STT055-P01 Room:Convention Hall Time:May 27 10:30-13:00

An investigation of seismic noise level of borehole-type broadband seismometer CMG-3TB (2)

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The borehole type very broadband seismometer (Guralp Systems CMG-3TB) was installed in the 700m-deep borehole at Matsushiro Seismological Observatory (MSO) in 2008. Tsuyuki et al. (2009) investigated the noise level of this seismometer comparing with the STS-1 in the observation tunnel of MSO and found that the noise of CMG-3TB is smaller than STS-1 significantly for short period band (less than a few seconds). On the other hand, they found that the horizontal component of CMG-3TB showed fairy large noise with period of more than several minutes. They suggested that this long period noise could be reduced by installation method. Then, we reconsidered the sensor installation method, and re-installed the sensor near the bottom of borehole without the rubber seats for protection. As a result, long period noise has almost disappeared and observed data become stable. In this study, we again investigate the ground noise level of the CMG-3TB compared with other broadband seismometers installed at observation tunnel at MSO.

We compared the power spectra of CMG-3TB with STS-1 and STS-2, and found that the noise level of CMG-3TB is smaller than STS-1 and STS-2 for the period of less than 2-3 seconds especially remarkable at around the period of 0.5 seconds. We could reconfirm the effect of deep borehole installation for CMG-3TB. For the period of 2-100 seconds, the noise level is almost same for CMG-3TB and STS-1. For the period of 100-1000 seconds, we can see that the noise level of CMG-3TB is a little larger than that of STS-1, but this feature is not seen for components and analyzed periods. In addition, we confirmed that the records of tidal component were almost same for CMG-3TB and STS-1. Thus, it is considered that CMG-3TB has almost as same frequency characteristic as STS-1.

Keywords: Borehole-type broadband seismometer, noise level

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Seismic array observation at Nagatani dam site

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We carried out a seismic array observation in Nagatani dam site, Fukuoka City, Kyushu, Japan. This area are located at about 15 km away from the focal area of the 2005 West Off Fukuoka Prefecture Earthquake. Recent studies about heterogeneous structure around the focal area found strong scatteres at the SE part of the fault and the SE-extension of the fault. The part where strong scatterers exist corresponds to segment boundary between the earthquake fault and the Kego fault. However, the structures of the SE-extension have not been revealed in detail in the previous studies because of less resolution in this area. In order to investigate the inhomogeneous structures around the Kego fault, we need to obtain seismograms with high S/N ratio. The purpose of this observation is that we attempt to image distribution of scatteres around the Kego fault by dense seismic array.

We carried out the array observation from August 30 to November 25, 2010. This array covered 620 m in the EW direction and 650 m in the NS direction. We installed 67 temporary seismic stations in the site. The array was composed of 2-Hz three-component seismometers with a site spacing of about 20 m. They were installed on 5 lines owing to the topography around the dam site. The lines consisted of 4, 11, 6, 24 and 22 stations, respectively. The sampling frequency was 250 Hz. More than 60 earthquakes were recorded during this period with good S/N ratios. By using these data, we will estimate scatteres around the Kego fault.

Keywords: seismic array

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Automatic Hypocenter Determination in Swarms and Aftershocks

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It is very important to estimate the spatial and temporal hypocenter distributions in swarms and aftershocks quickly. We need the automatic determination to grasp seismic activities in real time, because the manual hypocenter determination takes a lot of times.

JMA can usually determine 90% or more hypocenters automatically compared with JMA catalog ($M >= 2.0$). However they fall to 20-30% in swarms and aftershocks due to the rise of a trigger level and wrong pickings. Therefore, we applied an efficient automatic hypocenter determination method (Sakai, 1998) in swarms and aftershocks.

The method is as follows. In a swarm, hypocenters are close to each other, so the differences of the arrival times between stations would be also close to each other. Therefore, he referred to some hypocenters (we named them the reference events) determined by manual picking, shifted the observed waves by the differences of the arrival times and stacked the waves to detect events efficiently.

We applied that method for some swarms and aftershocks, including the case off the east coast of Izu Peninsula in December, 2009, the case of western Fukushima Prefecture in September, 2010 and the case of the Iwate-Miyagi Nairiku Earthquake in 2008.

In the case off the east coast of Izu Peninsula, we could grasp that the seismic activity became shallower and the number of events was increased before the first large event. However, in the case of aftershocks of the Iwate-Miyagi Nairiku Earthquake in 2008, the aftershock area was estimated obscurely because it was so large and some aftershocks were far away from the reference event. In order to solve the problem, we set some reference events. It might perform well, but we don't know where the reference events should be set in real time. We still have some problems, such as the parameter settings of the trigger and the picking.

References: Sakai, 1998, Abstr. of SSJ 1998 Fall Meeting, 140.

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Automated hypocenter determination of aftershocks and earthquake swarms

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Various techniques have been proposed to achieve automated hypocenter determination. However, interactive processing by analysts is still necessary to get reliable seismic catalog. When a big earthquake occur, delay in hypocenter determination is often seen, and it makes difficult to grasp the source area of the earthquake soon after the occurrence.

Automated processing methods of earthquake swarms have been proposed (e.g., Horiuchi et al., 1999), in which hypocenter locations are assumed in a restricted area. When the Tonankai and Nankai earthquake occur at the same time, the source area would extend for several hundred kilometers. It would be impossible to assume a limited area of aftershock activity for such large earthquakes. We are developing an automated hypocenter determination system to grasp source areas of large earthquakes soon after the occurrence.

In aftershock activity, successive events occur before the decay of the seismic wave of the previous event. A logic of detecting successive phase was introduced. Two decay time were set in the calculation of the long-term average.

It would be important in the automated seismic processing to distinguish reliable onset times from data which include many onsets due to seismic wave of other events, ground noise, and erroneous phase picks. We use grid search method for locations. Probability fucntion of a origin time is calculated from the assumed location and an observed onset time. Product of probability functions of plural onsets are calculated from data set. Origin time estimation is obtained as time of maximum probability for a grid point. The grid point with the largest probability would be the solution of the hypocenter location. Other evenets can be detected with the same procedure after removing the data of the largest probability.

However, trade-off between an origin time and epicentral distance was seen for cases of one-sided station distributions. Information of S-wave arrival can constrain the origin time. To include information of S-wave arrival, we took in the times of maximum amplitude in the calculation of the probability function of the origin time. We are testing and tuning up the programs.

We used seismic data from the National Research Institute for Earth Science and Disaster Prevention, Hokkaido University, Hirosaki University, Tohoku University, University of Tokyo, Nagoya University, Kyoto University, Kochi University, Kyushu University, Kagoshima University, the National Institute of Advanced Industrial Science and Technology, Tokyo metropolitan government, Shizuoka prefectural government, Kanagawa prefectural government, the City of Yokohama, the Japan Marine Science and Technology Center, and the Japan Meteorological Agency.

Keywords: automated hypocenter determination, observation of aftershocks and earthquake swarms

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Improvement of Channel Information Management System

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The WIN format [Urabe, 1994] is the national standard format of the seismic waveform data in Japan. The specification of this format is the waveform data and their channel information (i.e. channel ids, sensor types, components, data resolutions, sensor sensitivities, sensor locations, etc.) are separated. This format is useful to exchange waveform data among seismic observatories and stations because the data size is smaller than other format. When using the waveform data, the channel information must be required. In other words, the correct management of channel information is very important. We developed the Channel Information Management System (CIMS), which treats the unified channel information using the distributed database system [Nakagawa *et al.*, 2007]. The user of this system accesses the database by web, and updates or browses the channel information which is requested by user. This system has a function that the CIMS servers deployed at the seismic observatories of the Japanese universities and other institutes automatically negotiate with one another and exchange the channel information. So, CIMS is not only the distributed database system but also the mirror database system.

The most important feature of CIMS is a retroactive change of channel information accurately. To preserve change logs of channel information and to ensure the consistency among the CIMS servers, a command for deleting the channel information from the database was not implemented. After we started the operation of CIMS, incorrectly-inputs of data occurred frequently. To correct the data, we needed to directly access the database middleware of CIMS and fix the data. This is not undesirable way in terms of maintaining consistency.

In this study, we improve the CIMS by implementing a deleting the data command. It is need attention that the correct data was not deleted by error if a delete command is executed. So, deleting data consists of two stages. First stage is to set an invalid flag, and second stage is to delete data which have invalid flags from the CIMS database. This improvement has finished in January 2011, and operates the improved CIMS. We enhance the reliability and stability.

Keywords: database, channel information, WIN format