Analysis the Site Effect and the Influence on ML Determination Using Downhole Stations in Taiwan

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This study analyzed site effects in terms of PGA and empirical transfer functions at 15 selected surface–downhole stations in Taiwan, as well as discussed its influence on local magnitude determination. The site amplification factors of the PGA were calculated using the ratio between the surface and downhole recordings as well as an alternative approach of fitting a power-law equation. The mean PGA amplification factors ranged from 2 to an exaggerated value of 20 at different stations. Strong ground motions with and without site effects throughout Taiwan could be observed by comparing intensity distribution maps generated using the surface and downhole accelerations from four earthquakes ($M_L >6$). Empirical transfer functions derived using the single-station (HVSR) and two-station (HHSR) methods at the same sites showed comparable dominant frequencies and amplification factors. Moreover, the empirical transfer function derived using the two-station method showed clearer resonance peaks, not only at fundamental frequencies but also at higher mode resonance frequencies. The HHSR and the HVSR are highly similar, particularly at medium frequencies. This finding supports that the HVSR can be used instead of the HHSR when only the surface recording is available. In addition, the local magnitudes calculated using surface accelerations were higher than those calculated using downhole accelerations. The differences are attributed to the amplification caused by the sedimentary layers and resultant in 0.36, 0.46 and 0.49 on average for events with $M_L >6$, 5–6, and 4–5. Furthermore, HHSRs at 5–10 Hz and 1.1–1.7 Hz were found strongly correlated with PGA amplifications and M_L differences, respectively.