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Analysis on 4- component borehole Strainmeters data in China

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Since 2006 the 4-component borehole strainmeters have been installed in China's National Digital Network of Earthquake Observation. The purpose of the network is to monitor micro crustal deformation related to earthquakes. The 4-component borehole strainmeters are installed at 30-60 feet down a borehole, recording the high-precision measure of strain sampled once per minute.
All strain data have been an initial quality assessment, such as stability, continuity and relative calibration. Areal strain is the sum of two perpendicular components, so the relative calibration of each component can be examined by two areal strains, namely self-checking:s1+s3=s2+s4, s1, s2, s3, s4 are strain data of 1,2,3,4 component, which is 45 degree between two component orientation respectively. The data of each component can be corrected by relative calibration. There are about 25 stations are satisfied assessment out of 40. Using data of 25 stations, we can obtain two shear strains: s1-s3, s2-s4, the result shows that the shear strains rate are 2-3 times faster near the China South-north Seismic Zone than others.
Some strain data were disturbed by environmental influences, such as rainfall and seasonal river water levels near the station. Based on the tidal observation model, using the data of strain, water-level and pore pressure monitoring in the same borehole, the parameters such as tidal response ratio and phase lag, barometric coefficient, coefficient of water level have been obtained. The data approximate errors were less than 10-11 of 25 stations except 6% data, the coefficients of pore pressure were less than , coefficients of water level were less than , and the values of tidal response ratio were between 0 and 2, the absolute values of tidal phase lag were less than 37 minutes.
Using the observation model containing quadratic de-trend, de-tide and effects of air pressure disturbance, the time series of tidal and nontidal parameters can be calculated by quadratic approximation formula, and the daily abnormal frequency of each component can be obtained from the residual data.
Some strong earthquakes occurred in China during the measurement; we analyzed abnormal changes in the data which may be related to the earthquakes, Huili 6.1 and Wenchuan 8.0, for resample. Huili 6.1 earthquake occurred at NS-trending Hongge fault, which was 180km apart from Xiaomiao site. The measuring site located in the north of Hongge fault. The result showed that M2 tidal factor of NS component of Xiaomiao site was decreased a half year before the earthquake. The loading and unloading response ratio (i.e.) of shear strain began to be unstable 10 months before earthquake, and the daily abnormal frequency increased before Huili 6.1 earthquake and Yaoan 6.0 earthquake which occurred 280km apart from the site. It seems that strain data of this site was overly sensitive which characteristic may be relevant to the intersection of the three faults: Anninghe fault, Zemuhe fault and Hongge fault. Guza site is the nearest to Wenchuan 8.0 earthquake (rupture length is 216km), 160km away from the epicenter. The strain data curves of Guza site were disturbed by short-term signals, and the daily abnormal frequency increased gradually a year before the earthquake, and gradually recovered original background levels after the earthquake.
Nevertheless, we should notice that phenomena observed though the mechanism is not very clear. There is some indication that this tremor event may be the related to the seismic structure. Further research and comparison with data from other fault lines prior to seismic activity is needed to achieve better understanding of the value of strain gages in analysis of shear strain prior to earthquakes.