Underground water observation in “Wari-ishi hot spring”, Gifu Prefecture

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Abstract

We have observed the flow rate and radon concentration of the underground water in “Wari-ishi hot spring”, the north of Gifu Prefecture, center part of Japan. The depth of hot spring well is 850m. Flow rate and temperature of hot spring water were measured in the last 25 years. Persons for hot spring maintenance were recorded the data 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. Amount of the spring water was measured by the electromagnetic flow meter with the accuracy of 0.1 l/min, in the second observation period from 1998 to 2003. The observation results of the hot spring water were analyzed, and displayed in the Web Page.

On the first observation period, four coseismic changes in flow rate of spring water were detected in the four earthquakes. On the second period, a clear coseismic change in flow rate of the hot water was detected in four earthquakes. The flow rate of the spring water in seven earthquakes increased after occurring the earthquake. The flow rate decreased to the original level before the earthquake. In the Central Japan Sea (Nihon-kai Chubu) earthquake in 1983, flow rate of the spring water has decreased before and after the earthquake. There is a threshold to detect the coseismic change in the relationship between earthquake magnitude and the well-hypocenter distance.

Tidal analysis program was applied to decompose the time series data of water flow rate into atmospheric pressure, tidal, observation irregular component and residual water flow data, on second period. The response of water flow in tidal strain was estimated to be 0.16 and 0.15 (l/min)/($\times 10^{-8}$ cubic strain) on O1 and M2 earth tide constituent, respectively.

Volumetric Strain was calculated in the eight earthquakes detecting coseismic changes by earthquake fault model using the MICAP-G program. Expected volumetric strain was estimated by tidal response from change of water flow. The volumetric strain from the water flow rate was 60 times larger than the values calculated from earthquake fault model.

The flow rate of the hot spring water greatly fluctuated when the hot spring water including a lot of gases passes to the electromagnetic flow meter. Irregular component of the flow rate was related with the amount of the resolved gas in the hot spring water. Irregular component was decreased with 1/3 after occurrence of earthquake. Because of the volumetric strain change by earthquake, the gas gushed out from the deep hot spring well.