The Impact of 921 Chi-Chi Earthquake on Groundwater of the Choushui Chi Alluvial Fan: Isotopic and Hydrologic Evidences

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The changes in the isotopic composition and the groundwater level in the Choshui River alluvial fan near the ruptured Chelungpu fault during and following the 1999 (M_w=7.5) Chi-Chi earthquake, Taiwan are reported. Oxygen isotope compositions measured before and after the Chi-Chi earthquake for monitoring wells in the Choshui River fan reveal distinct and interesting patterns for various aquifers. For the top Aquifer I, it is relatively enriched in $\delta^{18}O$ values, indicating sources with enriched oxygen isotope compositions were mixed into it. After the Chi-Chi earthquake, monitoring wells in the proximal area slightly shifted toward relatively depleted values till summer 2002, suggesting that the origin from the Choshui River increased and remained as such for more than one year.

The isotope changes after the earthquake were even more evident for confined aquifers II and III with much depleted $\delta^{18}O$ values that mainly derived from the Choshui River, especially in the Changhua section where the old river channels positioned, suggesting enhanced exchanges of water between the Choshui River and the groundwater. However, unexpected low $\delta^{18}O$-contour patterns were found in the remote northwestern coastal region, not in the proximal area close to the Choshui River origin. Vertical mixing among aquifers with source under the Aquifer III is interpreted as the likely cause, but a $\delta^{18}O$-depleted water source off the current shoreline might also play a possible role. The convergence of both $\delta^{18}O$ values and coseismic groundwater level changes after the earthquake for some wells provides additional evidence for water exchanges between aquifers, which implies enhanced permeability due perhaps to the fracturing and breaching of aquitards. The effect of earthquake on the groundwater flow persisted at least one year in Aquifer II, and even longer in Aquifer III.

The contours of coseismic groundwater-level exhibit quite different patterns for unconfined and confined aquifers, though they all had great positive variations in the Choshui River fan. Most liquefaction on the Choshui River fan occurred in an area of ~100 km^2 west of the Pakua Tableland in Aquifer I, where coseismic groundwater level changes exceeded 3m. There is no correlation of coseismic groundwater level change contours of aquifers II and III with the occurrence of liquefaction, suggesting the liquefaction happened only in the upper aquifer. Little similarity was found between the spatial patterns of coseismic groundwater level changes and oxygen isotope change. Obviously, the processes that caused the coseismic water-level change did not induce any significant geochemical changes, and the processes that caused the geochemical changes did not produce any significant coseismic water-level change.

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