Rainfall-induced bedrock deformation and its possible association with regional characteristics of the bedrock

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Rainfall-induced bedrock deformation is a significant noise for crustal movement observation and for earthquake prediction, and its analysis of influences of the noise on the measurement is a major theme in the monitoring at the observatory vault. And then, analysis of the rainfall-induced rock strain may possibly help understand precausal of rainfall-induced deep seated rock avalanches, since the bedrock deformation processes in the mountain have not been clarified enough based on in-situ measurement if such anisotropy and time-dependency of the deformation are influenced by external effects and internal rock heterogeneity. To clarify the rainfall-induced bedrock deformation processes, we analyzed datasets of strain that measured on a set of three quartz tube extensometers whose length are 40 m installed in the Nokogiri-yama crustal movement observatory in Chiba prefecture, Japan. Nokogiri-yama mountain locates at southwestern tip of Boso peninsula and consists of Mio-Pliocene sedimentary rock of Miura group whose geology is comparable with that of Aburatsubo crustal movement observatory in Miura peninsura in Kanagawa prefecture. Monitoring results measured at the Aburatsubo observatory were used to compare with that of the Nokogiri-yama observatory. Datasets of hourly strain of 2013 and 2015 were analyzed monthly at a time, and tidal, barometric response, noise components were eliminated using BAYTAP-G (Tamura et al. 1991), and trend components of the remnant were used for daily calculation of principal, areal, and deviatoric strains. Annual precipitation at Kyonan station (JMA) where 4 km away from the Nokogiri-yama observatory were 1662 mm and 1846 mm, and maximum rainfall intensities were 46 mm/h and 30 mm/h for 2013 and 2015, respectively. Our result showed that changes of the areal strain during measurement periods indicated that they decreased -50–-90 nano-strain/day during intense rainfall events. And after that they increased 100–200 nano-strain/day and then returned to previous strain rate when the rainfall ceased. Furthermore, the magnitudes of areal strain during rainfall seemed to be changed with duration and intensity of rainfalls. On the other hand, in the Aburatsubo observatory, areal strains in maximum were several tens nano-strain/day for both periods. We thus shifted our attention to the clarification of the regional characteristics of the bedrock. Numerical analysis would help understand the physical processes while governing equations require settings of assumptions and parameters for representing regional characteristics of the bedrock if the pore water pressure is influential. At the Aburatsubo observatory groundwater table is lower than several meters from the tunnel floor, suggesting that bedrock to be measured using extensometers is upper than groundwater table, and is unsaturated. Whereas, yielding out of spring water from fissures of bedrock is observable constantly at several points at 200–220 m of elevation in mount Nokogiri-yama. Therefore, these results indicate that regional characteristics of the bedrock involving hydrogeological environment would possibly associated with mechanisms of the rainfall-induced bedrock deformation.

Keywords: strain, Quartz tube extensometer, Nokogiri-yama crustal movement observatory, ground water, geology

