

Measuring ground deformation across the Chegualin and Chishan faults, Southwestern Taiwan using aerial image correlation and DSM time series

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Abstract

Ground-based geodetic observations in southern Taiwan reveal a striking deformation pattern, with two sub-parallel southeast-dipping thrusts, the Chegualin fault and the Chishan fault, exhibiting opposite slip sense. A geodetic network (GNSS, levelling and traverse) installed along the freeway No.3, which crosses both thrusts, documented limited net shortening (15 mm/yr) across both faults, but 50 mm/yr shortening across the Chegualin fault and 32 mm/yr extension across the Chishan fault. Uplift between the two faults increases eastward from 20 to 80 mm/yr relative to the eastern block. Sharp deformation gradients indicate aseismic slip on both structures. This study proposes further monitoring using aerial image correlation and DSM time series from 2008 to 2015 to complement existing observations. The results show significant shortening (50 mm/yr) across the Chegualin fault, extending about 2 km along the fault strike. Our results also reveal rotational displacement within the central block with a clockwise rotation north of the freeway and a counter-clockwise rotation south of it. Challenges in quantifying extension across the Chishan fault due to vegetation remain. Geological evidence for the reverse Chegualin fault and a steep southeast-dipping normal fault near the Chishan fault has been locally found in the field. These investigations show a good consistency with geodetic observations. Ongoing surveys aim to link deformation patterns with geological structures. Eventually, this research will contribute to understanding the mechanism leading to the observed deformation and its relation to regional tectonics.

Keywords: Image correlation, Photogrammetry, Surface displacement, Zhongliao tunnel, Active faults, Creeping faults.

利用航空影像關聯和 DSM 時間序列測量台灣西南部車瓜林斷層和旗山斷層之間的地表變形

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摘要

台灣南部的地表大地測量揭示了引人注目的地表變形模式，其中兩條向東南傾斜且彼此平行的逆衝斷層，車瓜林斷層和旗山斷層，卻呈現出相反的滑動方向。在橫跨這兩條斷層的國道 3 號上，佈署了一套由全球衛星定位系 GNSS、水準測量及導線測量所組成的大地測量系統，該系統紀錄到兩個斷層的總水平壓縮量相當有限（每年 15 毫米）；然而車瓜林斷層的水平壓縮量為 50 毫米/年，旗山斷層則有 32 毫米/年的伸張量。在兩個斷層之間愈往向東側移動，相對於東南地塊的垂直抬升速度從每年 20 毫米增加到 80 毫米。陡峭的變形梯度則表明此二構造活動為無震滑移。本研究提出進一步利用 2008 年至 2015 年的航空影像關聯和 DSM 時間序列來補充現有的觀測。結果顯示，車瓜林斷層上有顯著水平壓縮（約每年 50 毫米），且該現象可以沿斷層走向延伸約 2 公里。我們的結果也顯示在中央區塊內有旋轉位移，國道以北呈順時針旋轉，以南則呈逆時針旋轉。由於植被覆蓋，旗山斷層的伸張量仍難以測量。在野外已經發現了車瓜林斷層逆移以及旗山斷層附近高角度向東南傾的正斷層的地質證據，這些調查成果也與大地測量成果相當一致。本研究正持續進行的調查旨在將地表變形模式與地質結構聯繫起來，最終致力於理解這些變形的機制及其與區域構造的關係。

關鍵字：影像關聯、攝影測量、地表位移、中寮隧道、活動斷層、潛移斷層