

Observations of Water-Level Fluctuations induced by Local and Distant Earthquakes at Two Wells in Hualien, Eastern Taiwan

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Abstract

Sustained water level fluctuations may occur in response to local changes of volumetric strain associated with passage of seismic waves or ground deformation. Two wells, namely HLC-05 and HLC-03, with high sampling rates (1 and 6 second) have been deployed for the purpose of monitoring the dynamic response of water level and static steps induced by earthquakes in Hualien area, eastern Taiwan since 2002. Through our observations, we have found the following results. (1) The water level changes may occur with earthquakes of magnitude $M \geq 0.43 + 2.39 \log_{10}(D)$, where D is the distance from the well; (2) the peak water level fluctuations (PWL) are apparently proportional to the peak ground velocity (PGV) and peak ground displacement (PGD) on logarithmic scales, but no clear trend with the peak ground acceleration (PGA). We performed regression to obtain the relationships between PWL and PGV, and PWL and PGD, respectively, as follows:

For the HLC-05 well:

$$\ln(\text{PWL}) = 0.83 \times \ln(\text{PGV}_H) - 3.22$$

$$\ln(\text{PWL}) = 0.97 \times \ln(\text{PGV}_V) - 2.27$$

$$\ln(\text{PWL}) = 0.80 \times \ln(\text{PGD}_H) - 1.70$$

$$\ln(\text{PWL}) = 0.91 \times \ln(\text{PGD}_V) - 0.83$$

For the HLC-03 well:

$$\ln(\text{PWL})=0.73 \times \ln(\text{PGV}_H) - 3.29$$

$$\ln(\text{PWL})=0.73 \times \ln(\text{PGV}_V) - 2.65$$

$$\ln(\text{PWL})=0.53 \times \ln(\text{PGD}_H) - 2.44$$

$$\ln(\text{PWL})=0.57 \times \ln(\text{PGD}_V) - 1.93$$

where the subscripts H and V represent the horizontal and the vertical component, of ground motion respectively.