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Short Note

Basement Imaging Using *Sp* Converted Phases from a Dense Strong-Motion Array in Lan-Yang Plain, Taiwan

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Abstract We have collected a large number of accelerograms recorded by the Taiwan Strong Motion Instrumentation Program (TSMIP) stations to study the thickness variations of Quaternary alluviums beneath Lan-Yang Plain, Taiwan, using an *Sp* converted wave. The estimated thicknesses of the Quaternary sediments inferred by the travel-time difference of *S* and *Sp* waves are between 200 and 1400 m and become thicker toward the northeast. In general, our resulting features of the time difference of arrivals between *Sp* and *S* waves are consistent with the previous studies on thickness variations of the Quaternary alluviums beneath Lan-Yang Plain assuming the converting point is at the unconsolidated Quaternary alluvial sediments–Miocene basement interface. Our study suggests that this technique of using *P*-*S* converted phases could be applied to the other populated basins or plains in the Taiwan region based on its dense coverage of the TSMIP stations and high seismic activity. This technique is simple and time effective and can be used to determine the general characteristics of velocity/thickness structure of a study area.

Introduction

It is well known that unconsolidated, alluvial sediments have a profound effect on the characteristics of ground shaking because of a strong impedance contrast between soft sediments and the underlying hard basement rock (Aki, 1988; Darragh and Shakal, 1991; Langston, 2003a). In addition to high values of site amplification and anelastic attenuation (Phillips and Aki, 1986; Langston, 2003b) that are commonly recognized as effects of near-surface soft, low-velocity sediments, *P*-*S* converted phases (i.e., *P*-to-*SV* or *SV*-to-*P* conversions) could be efficiently produced at a sediment–basement boundary of a strong impedance.

P-*S* converted waves have been used to map interfaces at a wide range of scale lengths. The discontinuities between lower crust and upper mantle (e.g., Moho discontinuity) and subducting lithosphere boundary have been mapped by *P*-*S* conversions (Snoke *et al.*, 1977; Ruppert *et al.*, 1998; Frederiksen *et al.*, 2003; Serrano *et al.*, 2003; Zeyen *et al.*, 2005). In the upper crust, the *P*-*S* converted phases generated at the interface between the Cenozoic unconsolidated sediments and the underlying rocks have also been studied to constrain the sediment–basement boundary (Andrews *et al.*, 1985; Chen *et al.*, 1996). Hough (1990) provided an encouraging example of using *P*-*S* conversions generated at a very shallow depth to constrain the thicknesses of low-velocity, Quaternary alluvium and Holocene mud in the San Francisco Bay area.

Lan-Yang Plain of northeastern Taiwan island is a flat, alluvial delta with an approximately equilateral triangle shape of about 30 km long at each side and located at the western terminus of the south Okinawa Trough (Fig. 1a). Lan-Yang Plain is bounded by the Hsuehshan and Central mountain ranges on its northwestern and southern sides, respectively. Inside the Lan-Yang Plain, most sediment is unconsolidated Quaternary alluvium, which is divided into two units: upper recent Holocene alluvium and lower Pleistocene clay (Chiang, 1976). According to seismic survey by the Chinese Petroleum Corporation presented in the study of Chaing (1976) and refraction survey of Wen and Yeh (1984), the unconsolidated Quaternary alluvial sediments of Lan-Yang Plain are underlain by the Miocene base complex, which has a *P*-wave velocity of 3.3–4.0 km/sec. The *P*-wave velocity of overlying recent alluvium and Pleistocene layer are of 1.4–1.7 km/sec and 1.8–2.0 km/sec, respectively. The deepest depths of recent alluvium and Pleistocene layer are about 400 and 1600 m, respectively. Figure 1c depicts the *P*-wave velocity structure of Lan-Yang Plain. The *P*-wave velocities and layer thicknesses are given in Chiang (1976) and Wen and Yeh (1984). In general, the Miocene basement tilts and the alluvium thicknesses become thicker both toward the northeast.

Furumura *et al.* (2001) observed large amplitude fundamental-mode Love waves in Lan-Yang Plain during