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Detection of temporal changes in microseisms during Onikobe geyser's activity

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Onikobe geyser, which is located at Miyagi prefecture, effuses hot water every about 5 to 20 minutes. Hot water is constantly supplied to the geyser system, and effusions repeatedly occur due to de-pressurization and boiling mechanism. Tilt observation shows that the ground surrounding the vent is deformed before and after each effusion, which reaches about 4 micro radians at stations 7 m from the vent. This geyser activity may cause some changes in the structure or generate additional seismic signals, but ambient noises are too large to distinguish such signals in raw data even recorded at stations very close to the vent. In this study, we examine slight changes in microseisms during the activity of the geyser by applying the coda wave interferometry method. We analyze microseisms recorded by five seismometers installed at distance from 4 to 18 m from the vent. Vertical component signals from short period (0.5 s) seismometers were digitized at a 200 Hz sampling frequency with a 24bit A/D resolution by a data logger (LS-7000XT). Continuously recorded signals for three days from November 10 to 12, 2006, when effusions repeatedly occurred every about 12 minutes, were used for the analyses. Since the geyser repeatedly effuses hot water, we are able to precisely estimate the properties of microseisms by stacking the data. We calculate autocorrelation function of microseisms, which may represent a convolution of the source term and Green's function at the same source-receiver location. To examine temporal changes after an effusion to just before the following effusion, we calculate the autocorrelation functions at eight preparation stages of one-minute length for 8 minutes to 1 minute before each effusion. We stack about 365 autocorrelation functions for each preparation stage to obtain the averaged properties. Since the stacked autocorrelation functions for eight preparation stages are quite similar to each other, we calculate the difference of stacked autocorrelation functions for two successive preparation stages to detect a very small change. Any significant differences of stacked autocorrelation functions at all of the preparation stages are not observed at stations far from the vent. This indicates that the structure far from the vent does not change and any seismic sources do not temporally emerge. However, stacked autocorrelation functions at three stations close to the vent (4 to 6 m) show some differences within lag times of 0 to 0.5 s for the preparation stages just after and before each effusion (1 and 8 minutes before effusion). The differences of signal are dominant at about 30 Hz and one of the stations shows a 2 Hz oscillation. Such differences are not observed during preparation stages from 2 to 7 minutes before effusion. The analyses of microseisms using coda wave interferometry method succeeded in detecting very small changes in structure or seismic sources due to, for example water supply to the geyser system or bubble motions in the conduit.