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The Deep Electrical Structure of Southern Taiwan and Its Tectonic Implications

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ABSTRACT

The Taiwan orogen has formed as a result of the arc-continent collision between the Eurasian continental margin and the Luzon volcanic arc over the last 5 million years and is the type example of an arc-continent collision. The tectonic processes at work beneath Taiwan are still debated; the available data have been interpreted with both thin-skinned and lithospheric collision models. In 2004, the Taiwan Integrated Geodynamical Research (TAIGER) project began a systematic investigation of the crustal and upper mantle structure beneath Taiwan. TAIGER magnetotelluric (MT) data from central Taiwan favor a thick-skinned model for that region. The Taiwan orogen becomes younger to the south, so the earlier stages of collision were investigated with a 100-km-long MT profile in southern Taiwan at latitude of 23.3°N. Data were recorded at 15 MT sites and tensor decomposition and two-dimensional inversion were applied to the MT data. The shallow electrical resistivity structure is in good agreement with surface geology. The deeper structure shows a major conductor in the mid-crust that can be explained by fluid content of 0.4 - 1.4%. A similar feature was observed in central Taiwan, but with a higher fluid content. The conductor in southern Taiwan extends to lower crustal depths and is likely caused by fluids generated by metamorphic reactions in a thickened crust. Together the central and southern Taiwan MT profiles show a crustal root beneath the Central Range.

Key words: Electrical structure, Magnetotellurics, Arc-continent collision, Taiwan tectonics

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1. INTRODUCTION

The island of Taiwan was formed by the arc-continent collision between the Luzon volcanic arc on the western margin of the Philippine Sea Plate (PSP) and the passive continental margin of southeastern China, beginning some 5 Ma ago (Suppe 1981; Ho 1986). The polarity of subduction changes across the island; in the northeast the PSP is subducting to the northwest beneath the Eurasian Plate (EUP), while in the south a portion of the continental EUP subducts to the east beneath the PSP (Tsai 1986; Seno 1993; Kao 2000). Convergence in southern Taiwan occurs at 80 mm yr^{-1} in the direction N54°W (Yu et al. 1999). Taiwan represents a young active orogen and is a unique natural laboratory for studying arc-continent collisions.

The major geological structures in Taiwan are aligned from N20°E to N30°E and the major tectonic provinces are separated by narrow fault zones and geologic contacts (Fig. 1). The major geological units in Taiwan are (from west to east): (1) the Coastal Plain (CP) comprised of Quaternary sedimentary rocks; (2) the Western Foothills (WF) which are a classic fold and thrust belt; (3) the Hsuehshan Range (HR) consisting of shallow marine quartizite and slate; (4) the Backbone Range (BR) of metapelite and metagraywackes; (5) the Eastern Central Range (ECR) which includes the pre-Tertiary Tanano schist, phyllite, metasandstone, and metabasite; (6) the Longitudinal Valley (LV) which overlies the suture zone between the EUP and PSP; (7) the Coastal Range (CR) consisting of deformed forearc and remnant volcanic arc materials (Fig. 1). The WF and HR are separated by the Chuchih fault, which merges with

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