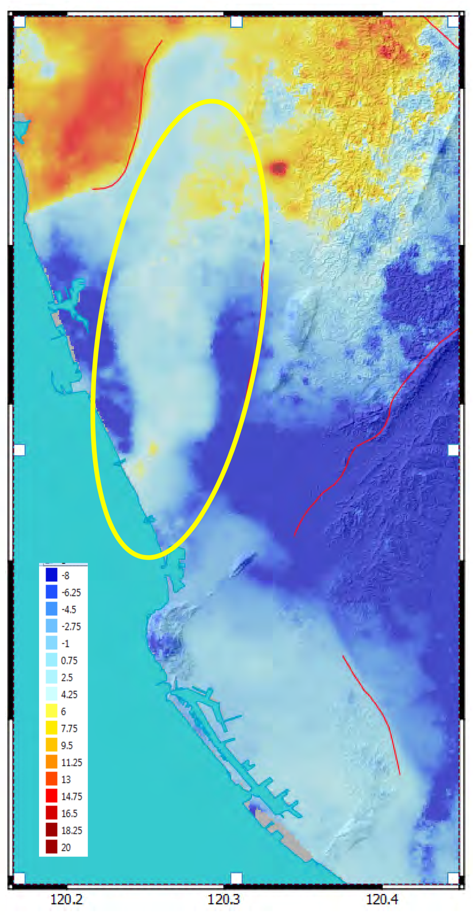

Figure 10: Sentinel-1 LOS mean velocity map corrected from coseismic step.

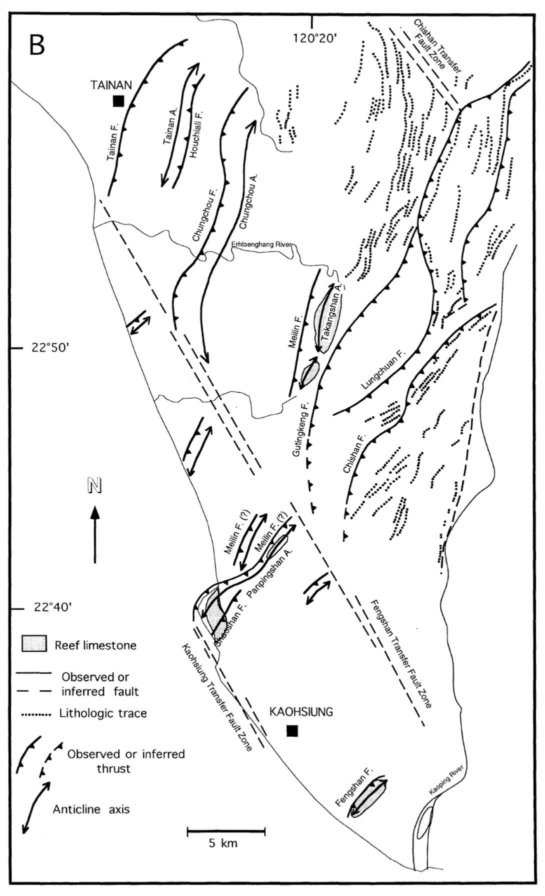

Figure 11: Structural interpretation of morphologic features from Lacombe et al 1999.

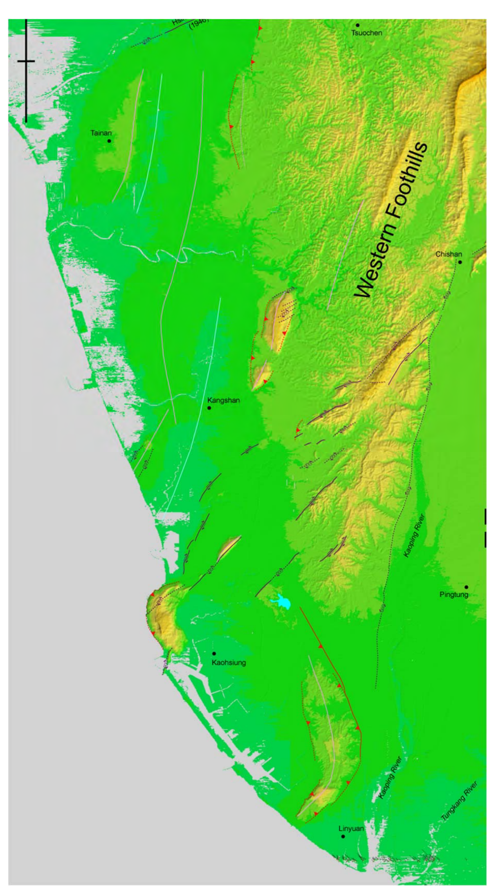

Figure 12: Structural interpretation of morphologic features from Shyu et al 2005.

- Sentinel-1 LOS mean velocity map (**figure 10**) show new evidences about on-going deformation (several mm/year) on the Chungchou anticline. Located in the coastal plain, South of the Tainan anticline and North of the Panpingshan anticline, the Chungchou anticline is slighty marked in the landscape (**figure 9**). This morphologic signature has been identified by several authors (e.g. Lacombe et el 1999, Hsieh et al 2005) but its present-day activity was not quantified.
- The Chungchou anticline was also known since the 60's from gravity anomaly and seismic measurements (**figure 13 and 14**). InSAR time-series analysis of reveals a surface deformation pattern spatially also well correlated with the NNE-SSW anticline axis.

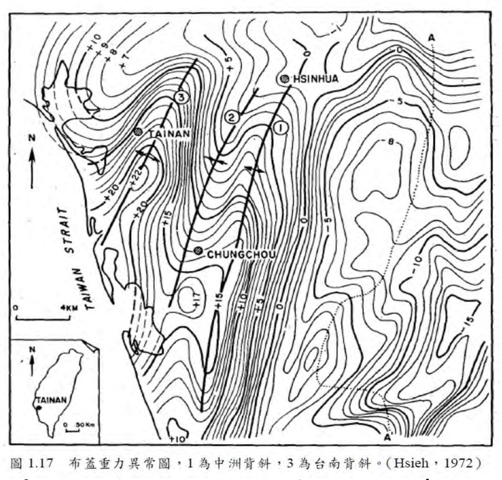

Figure 13: Bouger gravity anomaly map from Hsieh **, 1972.**

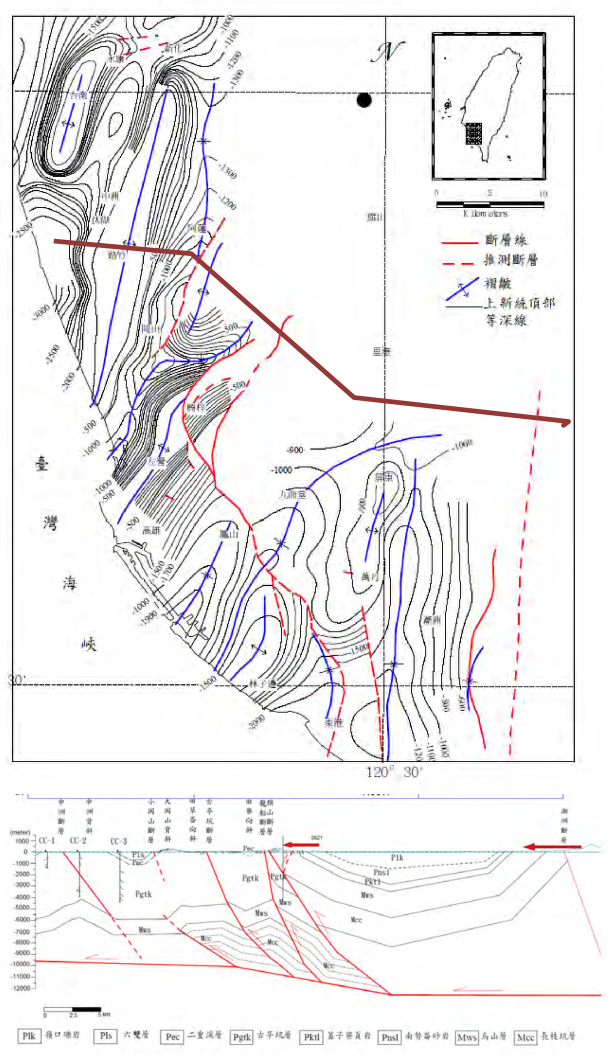

Figure 14: seismic map of the top of Pliocene formation and geological cross section.(Chen et al 2000 from Pan, 1978)

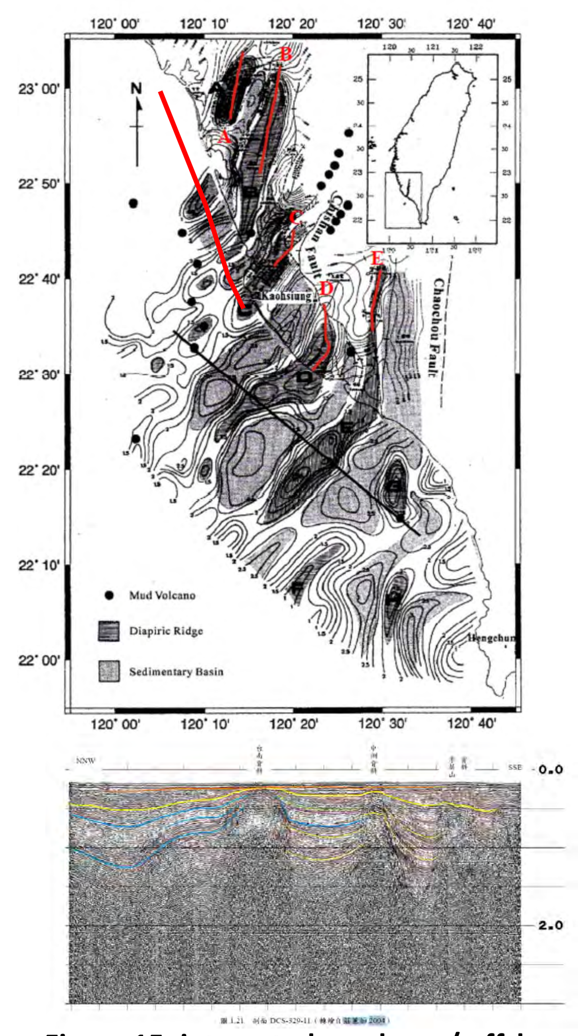

Figure 15: integrated on-shore / offshore seismic map of the top of Pliocene formation and seismic profile DCS-329-11 (loc. in red) from Yu 2000.

- Our observations also clearly suggest an offshore prolongation of the anticline deformation toward the SSW, which is structurally consistent with offshore seismic profiles and derived seismic map of the top of Pliocene formation (**figures 14 and 15**)
- The geology and the spatial wavelength of the observed deformation suggest a relatively shallow (> 8km) origin, which implies mostly aseismic process as the seismicity shallower than 12km in this area is almost inexistent for Magnitude > 2.

acknowledgements

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