Imaging the subsurface fault systems with the magnetotelluric surveys in the southern Ilan plain of NE Taiwan

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The high sedimentation rates as well as the frequent human activities have caused the difficulties in mapping the surface traces of the active faults in most of the populated areas of Taiwan. The basement topography of the sedimentary basin, on the other hand, should show the direct results of fault movements and is free from the sedimentary effects. Therefore in the study we attempt to use the magnetotelluric(MT) surveys to delineate the basement topography of the southern Ilan plain, which is consisted of Tertiary metamorphic rocks such as Argillites and Slates. The recent extension of the Okinawa Trough starting from approximately 0.1 Ma involved ENE- and WSW-trending normal faults in the Ilan plain. The plain is therefore thought to be a subsidence basin bounded by the Hsueshan Range in the north and the Central Range in the south. We deployed over 70 MT stations across the plain and tried to map the relief variations of the basement with the inverted resistivity images, since the saturated sediments are relatively conductive and the consolidated rocks are resistive. We found that there are a series of N-S trending horsts and grabens in addition to the pre-existing ENE-WSW normal fault systems in the inverted MT profiles. The preliminary results suggest that a younger N-S trending normal fault system may modify the relief of the basement in the recent stage. The findings of the MT resistivity images provide new information to further review the tectonic explanations of the region in the future.

Keywords: magnetotelluric, Ilan plain, normal fault

A study of the near surface geometries of the Chimei and Chihshang faults with the electrical resistivity imaging surveys in the Yuli area

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The Longitudinal Valley(LV) in eastern Taiwan represents the collision boundary between the Eurasian Plate and the Philippine Sea Plate. The Longitudinal Valley Fault (LVF) is the main active fault having a surface length of about 150km from Hualien to Taitung. A significant surface creeping was found at the Chihshang fault in the south part of LVF. However, the GPS and PSInSAR (Persistent Scatterers InSAR) results showed that the Rueisui Fault and Chimei Fault area in the middle part of LVF had less surface movements than the Chihshan fault area in the south. The junction of the Rueisui, Chimei and Chihshan faults was at the Yuli area. In this study, we try to find the shallow structure of faults between the Chimei fault and Chihshang fault. Six 2D electric resistivity profiles were done alone the Chimei fault in Yuli area. After the field data collecting and 2D inversion of the resistivity measurements, the electrical models show that the Chimei fault and Chihshang fault might not be jointed at where researchers expected before in the Yuli area, and their surface fault traces are separated as two parallel lines in the area. The new evidences from the resistivity measurements suggest that we need to review the conventional fault junction model for the LVF in the Yuli area, and more detailed geophysical surveys are needed in order to resolve the regional fault structures.

Keywords: Longitudinal Valley Fault, electric resistivity, Chimei fault

A Study of the Deformation and Kinematic Characteristics of the Sanyi Thrust Fault by Incorporating the Outcrop Analysis and Resistivity Imaging Results

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For the purposes of hazard mitigation in metropolitan area, it is very important to map the fault trace in order to delineate the susceptibility zones of the active faults. In this study, we focused on the outcrop analysis and near surface resistivity mapping of the fault traces of the Sanyi thrust fault. From the outcrop along the Dajia river, we studied the kinematics and deformation characteristics of the Sanyi fault. The Kweichulin formation forms the hanging wall of the Sanyi Fault and the footwall is composed of the unconsolidated gravels and sands in the study area. We observed that the Sanyi Fault is composed of a major and three minor fault zones. The major fault zone extends about 100 meters, and is consisted of 1.5-m thick fault gouges and breccias. We also conducted electrical resistivity imaging near the outcrop and sites with drilling records. Compared with the data and inverted resistivity images, we concluded that the Kweichulin formation in the hanging wall exhibits a resistivity lower than 100 Ohm-m and the thick gravel layers in the foot wall have a resistivity higher than 100 Ohm-m. With the results we may quick differentiate the hanging wall from the footwall in the area, and to search the possible locations of the fault trace between the hanging wall and footwall. Our study shows the fault trace may pass through the east side of the Fengyuan township, and extends southeastward into the area that between the hill and the alluvial plain of Taichung Basin.

Keywords: Sanyi Fault, resistivity imaging, outcrop

Magnetic Fabrics Analysis across the Central Region of the Chimei Fault in the Coastal Range of Eastern Taiwan

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Taiwan is an ongoing orogen located in the conjunction of two subduction-arc systems with opposite vergences between the Philippine Sea and Eurasian plates. The Coastal Range along the eastern Taiwan is the accreted terrain composited of Luzon arcs and surrounding basins onto the Eurasian crust. The Chimei fault, a typical lithology-contrast fault thrusted the Miocene volcanic Tuluanshan Formation over the Pleistocene sedimentary Paliwan Formation, is the only major reverse fault across the entire Coastal Range. To investigate the deformation pattern and strain history across the Chimei fault, we analyzed oriented samples in the footwall of mudstone and in the hanging wall of volcanic rocks along the Hsiukuluan River via anisotropy of magnetic susceptibility (AMS).
Results of AMS across the central part of the Chimei fault show that the direction of k_{MAX} changed from N-S orientation to sub-vertical and the orientation of k_{MIN} switched from 270/70 to N-S orientation when samples of the footwall were approaching to the fault zone. At the same time, anisotropy was increasing and susceptibility ellipsoid changed from oblate in the fractured zone through prolate in the folded zone to oblate in the faulted zone. Based on identification experiments of magnetic minerals, the major magnetic carrier is magnetite with pseudo-single domain, suggesting paramagnetic minerals control the AMS. With increasing deformation, oblate ellipsoids with strong anisotropy developed within the fault zone highlighted the strain history of the central part of the Chimei fault. As a result, it strongly speculated that stress altered from sub-vertical sedimentary loading to horizontally NW-SE compression during collision stage and current N-S compression orientation could be resulted from 30 degree clockwise rotation during accretion stage.
This study demonstrates that AMS pattern across the Chimei fault is the consequence of finite deformation. Our results of magnetic fabrics evolution across the Chimei fault can provide insights into understanding the tectonic history of Chimei fault.

Keywords: Anisotropy of Magnetic Susceptibility, Chimei Fault, Coastal Range, Taiwan

Fault trace investigation of the blind segment of the Sanyi fault, Central Taiwan

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Sanyi Fault, the reversal active fault, which is extending about 30 km along the foothill and Taichung Basin in central Taiwan. The fault trace of the Sanyi Fault has been covered by the Holocene deposits along the lower river terrace and Taichung basin, which is a blind segment of the fault without displaced landform. In this study, we investigated subsurface fault trace by using boring data and Resistivity Image Profiling Method, and established the subsurface geological profiles cross to the fault trace. According to the subsurface geological profiles, the fault zone character and distribution in the subsurface of the blind segment of the Sanyi Fault are interpreted.

Keywords: Sanyi fault, Central Taiwan

Fault or landslide creeping at Tapo, frontal deformation of Chihshang active fault in eastern Taiwan

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The Chihshang fault forms the south-central segment of the Longitudinal Valley fault, located at the suture between the Philippine Sea plate and the Eurasian plate in eastern Taiwan. In the past century, the fault ruptured twice accompanied by two moderate to large earthquakes during the 1951 Yuli earthquake with a magnitude of 7.1 and the 2003 Chengkung earthquake with a magnitude of 6.8, respectively. It is also well-known as a creep fault in the world. However, the cause of surface deformation, i.e. either fault creep or landslide creep, has been debated for decades at Tapo site where the fault trace passes. In order to resolve this disputation, both geological and geophysical methods have been performed within the past two years. To reveal the shallow subsurface structure, two survey lines for electrical resistivity tomography were conducted and 4 wells for collecting rock cores were drilled up to 30 meters at depth. To analyze and characterize fault activity, some organic layers were dated and a real-time clinometer was installed and has functioned since last May.

Keywords: active fault, Chihshang fault , creeping fault, real-time inclinometer

