

Japan Geoscience Union Meeting 2011

(May 22-27 2011 at Makuhari, Chiba, Japan)

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STT055-01

Room:302

Time:May 27 08:30-08:45

Development of an artificial vibration source by use of giant magnetostrictive material

Hiroshi Ishii^{1*}, Teruo Mori², SANO Osam¹

¹Tono Res. Institute of Earthq. Sc., ²GMMtech Co.,Ltd.

We can obtain many information about rock bed such as modulus of elasticity, attenuation, variation of stress and so on, utilizing elastic wave propagation. If we can make an artificial vibration source which is strong and easy to handle, we can easily know information about rock bed. Therefore, we have developed an artificial vibration source by use of a giant magnetostrictive material. A giant magnetostrictive material deform by applying magnetic field and a deformation is larger than other materials. This time we employed a giant magnetostrictive material with cylinder size of 40mm diameter and 150mm length. A coil is rolled up around the material and it is installed into a cylinder type vessel that is 60mm diameter and 300mm length. The vibration source can be drove by AC 100volt and output power is about 2000kgf. And it can drive wave forms made by an oscillator.

We will present the vibration source system and some experimental results.

Keywords: artificial vibration source, giant magnetostrictive material, development, elastic wave

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STT055-02

Room:302

Time:May 27 08:45-09:00

Development of precise and longterm monitoring system of V_p with magnetostrictive transducer

SANO Osam^{1*}, OKUBO Makoto¹, ISHII Hiroshi¹

¹TRIES

Precise and continuous monitoring of V_p can be a measure for small stress change in rock [Reasenberg and Aki, 1974]. Piezo-electric transducers were employed as a transmitter by one of the authors for such a precise measurement. Based on the V_p change in situ and pressure dependence of V_p in laboratory, stress variation of the order of hPa was estimated at Kamaishi test site. In this study, a magnetostrictive transducer is employed as a transmitter, because of higher power than piezo-electric transducers. The newly developed measurement system is set at Mizunami test site of Nagoya University. Boxcar signal of 500 Hz is continuously applied to the transmitter. The applied voltage is 1000 V and 40 V for piezo-electric transducer and magnetostrictive transducer, respectively. The length of measurement path is 20 m and 100 m for piezo-electric transducer and magnetostrictive transducer, respectively. Based on the rock properties, in the rocks of higher quality than the rock at Mizunami, such as granitic rocks, measurement path of several kilo-meters should be available with the use of magnetostrictive transducers.

Keywords: stress, V_p , magnetostrictive transducer, precise monitoring, continuous monitoring

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STT055-03

Room:302

Time:May 27 09:00-09:15

The improvement of auto-determined hypocenter location, focal mechanism and CMT-solution

Hiroshi UENO^{1*}, Shimpei Adachi¹, Yuji Usui¹, Masashi Kiyomoto¹, Koji Sakoda¹, Koji Tamaribuchi¹, Takahiko Yamauchi¹, Yasumasa Shiozu¹, Takashi Yokota¹

¹SVD/JMA

We issue hypocenter parameter of felt earthquakes immediately after earthquake occurred. And after two days, we re-issue more precise hypocenter parameter of all earthquakes occurred in and around Japan.

On the other hand, after four business days, the parameter of the mechanism solution issue.

It is effective in the disaster prevention measures to know immediately the parameter of the hypocenter and mechanism solution.

This time, we have improved the automatic determination method of the hypocenter location, focal mechanism and CMT-solution with EPOS(Earthquake and Phenomena Observation System) and REDC(Regional Earthquake information Data Center) system updating.

We plan to publish in JMA HP(in Japanese only) by following criteria in the spring of this year.

1. The publishing time: In about 30 minutes after the earthquake occurs

2. The publishing magnitude of earthquake

2-1. auto-hypocenter location:

(1) All felt earthquake

(2) JMA magnitude of earthquake which occurred inland is 1.5 and over.

(3) JMA magnitude of earthquake which occurred in sea and deep area is 4.0 and over.

2-2. auto-mechanism

(1) Focal mechanism: JMA magnitude of earthquake is 3.5 and over.

(2) CMT-solution: Moment magnitude of earthquake which occurred in and around Japan is 5.0 and over. Moment magnitude of earthquake which occurred over the world is 6.5 and over.

Keywords: AUTO hypocenter location, AUTO focal mechanism, AUTO CMT solution, EPOS, REDC

STT055-04

Room:302

Time:May 27 09:15-09:30

Development of high quality seafloor earthquake and Tsunami observation in DONET project

Eiichiro Araki^{1*}, Katsuyoshi Kawaguchi¹, Hiroyuki Matsumoto¹, Takashi Yokobiki¹, Yoshiyuki Kaneda¹

¹JAMSTEC

We developed seafloor cabled observatory network called Dense Ocean-floor Network for Earthquake and Tsunamis (DONET) in the rupture zone of Tonankai earthquake and around to monitor earthquakes and tsunamis as well as crustal activity in the seafloor. Observation targets of DONET are earthquakes from micro-earthquakes to large earthquake of magnitude 8 such as the last Tonankai earthquake in 1944, episodic slow slip events such known as very low frequency earthquakes, tsunami generation process in the epicenter area and so on. In DONET project, 20 seafloor observatories are planned to connect to 5 seafloor observation node with 10 km extension cables. The seafloor observation nodes are connected to a backbone submarine cable of both ends landed to supply power and communicate with each observatory. With this system of backbone cable, observation node, and extension cables, we are able to establish an observatory network much denser (10-30 km separations) than the past cabled observatories.

Each seafloor DONET observatory consists of a set of seismometers observing earthquakes and a set of pressure gauges observing earthquakes, tsunamis and slow crustal motion, as well as seafloor water thermometer intended for seafloor turbidity current monitoring. The seismometers are a set of broadband seismometer (Guralp CMG3T) and strong motion accelerometer (Metrozet TSA100-S), which support ground motion monitoring from the smallest to 4 G ground acceleration. The pressure gauges are a set of quartz pressure gauge (Paroscientific 8B7000-2), deep sea differential pressure gauge and hydrophone, which support seafloor pressure observation of much less than 1 Pa, very slow seafloor vertical movement as well as pressure wave of over a few MPa during a large earthquake in the vicinity. With the DONET seawater thermometer, seafloor water temperature can be monitored with an accuracy of 5 mK and 1 mK resolution which will be necessary to detect seafloor turbidity current.

In the DONET project, we also developed a technique to install a seismometer to avoid influences of seafloor current flowing in the seafloor. With the developed technique, the seismometers are completely buried beneath the seabed. As a result of complete burial, low frequency noise of seafloor broadband seismometer was lowered by more than 40 dB for horizontal components. With this noise reduction, we were able to clearly observe the effect of long period ocean gravity wave deforming the seabed in the period longer than 50 seconds. This ground deformation due to the long period ocean gravity wave is regarded as a noise for earthquake monitoring, but this effect may also be reduced by monitoring seafloor pressure at the same place of ground motion monitoring by the broadband seismometer. This is possible with differential pressure gauge in the DONET seafloor observatory. This is an example showing the importance of measuring both ground motion and pressure in the seafloor.

STT055-05

Room:302

Time:May 27 09:30-09:45

Performance evaluation of a laser-interferometric broadband seismometer for observations in extreme environments

Teruhito Hori^{1*}, Akito Araya¹, Hideaki Kakuma², Naoki Kobayashi³, Hiroaki Shiraishi³, Tatsuaki Okada³, Takehiko Satoh³, Hideki Murakami⁴

¹ERI, ²ADEP, ³JAXA, ⁴Kochi

We have developed a Laser-interferometric broadband seismometer for observations in extreme environments.

As such environments, the seafloor (ocean bottom borehole) and the planet (Mars investigation etc.) are so important sites from the viewpoint of seismology.

The seismic observation in ocean bottom boreholes in subduction zones is a critical way to get better comprehension of earthquake generation process and the prediction.

Also, the seismic observation on a planet (earthquakes, free oscillation) is so effective way to reveal its internal structure.

To perform valuable observations for such purpose, many superior specifications are simultaneously required for the seismometer, such as high sensitivity, broadband, maintenance-free, robustness, low noise, compact size (borehole/hand size), durability in high/low temperature, and radiation durability (cosmic ray).

As there are no seismometers on the market that have these specs, we have originally developed a laser-interferometric type broadband seismometer.

This seismometer consists of 3 sections: a laser interferometer, a long-term pendulum, and a feedback servo electronics.

Having passed through the vibration test and the temperature test, we have made the breadboard model of this seismometer.

In this presentation, we will mainly show the details of the self-noise test and the evaluation through the test observation at Nokogiriyama observatory.

Keywords: seismometer, broadband, borehole, planet, ocean, laser

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)

Takumi Koyama^{1*}, Naoya Mikami¹, Hiroyuki Takayama¹, Tomomichi Furudate¹

¹Matsushiro Seismological Observatory,JMA

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 fairly 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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STT055-P02

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Seismic array observation at Nagatani dam site

Manami Nakamoto^{1*}, Satoshi Matsumoto², Kei Ikehata², Hiromi Chikura¹, Masahiro Miyazaki¹, Tomoyuki Takeda¹, Hiroshi Shimizu², Natsumi Itoya¹, Yusuke Yamashita¹, Takeshi Matsushima²

¹Grad. Sci. Sci., Kyushu Univ., ²SEVO, Kyushu Univ.

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

STT055-P03

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Automatic Hypocenter Determination in Swarms and Aftershocks

Koji Tamaribuchi^{1*}, Yasuyuki Yamada¹, Masaki Nakamura¹, Kiyomoto Masashi¹

¹JMA

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 ($M \geq 2.0$). 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.

STT055-P04

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Automated hypocenter determination of aftershocks and earthquake swarms

Akio Katsumata^{1*}, Shigeki Aoki¹, Yasuhiro Yoshida¹, Kazuhiro Kimura¹

¹Meteorological Research Institute

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 function 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 events 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

STT055-P05

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Improvement of Channel Information Management System

Shigeki Nakagawa^{1*}, Hiroshi Tsuruoka¹, Kiyoshi Takano¹, Shin'ichi Sakai¹

¹ERI, the Univ. of Tokyo

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