

Underground water observation in “Wari-ishi hot spring”, Central Japan

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Abstract

We have observed the flow rate and radon concentration of the underground water in “Wari-ishi hot spring”, Northern Gifu Prefecture, Center Japan. The depth of hot spring open well is 850m. Flow rate and temperature of hot spring water were measured in the last 30 years. The maintenance persons for hot spring were recorded the data of a week interval by using of a bucket and stopwatch in the first observation period from 1977 to 1997. The radon detector and the electromagnetic flow meter and the thermometer were installed in July-1998. Flow rate was measured by the electromagnetic flow meter with the accuracy of 0.1 liter/min with 10min intervals in the second observation period from 1998 to 2003.

On the first and second observation period, eight co-seismic changes were detected for the amount of spring water, and were reported on 3rd Japan-Taiwan International Workshop in Tsukuba. There is a threshold to detect the co-seismic change in the relationship between earthquake magnitude and observation site to hypocenter distance. Volumetric Strain was calculated by earthquake fault model using the MICAP-G program and by tidal response from changes of water flow. Changes of flow rate associated with eight earthquakes were 60 times larger than the values expected from fault model, and the sign of the dilatation and contraction was disagree between and observation and model. The data taking using the 1Hz-sampling system was started on July-2004 in the third observation period 2004 to 2007.

On the third observation period, new co-seismic changes were detected in five earthquakes, Off-Kii Peninsula(2004, M6.8 and M7.2), Chuetsu(2004, M6.8), Gifu Hida(2005, M3.0, very near to site), Off-Noto Peninsula(2007, M6.9), Off-Chuetsu (2007, M6.8) with 1Hz data sampling. The tidal components were clearly observed in the open well, and tidal response was analyzed with atmospheric pressure of the association data by using BAYTAP-G program. Tidal sensitivity of M2 showed to be $0.15(\text{liter}/\text{min})/(10^{-8} \text{ cubic strain})$, and the amplitudes were observed a changes among ten year of 1998 to 2007. The changes of 1Hz water flow data were presented in above five earthquakes, and far away big three earthquakes, Sumatora Island(2004, M9.0), Southern Taiwan(2006, M7.1) and Eastern Chishima(2006, M8.3). The observed change was compared with seismic waves recorded by Hi-net and STS seismometers in Off-Noto Peninsula(2007, M6.9). The time of initial decrease of discharge was coincided with the initial movement of Hi-net and STS data on P-wave arrival time 2007/03/25 9:42:17. The precise water flow data with 1Hz data was shown that the irregular component was decreased with 1/3 after earthquake occurrence. Unexpected increase of water flow was observed. Dissolved gas will be gushed out from open well because of the strain changes by earthquake.