

中華民國地球物理學會補助出席國際學術會議報告

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**The Seismogenic Structures beneath the Ma River Fault, Vietnam: Insights  
from Studys of Focal Mechanisms**

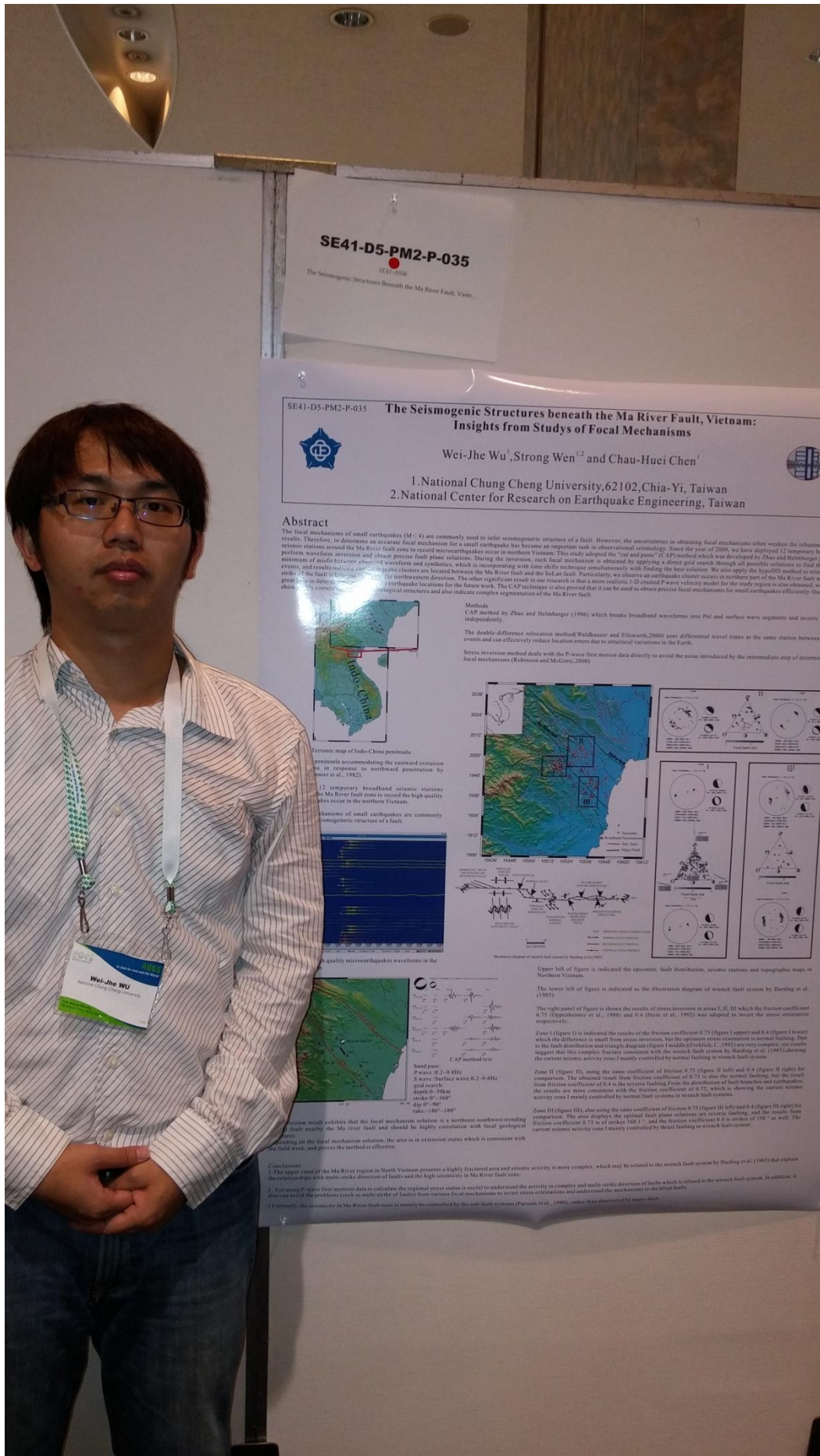
與會心得

這次出國參加會議是我第一次的國際性會研討會，先感謝地震資料處理室的學長姐學弟妹的協助，以及陳朝輝老師的指導，讓我可以將自己的研究成果盡可能的呈現出來，能夠發表在國際性的會議上，使我倍感光榮。

參與會議的過程中，觀看了許多自己所感興趣的地震學相關研究，例如微震顫 (tremor) 的一些新的進展，以及目前許多人再進行的聯合逆推的研究，以及與我的研究息息相關的高頻波形反演的工作，並且補充我之後研究所需要的三維高精度速度構造反演的研究的相關內容，並且帶回了大量的 POST 海報照片，希望透過這次的會議，加強我之後研究的一些想法以及方法的部分。

最後感謝中華民國地球物理學會提供經費上的贊助，讓學生減輕家庭的負擔，無後顧之憂的前往日本參加 AOGS。有了這次的經驗，將能提供我進一步的想法去改良我的研究方法以及研究的成果。

下圖為我此次參與 AOGS 所發表的海報合影，所發表內容為越南 Ma River 地區的微震源機制解的反演以及相關的地質解釋，結合了數種的方法，全面的對於越南 Ma River 地區進行地震學方面的研究，此研究成果算是首度發表於國際會議上。



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The Seismogenic Structures beneath the Ma River Fault, Vietnam.

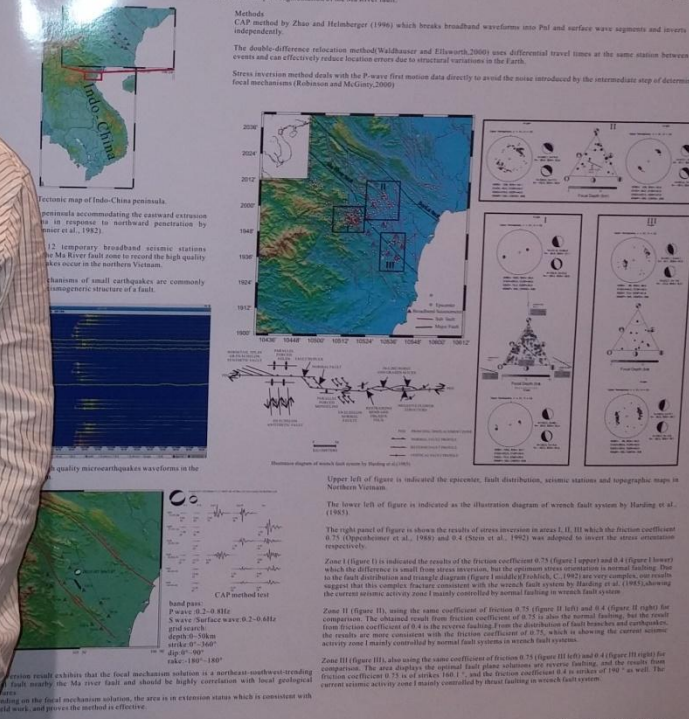
## The Seismogenic Structures beneath the Ma River Fault, Vietnam: Insights from Studies of Focal Mechanisms

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### Abstract

The focal mechanisms of small earthquakes (M < 4) are commonly used to infer seismogenic structure of a fault. However, the uncertainties in obtaining focal mechanisms often weaken the robustness results. Therefore, to determine an accurate focal mechanism for a small earthquake has become an important task in observational seismology. Since the year of 2009, we have deployed 12 temporary seismic stations around the Ma River fault zone to record microearthquakes occur in northern Vietnam. This study adopted the "cut and paste" (CAP) method which was developed by Zhao and Helmberger (1990) to invert waveform inversions and obtain precise fault plane solutions. During the inversion, each focal mechanism is obtained by applying a direct grid search through all possible solutions to find the minimum of misfit between observed waveforms and synthetics, which is incorporating with one shift technique simultaneously with finding the best solution. We also apply the Hybrid method to refine the focal mechanism. The earthquake clusters are located between the Ma River fault and the Red River fault. Particularly, we observe an earthquake cluster occurs in northern part of the Ma River fault with great loss in determining focal mechanisms for the future work. The CAP technique is also proved that it can be used to obtain precise focal mechanisms for small earthquakes efficiently. Our study also indicates the seismogenic structures and also indicate complex segmentation of the Ma River fault.



Upper left of figure is indicated the epicenter, fault distribution, seismic stations and topographic maps in Northern Vietnam.

The lower left of figure is indicated as the illustration diagram of wrench fault system by Harding et al. (1985).

The right panel of figure is shown the results of stress inversion in areas I, II, III which the friction coefficient 0.75 (Oppenheimer et al., 1980) and 0.4 (Stein et al., 1992) was adopted to invert the stress orientation respectively.

Zone I (Figure I) is indicated the results of the friction coefficient 0.75 (Figure I left) and 0.4 (Figure I right) which the difference is small from stress inversion, but the optimum stress orientation is normal faulting. Due to the fault distribution and tectonic diagram (Figure I middle) (Rubin, C., 1992) are very complex, our results suggest that this complex fracture consistent with the wrench fault system by Harding et al. (1985) showing the current seismic activity zone I mainly controlled by normal faulting in wrench fault system.

Zone II (Figure II), using the same coefficient of friction 0.75 (Figure II left) and 0.4 (Figure II right) for comparison. The obtained result from friction coefficient of 0.75 is also the normal faulting, but the result from friction coefficient of 0.4 is the reverse faulting. From the distribution of fault branches and earthquakes, the results are more consistent with the friction coefficient of 0.75, which is showing the current seismic activity zone II mainly controlled by normal faulting in wrench fault system.

Zone III (Figure III), also using the same coefficient of friction 0.75 (Figure III left) and 0.4 (Figure III right) for comparison. The obtained result from friction coefficient of 0.75 is of strikes 140° E, and the friction coefficient 0.4 is strikes of 190° W as well. The current seismic activity zone III mainly controlled by thrust faulting in wrench fault system.

Conclusions

1. The upper part of the Ma River region in North Vietnam presents a highly fractured area and seismic activity is more complex, which may be related to the wrench fault system by Harding et al. (1985) that explain the relationships with north-south direction of faults and the high seismicity in Ma River fault zone.

2. For strong P wave form data to calculate the regional stress status is useful to understand the activity in complex and multi-strike direction of faults which is related to the wrench fault system. In addition, it also can avoid the problems (such as multi-strike of faults) from various focal mechanisms to invert stress orientations and understand the mechanisms on the blind faults.

3. Currently, the accuracy in Ma River fault zone is mainly controlled by the sub-fault systems (Parsons et al., 1990), rather than determined by major fault.