Estimating the Anomalous Stress-source Area by Using Earthquake-triggered Groundwater Fluctuations

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ABSTRACT

Earthquakes are usually triggered in the stress-concentrated area. To explain the stress-pore pressure relationship, poroelastic theory is one of the commonly used models. In this model, stress and pore pressure are coupled. We applied an analytical solution of the poroelastic model with point force source to estimate the stress-concentrated area based on earthquake-triggered groundwater fluctuations. A classification system of groundwater level anomalies is developed and step groundwater fluctuations are used for data analysis. The collected anomalous data shows that the detectable distance of groundwater level anomaly increases as the earthquake magnitude increases. The maximum detectable distance is about 250 km and the minimum detectable earthquake magnitude is about 5.0 based on the groundwater fluctuations. Semi-analytical and empirical models are also developed to construct the relations among earthquake magnitude, epicentral distance, and groundwater level anomaly. Using the principle of superposition, the stress-concentrated areas can be estimated from two earthquake events in Taiwan. The results show that earthquake-triggered groundwater fluctuations can be a potential tool to estimate the stress-concentrated area and may be used to indicate the possible area of an epicenter.

Key words: poroelasticity, earthquake, groundwater level, epicenter, stress-concentrated area