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Anomalous Seismic Attenuation along the Plate Collision Boundary in Southeastern Taiwan: Observations from a Linear Seismic Array

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Abstract Lateral variations of seismic attenuation are investigated using data from a linear seismic array deployed across southern Taiwan. The attenuation parameter t^* is obtained by fitting the amplitude spectra of P and S waves with a theoretical spectrum using an ω^2 model. The observed t^* data are then plotted against the travel time, back azimuth, and focal depth, respectively, to explore the spatial variations of t^* for P and S waves. Significant lateral variations of seismic attenuation are found between the eastern mountainous and western plain areas of Taiwan. Large attenuation contrast with depth in the east indicates that an anomalously high-attenuation zone is located in a shallower area north of the array in southeastern Taiwan. A 2D raytracing method is applied to show that the probable depth of the anomalous zone is at about 15–20 km. This anomalous attenuation zone coincides with an area marked by low-P and low-S velocities as well as a total absence of seismicity. The area is also marked by other prominent manifestations of active collision between the Eurasian and Philippine Sea plates, for example, high mountain ranges, rapid uplift, and high heat flows.

Introduction

Taiwan is located in the boundary between the Eurasian and Philippine Sea plates. The Eurasian plate subducts under the Philippine Sea plate in southern Taiwan whereas the Philippine Sea plate subducts under the Eurasian plate in northeastern Taiwan. Between these two subduction zones the two plates converge along the northwest–southeast direction at about 80 mm/yr. The collision between the two plates is most intense in southeastern Taiwan where the tallest peaks of the Central Ranges stand. Frequent earthquakes are common near the east coast of Taiwan along the boundary of the two colliding plates (Fig. 1). Curiously, a remarkable aseismic area beneath the southeastern Central Range can be seen from the seismicity map. Although previous studies indicate that the aseismic area may be associated with geothermal and/or partial melt effects (Ma *et al.*, 1996), its cause remains a puzzle.

Seismic attenuation is a physical parameter representing anelastic behaviors of materials along which seismic waves propagate. Because attenuation of seismic waves is also very sensitive to temperature, cracks, and fluid content in the material, study of seismic attenuation may provide clues about its physical state. On a small laboratory scale, seismic attenuation can be measured directly from a sample (Jones and Nur, 1983). On an intermediate scale from several meters to hundreds of meters, anelastic behaviors can be studied as deamplification effects of local site response by both geotechnical engineers and seismologists (Lee *et al.*, 2006).

On a large scale from several kilometers to hundreds of kilometers, seismic attenuation of tectonic structures can be studied by the analysis of seismic waves. Attenuation structures related to fault zones, collision belts, and subduction zones have been successfully studied by using local or regional earthquake sources (e.g., Scherbaum, 1990; Lees and Lindley, 1994; Sarker and Abers, 1998; Eberhart-Phillips and Chadwick, 2002). This study will focus on seismic attenuation along the plate collision boundary in southeastern Taiwan aiming to shed new light on the possible cause of an aseismic zone there.

Seismic attenuation of P waves and S waves in Taiwan has been studied previously using data from the Telemetered Taiwan Seismographic Network (TTSN) and the Central Weather Bureau Seismic Network (CWBSN) (e.g., Chen *et al.*, 1996; Chen, 1998). The available station numbers of the TTSN and the CWBSN for these studies, about 25 and 45, respectively, were not sufficient to resolve detailed spatial seismic attenuation structures in the whole of

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