

出國報告（出國類別：移地研究）

郭陳浩助理教授赴美國南加大及德州大學奧斯丁分校移地研究

服務機關：國立中央大學地球科學系

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出國期間：103/08/24-103/09/06

報告日期：103/09/15

摘要

在南加大與德州大學奧斯丁分校為期約 10 天的研究中，完成兩篇學術論文與未來台美合作研究規劃。在兩篇學術論文中，其中一篇為釐清台灣地體構造中爭論已久的梨山斷層活動性，從密集的地震陣列資料中記錄到梨山斷層下有叢聚的地震活動而證實梨山斷層仍俱有活動性。第二篇論文為整合地震、陸上炸測與空氣槍訊號完成台灣中部二維的高解析地殼速度構造，探討台灣山脈與板塊邊界構造。最後，並討論未來的合作計劃與中央大學學生方面的學術研究交流。

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壹、目的

此次移地研究目的可分為兩部分，第一部分為研究台灣梨山斷層的活動性（南加大）與台灣中部地區高解析的二維震波速度構造（德州大學奧斯丁分校），而第二部分為規劃討論未來台灣-美國地球物理探勘方面的合作研究項目（南加大與德州大學奧斯丁分校）。

貳、過程

1. 8/24-8/31（南加大）：在為期 7 天的移地研究中，主要與吳大銘教授（中央地科系的講座教授）針對台灣地表地形上的明顯構造線-梨山斷層，從地震活動觀測與地體構造的角度探討其活動性。梨山斷層為台灣地表上大的構造線(約 200 公里長)，但其活動性與否仍十分有爭議，此次移地研究利用在集集地震之後所佈的密集地震站，發現梨山斷層極具活動性，因此在南加大研究中專門針對此一問題，完成一研究論文，並證實梨山斷層極具活動性，並為台灣地體構造演化中，佔有極重要的地位，本人為第一作者（請見附錄一，參考此篇研究論文全文，論文題目為：Is the Lishan Fault of Taiwan Active?）。除此之外，並規劃於明年在 Tectonophysics 與 TAO 期刊中，集合 20 多位研究學者對台灣地體構造的研究成果發表研究特刊。

論文題目：Is the Lishan Fault of Taiwan Active?

摘要：The Lishan fault has been considered an important boundary for the tectonic evolution of the Taiwan orogen. But issues regarding its existence or being active remain. However, post Chi-Chi seismic activities in the vicinity of the Lishan fault demonstrated that it appears to be a fault and is active. Most of the events were in the range of M_L 1-2 (114 events) with the largest about 3.5. Seismograms from a dense linear seismic array across the Central Range in central Taiwan deployed in 2001 by the Earthquake Research Institute, University of Tokyo, and also from the permanent stations of the Central Weather Bureau made the determination possible. The focal mechanisms and seismicity show that a 4 km section of the Lishan fault is a high-angle left-lateral structure (a $N37^\circ W$ strike with 76° dipping to the west). Combined with seismicity of previous studies, this fault zone extends down to 35 km depth from the surface and is still active. The role of the Lishan fault could serve as a boundary for the crustal thickening of the mountains and the uplift of the Central Range.

2. 9/1-9/4 (德州大學奧斯丁分校): 在為期 4 天的研究中, 分為研究論文撰寫與科學研究計劃規劃。主要與 K. McIntosh 與 H. Van Avendonk 兩位研究員進行合作。(1) 台灣中部地殼構造於 2012 年個人論文中已完成三維的速度構造, 此次研究更加提高解析度, 整合地震、海上空氣槍與陸上炸測訊號, 提高在二維空間上的解析度, 與 H. Van Avendonk 完成 Journal of Geophysical Research 期刊的第一次 revision, 本人為第二作者(請見附錄二, 參考此篇研究論文全文, 論文題目為: Deep crustal structure of an arc-continent collision: Constraints from seismic travel times in central Taiwan and the Philippine Sea)。(2) 規劃下一階段的台美方面地球物理探勘整合型計劃與中央大學研究生暑假或短期於德州大學訪問研究。

論文題目: Deep crustal structure of an arc-continent collision: Constraints from seismic travel times in central Taiwan and the Philippine Sea

摘要: The collision of continental crust of the Eurasian Plate with the overriding Luzon arc in central Taiwan has led to compression, uplift and exhumation of rocks that were originally part of the Chinese rifted margin. Though the kinematics of the fold-thrust belt on the west side of the orogen has been described in detail, the style of deformation in the lower crust beneath Taiwan is still not well understood. In addition, the fate of the Luzon arc and forearc in the collision is also not clear. Compressional wave arrival times from active-source and earthquake seismic data from the Taiwan Integrated GEodynamic Research (TAIGER) program constrain the seismic velocity structure of the lithosphere along transect T5, an east-west corridor in central Taiwan. The results of our analysis indicate that the continental crust of the Eurasian margin forms a broad crustal root beneath central Taiwan, possibly with a thickness of 55 km. Seismic velocities beneath the Central Range of Taiwan are as low as 5.5 km/s at 25 km depth, whereas seismic velocities in the middle crust on the eastern flank of the Taiwan mountain belt average 6.5-7.0 km/s. This suggests that the incoming sediments and upper crust of the Eurasian Plate are buried to mid-crustal depth in the western flank of the orogen before they are exhumed in the Central Range. To the east, the Luzon arc and forearc are deformed beneath the Coastal Range of central Taiwan. Fragments of the rifted margin of the South China Sea that were accreted in the early stages of the collision form a new backstop that controls the exhumation of Eurasian strata to the west in this evolving mountain belt.

參、心得與建議

此次移地研究成果十分豐碩，與美方學者在研究、計劃與學生交流做深入的討論，也完成實質的成果發表。

肆、附錄

附錄一、已完成未發表之論文全文：Is the Lishan Fault of Taiwan Active?

附錄二、1st revision J G R 期刊論文全文：Deep crustal structure of an arc-continent collision: Constraints from seismic travel times in central Taiwan and the Philippine Sea

Is the Lishan Fault of Taiwan Active?

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Abstract

The Lishan fault has been considered an important boundary for the tectonic evolution of the Taiwan orogen. But issues regarding its existence or being active remain. However, post Chi-Chi seismic activities in the vicinity of the Lishan fault demonstrated that it appears to be a fault and is active. Most of the events were in the range of M_L 1-2

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1. Introduction

The Lishan fault follows a topographically prominent valley that runs from the western apex of the Ilan Plain to central Taiwan for a distance of about 200 km (Figure 1). It is considered generally to be a major structural and stratigraphic boundary (Tsan, 1971; Ho, 1975; Clark et al., 1993) or even a plate boundary (Lu and Hsu, 1992; Huang et al., 1997). It is the fault that separates two of the main mountain ranges in northern Taiwan, the Hsuehshan and the Central Ranges. Although the Paleocene strata across the fault, belonging to two different formations are similar, the eastern unit is deemed a relatively thin unit overlying the schists and marbles of Paleozoic age (Brown et al., 2012) and thus a few kilometers below the surface the Eocene formation on the west side of the fault may be in direct contact with the Mesozoic Tananao schist. The similarities across the fault, however, were so remarkable that it was judged a non-fault on the most recent geologic map of Taiwan (Chen et al., 2000).

1 **Deep crustal structure of an arc-continent collision: Constraints from seismic travel**
2 **times in central Taiwan and the Philippine Sea**

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18 *Revised manuscript 2014JB011327*

19 *Submitted to Journal of Geophysical Research Solid Earth, August 8, 2014.*

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