Co-Seismic Groundwater Level Changes Induced by the May 12, 2008 Wenchuan Earthquake in the Near Field

Shi, Z., Wang, G., & Liu, C., 2013. Co-seismic groundwater level changes induced by the May 12, 2008 Wenchuan earthquake in the near field. *Pure and Applied Geophysics*, 1773-1783.

Presenter: Agustina Shinta Marginingsih

Advisor: Prof. Shih-Jung Wang

Date: 2023/05/05

Abstract

The fact that fluid in the crust is very sensitive to crust strain and solid deformation lead to groundwater level changes in a well from the confined aquifer even if the deformation in the crust is small. The 2008 Wenchuan earthquake (Ms 8.0) induced large scale of co-seismic groundwater level changes in China. The primarily studies focused on the co-seismic groundwater level change in the intermediated field and the far field. However, the analyses of this study lead to better understanding on the mechanism of co-seismic groundwater level changes in the near field. The epicenter distance <500 km is considered as the near field which is calculated by the length of the Longmenshan Central fault. There are 17 wells used in this study which primarily located along the fault zones. The sampling interval of the 12 wells and another 6 wells is 1 minute and 1 day, respectively. In order to analyze the co-seismic groundwater level changes, the co-seismic volumetric strain was estimated by the tide effect of groundwater and the co-seismic static stress was estimated using a fault dislocation model. The results show that the sign of the co-seismic water level change was consistent to the static strain change predicted using dislocation theory. The wells located along the Longmenshan fault and on its extensional cord could be explained by the static strain hypothesis. Furthermore, in the remaining wells, the strain calculated from the fault dislocation model is one or two orders of magnitude smaller than that calculated from the water level. Moreover, the static stress dominated at an epicenter distance <300 km, and the dynamic stress became significant beyond this distance (>300 km).

Keywords: Groundwater level, Earth tides, Dislocation theory, Dynamic stresses, Static stress, Wenchuan earthquake.

Pure Appl. Geophys. 170 (2013), 1773–1783

DOI 10.1007/s00024-012-0606-1

Pure and Applied Geophysics

Co-Seismic Groundwater Level Changes Induced by the May 12, 2008 Wenchuan Earthquake in the Near Field

ZHEMING SHI,[1] GUANGCAI WANG,[1] and CHENGLONG LIU[1,2]

Abstract—The large scales of co-seismic water level changes in mainland China were observed in response to the tragic 2008 Ms 8.0 Wenchuan earthquake. To better understand the mechanism of these hydrogeological phenomena, groundwater-level data at 17 confined wells, with an epicentral distance of <500 km, were collected. We compare the static strain predicted by dislocation theory with the volumetric strain calculated by the tide effect of the groundwater based on poroelastic theory. The results show that the sign of the co-seismic groundwater level change is consistent with the sign predicted by dislocation theory. Additionally, the magnitude of the strain calculated by the two methods is also concordant in half of the wells. In the rest of the wells, the strains inversed from the groundwater level are one or two orders of magnitude larger than the fault dislocation model. These wells mostly have an epicenter distance larger than 300 km; therefore, the dynamic stress induced by the seismic wave may be responsible for the co-seismic water level changes in these wells. According to these results, we roughly estimate that the effect range of the static stress is approximately 300 km for the Wenchuan earthquake, and the dynamic stresses dominate beyond this epicenter distance. In addition, geological and hydrogeological conditions and other mechanisms may be responsible for these changes.

Key words: Groundwater level, earth tides, dislocation theory, dynamic stresses, static stress, Wenchuan earthquake.

geophysical information, such as seismic waves, ocean tides, earth tides, atmosphere pressure, crust deformation, and rainfall. Therefore, a confined well-aquifer system can be regarded as a broadband seismograph (WANG *et al.*, 1988). Observing the groundwater level is one way to monitor crust deformation and predict earthquakes.

Furthermore, many hydrogeological phenomena occur following an earthquake. One of the most interesting phenomena is the change in groundwater level induced by the earthquake. This change in groundwater level may affect the supply of groundwater resources (GOROKHOVICH, 2005; GOROKHOVICH and FLEEGER, 2007; SINGH, 2008; CHEN and WANG, 2009). Seismic waves can affect oil well production (BERESNEV and JOHNSON, 1994). The redistribution of fluid pressure induced by an earthquake may trigger new seismicity (BOSL and NUR, 2002). Therefore, the study of the mechanism behind groundwater level