Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SEM22-P01 Room:Convention Hall Time:May 25 15:30-16:45

Statistics of the Local Electric Currents in Porous Geo-Materials Obtained by Pore-Scale Computer Simulations

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Computer simulations of steady-state electric currents in fluid-saturated porous sediment/rock were performed using pore-scale X-ray microtomographic images (Refs 1, 2). An example of the simulated local current magnitude is shown in the figure below (Berea sandstone image, 0.64mm x 0.64mm x 0.64mm, Solid voxels are dark blue. The direction of the macroscopically applied field gradient is indicated by a solid arrow). The main results are as follows. (i) The histogram of the magnitude of the local current flux vector obeys a unimodal log-normal distribution having a long positive tail. Simulations using model images were also performed to show that the flux broadening in large pores and the flux mixing at the pore network junctions are responsible for the log-normal shape. (ii) The simulation enabled us to directly visualize pore voxels with large and small fluxes, confirming the existence of transport pores and stagnant pores. Because of the unimodal nature, however, it was difficult to distinguish transport pores and stagnant pores using an objective threshold in the histogram. (iii) Another histogram of the flux vector component along the direction of the macroscopic potential gradient was analyzed. A negative tail was found in the histogram, indicating that local counter currents exist in the porous geo-materials. However, the population and intensity of the counter fluxes are too small and weak to contribute to the overall charge transport across the porous media system. A long positive tail representing a large-flux current pathway was also observed in the histogram. However, again, the population of the large-flux transport pores is small. As a result, the main conveyer of the electric charge is the stagnant pores (not the transport pores), which have small positive flux values but a large population. The present study was supported in part by JSPS KAKENHI (No. 23241012).

References:

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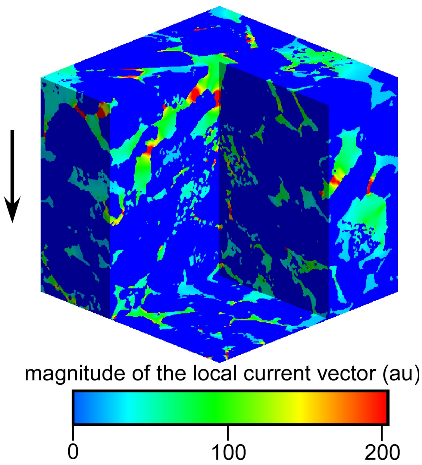
Keywords: formation factor, Archie's law, electric conductivity, pore-scale simulation, diffusion, x-ray microtomography



Japan Geoscience Union Meeting 2012
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SEM22-P02 Room:Convention Hall Time:May 25 15:30-16:45

Resistivity structure around the focal area of M6.4 earthquake beneath Mt. Fuji volcano

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Broad-band magnetotelluric (MT) measurements were conducted June to December, 2011 at Mt. Fuji volcano. The objective of this survey is to investigate the resistivity structure around the focal region of M6.4 earthquake, which occurred beneath Mt Fuji 4 days after M9 Tohoku Oki earthquake. MT Data were collected at 25 sites by using Metronix ADU07 system. The sampling frequency were 32Hz (15:00˜20:00 UT), 1024Hz (17:00˜17:30UT), and 32768Hz (14:50˜15:51). Because of the high noise circumstance of this area, typical duration of data sampling was one month for one site. By applying the comb filter to reduce the harmonics of 50 and 60Hz and the robust MT response function estimation code (Chave and Thomson, 2004), we obtained the impedance tensor in the frequency range of 10,000 ˜ 0.001Hz. In this presentation, we will show the resistivity structure by inversion, and will discuss the mechanism of the M6.4 earthquake beneath Mt. Fuji.

SEM22-P03 Room:Convention Hall Time:May 25 15:30-16:45

Resistivity imaging by magnetotelluric method on Taal volcano, Philippines -Evaluation of the sea effect-

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Taal volcano, located in the Taal caldera lake, the southern part of the Luzon Island, is one of the most active volcanoes in Philippines. We conducted a magnetotelluric resistivity survey to clarify the distribution of ground water and magma reservoir beneath the volcano. AMT and wideband MT data were measured along two lines, which were crossing the main crater lake (MCL) at the center of the volcano island, and the southwestern flank. The impedance tensor and induction vector were calculated from the time series data. Prior to a 2-D analysis, the phase tensor analysis suspected the electromagnetic strike direction in the study area as N35E, which is approximately perpendicular to our survey lines. Here, during the 2-D analysis, it is required to consider the sea effect to the MT data because the study area is surrounded by the ocean, being about 15 km distant from there. The measured induction vectors pointing toward the ocean are obviously affected by the seawater. The 3-D forward model assuming a simplified bathymetry with 0.3 ohm-m seawater evaluated this effect. The calculated induction vectors explained well the observed ones at a frequency band below 0.01 Hz, reflecting the sea effect. However, this effect to the impedance above 0.3 Hz was not so large as to give critical artifacts to a resistivity structure suspected by a 2-D analysis. Therefore, the apparent resistivity and impedance phase above 0.3 Hz were inverted to resistivity sections, by using the 2-D resistivity inversion scheme developed by Ogawa and Uchida (1996). The 2-D bathymetry was fixed during the inversion. The inverted resistivity section across the MCL indicates a relatively resistive body (30-100 ohm-m) at 1-3 km (b.s.l.) surrounded by conductive layer. Since this feature is common to the other resistivity section, the conductor can shape a kind of the shell spherically covering the resistive body. This resistive body can be interpreted as a volcanic gas reservoir or intruded rocks during past eruptions. The saturation of lake water and alteration due to volcanic fluid and heat can generate a surrounding conductor.

Keywords: volcano, Taal, magnetotelluric, resistivity structure

Japan Geoscience Union Meeting 2012
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SEM22-P04 Room:Convention Hall Time:May 25 15:30-16:45

Audio-frequency magnetotelluric surveys across the Yasutomi and Kuresaka-touge faults (2)

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The Yamasaki Fault System consists of the Ohara, Hijima, Yasutomi, and Kuresaka-touge Faults (northwest active faults group) and the Biwako ,Miki, and Kusatani Faults (southeast active faults group).The total length of the fault system is about 90 kilometers long. The Nagisen Fault zone is a reverse fault system that runs between southern foot of the Mt. Nagisen and the Tsuyama Basin. The general strike of the zone is EW and about 32 kilometers long.

Headquarters for Earthquake Research Promotion (2003) classified the Yamazaki Fault zone into three seismogenic faults, the Nagisen Fault zone, main strand of the Yamasaki Fault zone (the Ohara Fault - the Miki Fault), and the Kusatani Fault. The main strand of the Yamasaki Fault zone is divided into the northwestern part and the southeastern part. They evaluated the probability of earthquake occurrence within 30 years will be 0.07-0.1% for the Nagisen Fault zone, 0.06-0.8% for the northwestern part of the main strand of the Yamasaki Fault zone, 0.03-5% for the southeastern part of that, and about 0% for the Kusatani Fault. Audio-frequency magnetotelluric (AMT) surveys were undertaken along three lines (E-, C-, and W-line) across the Yasutomi and Kuresaka-touge Faults in 2009-2011 in order to reveal subsurface structure beneath the fault system. In this presentation we will show the results along W-line and E-line.

The survey was made at eight stations in 2010 and at four in 2011 along the E-line. Ueda et al. made observations at six stations to the north of the Yasutomi Fault and five to the south of the Kuresaka-touge Fault in 2009 along the W-line. Additional AMT survey was made at two stations in the area between the Yasutomi and Kuresaka-touge Faults in 2011.

MT responses of the frequency range between 10,400-0.35Hz were obtained at each site using the remote reference processing (Gamble et al., 1979). We determined dimensionality and strike direction of each line using the phase tensor analysis (Caldwell et al., 2004). Both of two lines showed the dominant two-dimensional nature. Then, we determined strike directions of each line; N60W-S60E for the E-line and E-W for the W-line.

Qualitative insights from pseudo-sections of the apparent resistivity and phase data of the TM and TE modes as follows.

E-line

In both modes, the apparent resistivity value is <100 ohm-m to the south of the Yasutomi Fault and >1000 ohm-m to the north of this Fault. But, in TE mode, a slightly high resistivity is recognized in the frequency range lower than 500 Hz beneath the surface trace of the Kuresaka-touge Fault and beneath 3km south of this fault.

Phase values between 30 - 40 deg. are widely recognized in both modes with a slightly high phase value of 45 deg. in the frequency range of 100-1000Hz beneath the Yasutomi Fault.

W-line

Low apparent resistivity (<100 ohm-m) region covering from the highest to the lowest frequency is recognized to the north of the Yasutomi Fault. Another low apparent resistivity region is recognized in the frequency range higher than 1000 Hz to the south of this fault. High apparent resistivity (>1000 ohm-m) in the frequency range lower than 1000Hz is found to the south of this fault, this high resistive zone is divided into two in TE mode.

Phase value is 50 - 60 degree to the north of the Yasutomi Fault in both modes. To the south of the Yasutomi Fault low phase value of 30 - 40 deg. covering from the highest to the lowest frequency is recognized in TM mode. In TE mode, low phase value of about 30 deg. is found in the frequency range higher than 500 Hz and it is about 45 deg. in the frequency range lower than that.

In this presentation we will also show the resistivity models of E-line and W-line across the Yasutomi and Kuresaka-touge Faults.

Keywords: conductivity, active fault, magnetotelluric

Japan Geoscience Union Meeting 2012
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SEM22-P05 Room:Convention Hall Time:May 25 15:30-16:45

A preliminary report on resistivity structure survey in southern Tokai region

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In the Tokai region, great earthquakes have occurred repeatedly and such one is also expected to occur in the near future. Several studies estimated the fault models of past earthquakes in this region based on the historical, the geological and the geodetic data (e.g., Ando, 1975; Ishibashi, 1981). Recently, Sagiya (2007) and Kumagai *et al*. (2009) proposed the model which suggested a buried branching fault in the southern part of the Tokai region in addition to the main fault along the plate boundary, because the existence of such fault can better explain the observed geodetic and geological data. But the clear geographical evidence has not been found yet. So we decided to conduct a MT survey to investigate the resistivity structure in the southern part of the Tokai region (Kakegawa city). In this region, since the commercial electrical noise is expected to contaminate the observed electromagnetic signals, we planned the observation for longer period relative to usual observation. For conducting such longer period's observation, we developed a new measurement system using general commercial data loggers. We have conducted a preliminary test observation using this system. Although the new system needs less electric power and enables a long term observation, its sampling frequency is restricted to 200 Hz at most. So, we conducted the short term observation to obtain the data with higher frequencies before the main observation. We located ten observational sites on a line in the direction of N33^{o}W with the length of 20 km approximately. The observation line is perpendicular to the strike of the buried fault estimated by Kumagai *et al*. (2009). Although we successfully obtained the data with the frequency from 10^{-3} to 10^{2} Hz, the data with the lower frequency are contaminated by the artificial noise at some sites. So, we processed the observed MT data with the remote reference technique, which resulted in great improvement of data quality. The apparent resistivity with the higher frequency is low and is approximately equal to 10 ohm-m at all sites. It might be derived from the sedimentary layers. The apparent resistivities with the lower frequency tend to increase in the northern sites and they attain to 1 k ohm-m. We will obtain more precise data with lower frequency by conducting long term observation for a few years and estimate the resistivity structure in this region.

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Keywords: resistivity structure, Tokai region, Tokai earthquake, buried fault

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SEM22-P06 Room:Convention Hall Time:May 25 15:30-16:45

Upwelling Fluids and Island-Arc Volcano in Subduction Zone: 3D Electrical Resistivity Structure of Lithosphere in Kyushu

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In the subduction zone, an aqueous fluid (seawater) brought into the Earth's mantle with subducting oceanic plate takes an important role on the formation of the island-arc volcano. The fluid is released by a dehydration reaction as reaching to a certain pressure-temperature condition. It is one of the most important factors for triggering partial melt of the mantle. The physical heterogeneity differences of downgoing plates have an influence on the partial melt and the igneous activity in the mantle. The Kyushu island in the SW Japan arc is a subduction zone, at which the Shikoku basin; a young Philippine Sea plate (PSP), and the old PSP subduct beneath the Eurasian plate. Many quaternary active volcanoes occur along the volcanic front (VF) associated with the PSP, whereas an active volcano in the backarc area of the northern Kyushu exists. Moreover, a non-volcanic zone of about 100 km long is seen along the VF. It is geophysically important to understand the origin of the unique volcanic distribution in Kyushu.

In this study, the Network-Magnetotelluric (MT) data sets, of which the exploration depth covers to the upper mantle, were used in order to determine regional scale electrical resistivity structure. The Network-MT method is particularly effective to the existence of fluids (the slab-derived aqueous fluid and/or melt) due to the electrical means. We applied three-dimensional (3D) inversion analyses using the WSINV3DMT inversion code for the Network-MT data [Uyeshima et al., 2008] for the purpose of investigating the correlation between fluids and the volcano distribution. The most important feature is a conductive anomaly of which the bottom extends to the backarc side exists beneath the each volcano. The existence of such anomaly suggesting upwelling from the back arc side to the VF has been reported in the NE Japan arc with the MT method [Mishina, 2009] and seismic tomography method [e.g., Hasegawa et al., 1991]. However, our results suggest that the conductive anomaly associated with each volcano has its characteristic scale in the horizontally and vertically. In this presentation, we would like to show details on the 3D resistivity structure related to the subducting PSP and the volcano distribution in terms of the fluids migration.

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SEM22-P07 Room:Convention Hall Time:May 25 15:30-16:45

Three-dimensional electrical resistivity structure around the 2007 Noto Hanto Earthquake

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The 2007 Noto Hanto Earthquake (M6.9) occurred near the west coast of the Noto Peninsula which is located in the back arc area of Central Japan, on 25 March 2007. The focal mechanism of this damaging earthquake shows a reverse fault with a small amount of strike-slip component with a strike of approximately N55E and high angle dip. The two largest aftershocks, both M5.3, occurred within one day near the offshore and onshore edges of the aftershock region. Yoshimura et al. [2008] carried out a wide-band magnetotelluric survey in the onshore area covering the eastern half of the source region, and obtained two-dimensional resistivity models along five profiles as a preparatory step for imaging three-dimensional structure, As the results, they pointed out that a conductive body, which seems to represent fluid-filled zone, is located beneath the mainshock hypocenter and the active aftershock region.

In order to verify the relationship between seismicity and electrical resistivity structure, we carried out additional two-dimensional modelings and three-dimensional analysis by using data of Yoshimura et al. [2008]. As a consequence of additional two-dimensional models, it is revalidated that the distributions of deep conductors correspond with the aftershocks activity. Using the results of two-dimensional analyses along nine profiles as initial and prior models, three-dimensional inversion (WS-INV3DMT: Siripunvaraporn et al., 2005) was applied to the data of Yoshimura et al. [2008]. The full components the impedance tensor at 14 periods 26 sites were inverted. Significant characteristics of the obtained preliminary model are: (1) distribution of resistive blocks at shallow depth seems to correspond to undulation of gravity basement structure (AIST, 2007); (2) a conductive body, beneath the mainshock hypocenter, spreads to the eastern edge of the active aftershock region.

In this presentation, we will show a whole image of two-dimensional and three-dimensional resistivity models compared with main and aftershock activity and discuss the sensitivity of remarkable features of models.

Keywords: resistivity, the 2007 Noto Hanto Earthquake

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SEM22-P08 Room:Convention Hall Time:May 25 15:30-16:45

3-D magnetotelluric inversion with minimum gradient support

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3-D MT inversion has progressed fast in recent a few decades. Madden and Mackie (1993) developed first practical 3-D inversion of magnetotelluric (MT) data by using the conjugate gradients (CG) to solve equations of inversion. Newman et al. (2000) introduced non-linear conjugate gradients (NLCG) in 3D MT inversion. Zhdanov (2000) used quasi-linear approximation in 3-D Electromagnetic inversion. Siripunvaraporn et al. (2005) proposed a new scheme of 3-D inversion in data space. Most of the inverse algorithms cited above involve a regularized inversion using a smoothness constraint. These algorithms provide smooth solutions, but few are suitable for clearly imaging geo-electrical interfaces. In the present study, we introduce a new constraint to address this limitation. Portniaguine and Zhdanov (1999, 2002) proposed a focusing geophysical inversion using the minimum gradient support (MGS) functional and used the MGS functional in gravity and magnetic inversion. Zhang (2009, 2010) used this theory to invert 2-D MT data and obtain clear images of geo-electrical interfaces.

In our research, the subsurface resistivity structure is divided by cubes. The conductivity in each cube is assumed uniform. Through changing the cube's volume, the accuracy of inversion can be ensured. Integral equation (IE) method by modified Neumann series (MNS) which was proposed by Singer (1995) and Avdeev et al. (2000) is used for forward calculation, which allows us to avoid calculation of large-scale linear equations. GPBi-CG is used to get the solution in modified Neumann series, and the efficiency is increased. The quasi-Newton method is used to optimize the objective functional. This approach is a kind of Newton method with simplified calculation of the Hessian matrix by using BFGS update (Koyama, 2002). In addition, BFGS update does not require search for the exact minimum point on line unlike the NLCG, and therefore iteration times of 3-D forward calculation can be reduced. For derivation of the sensitivity matrix, we use the method which was presented by Newman (2000).

We investigated some synthetic models and compared the results with those obtained by a smoothing inversion. For synthetic models having sharp geo-electrical interfaces, the MGS inversion was found to image structures with sharp interfaces more clearly and accurately with smaller RMS data misfit. On the other hand, the synthetic test indicated that the MGS inversion provides larger RMS data misfit and so is not advantageous compared to smoothing inversion for models with smooth interfaces.

Keywords: magnetotelluric, inversion, minimum gradient support, quasi-Newton method

SEM22-P09 Room:Convention Hall Time:May 25 15:30-16:45

Influence of statics shift in 3D magnetotelluric inversion

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Recent years, three-dimensional magnetotelluric(MT) inversions are widely used for geophysical investigation. These techniques have been reveal conductivity structure reasonably well, in case of simple structures. Compered with two-dimensional MT inversions, three-dimensional MT inversions can recover more realistic and clear conductivity structure, in the complicated geological settings.

However, the three-dimensional MT inversions have been applied to observed data recently. So many refinement should not been considered. An effect of local conductivity anomalies around observation points to a three-dimensional MT inversion is one of the major problems. This research reveals so-called "static effects" to three-dimensional MT inversion. The static shift is an example that local anomalies distort amplitudes of electric field and effect on MT response functions.

In order to improve results of three-dimensional MT inversion with static effects, we developed a three-dimensional MT inversion code in which static shift is adjusted local surface anomalies on the top layer of the model. This research shows static shift makes distortion in the result of former three-dimensional MT inversion code, and new code can reduce the distortion on an inversion result by static shift. But, in order to improve the result of three-dimensional MT inversion, we must develop the technique to correct the static shift based on the new code . In this research we modified WSINV3DMT(W. Siripunvaraporn et at, 2005) for a three-dimensional MT inversion code.

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SEM22-P10 Room:Convention Hall Time:May 25 15:30-16:45

Remote monitoring using mobile network for magnetotelluric observation

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Introducing the state-of-the-art mobile magnetotelluric(MT) observation system (LEMI-417), a long-period MT observation project has been observing MT data at Tohoku district, northeastern Japan for the aim of 3-D electrical conductivity distribution in the wedge mantle. A result analyzing obtained data indicates that electrically conductive zones correspond with seismic low velocity zones. The MT observation is operated in stand-alone. In past observations, there were many accidents in which wild animals and others harmed telluric cables and electrodes. Therefore it is important to perceive those anomalies as soon as possible.

In recent years, mobile network comes to be more accessible with the introduction of flat-rate and the expansion of service area. Though the stability and security are inferior to wired network, it is possible to access the Internet anywhere within the service area. In some of seismic and GPS observation sites in Tohoku University performs the remote maintenance and the automated data collection by telemeter system using a mobile data communications terminal.

We propose a data transmission system adopted to LEMI-417 system using mobile network for remote monitoring of MT observation data. We found that some MT observation sites are located within NTT docomo's FOMA service area. By access during pre-determined time, we can check observation data from our university in real-time. Our system was installed at an observation site in Izumi-ku, Sendai in November 21, 2011. In this presentation, we will report overview, operational status and problems of our system.

Keywords: Magnetotelluric(MT) observation, remote monitoring, mobile network

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SEM22-P11 Room:Convention Hall Time:May 25 15:30-16:45

Preprocessing of Network MT electric field data contaminated by leak currents to obtain the accuracy MT response (2)

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We report an improved prepocessing method of Network-MT electric field data affected leak currents for obtaining the accuracy MT response. In previous study we have showed that Principal component analysis was effective to reduce large leak current noises of electrical trains. However, some problems have been left unresolved;the selection method of principal component corresponding to leak currents, azimuthal dependence of the effect of reducing noise, and etc. In this study we interpret the physical meaning of each of principal components and report an advanced preprocessing method for reducing large leak currents.

Keywords: MT response function, Network-MT data, leak currents, multivariable analysis

SEM22-P12 Room:Convention Hall Time:May 25 15:30-16:45

Reanalysis of the MT response in the Shikoku district

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We report re-evaluated Network-MT MT response functions of Shikoku area, Japan, to restrict the previous resistivity models. There are some differences in resistivity models: the resistivity of area corresponding to lower crust of central Shikoku is 10 k ohm-m, but the resistivity of lower crust of west and east Shikoku is a few hundred ohm-m; Under Kii Peninsula the resistivity of region where deep low-frequency tremors occurred is very low, but the low resistivity region is not found under west Shikoku. Accurate MT response functions in the period range of 100 - 10000 sec are useful to solve these problems.

Keywords: Network-MT, MT response, Deep low-frequency tremor

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Variations in the magnetic field arising from the motional induction that accompanies seismic waves in far-field regions

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Variations in the electromagnetic field that accompany earthquakes are generated by various mechanisms, of which the present study focuses on variations in the magnetic field arising from motionally induced electric currents that accompany seismic waves at a large distance (several hundred kilometres) from the epicentre. As a simple but informative case, a situation is considered in which seismic waves are approximated by plane waves and the conductivity of the Earth's crust has a stratified structure. Solutions of Maxwell's equations corresponding to this situation have analytical expressions. Analysis of the solutions verifies that SH waves do not generate variations in the magnetic field, thereby implying that Rayleigh waves are dominant in generating variations in the magnetic field at a significant distance from earthquake epicentres.

Using the obtained solutions, variations in the magnetic field due to Rayleigh waves are quantitatively discussed in terms of a crust with a simple structure. Numerical examples demonstrate that the amplitudes of the generated variations in the magnetic field show a monotonic increase with increasing conductivity, although depression of the amplitudes due to the skin effect of electromagnetic waves cannot be ignored. In addition, the amplitudes of the generated magnetic field are sometimes sensitive to the conductivity of both the shallow and deep crust. Given the difficulty of precisely determining the conductivity of the deep crust, it is generally problematic to obtain precise estimates corresponding to the actual Earth. Nevertheless, calculations assuming a simplified conductivity structure provide an upper limit to the possible amplitudes of variations in the magnetic field due to seismic waves. For example, the amplitudes of variations in the magnetic field arising from a Rayleigh wave with a displacement amplitude of 10 cm and a period of 30 sec are as large as 0.1 nT, which is close to the limit of detection by fluxgate magnetometers under typical observation conditions. It is also suggested that phase differences between seismic ground motions and EM variations are not influenced by detailed conductivity structures, and they occur within a rather narrow range of values determined by the direction orientation of the ambient geomagnetic field. In the future, when data with an accuracy of 0.01 nT are available, this property may be used to distinguish variations arising from motional induction, from variations arising from other origins.

Keywords: motional induction, seismic wave, magnetic field

SEM22-P14 Room:Convention Hall Time:May 25 15:30-16:45

Characteristics of ULF emission for determination of earthquake precursors for strong earthquakes near Sumatra

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Earthquake precursor studies using magnetic-field power spectra in the ULF band have been affirmed as a way to identify earthquake precursors effective for short-term. In this paper we studied the characteristics of the earth's magnetic waves associated with earthquakes, which we regarded as a sign (signature) before the earthquake.

Several methods of signal analysis have been used in this research, including spectral analysis in the Pc-3 range (10-45 seconds), ratios of the Power Spectral Density (PSD) between Hs (Zs) in Kototabang (KTB, located near the epicenter) and Pelabuhan Ratu (PEL, located far from the epicenter), and the correlation between Hs (Zs) in KTB and PEL. The goal of the signal analyses is to assure that the disturbance signal (perturbation) really reflects the lithospheric activity.

The results of the above-stated analyses are as follows: For a few strong earthquakes in Sumatra in 2008-2011, perturbations in the geomagnetic field had signatures which could be regarded as earthquake precursors. We also found relationships between the earthquake magnitude, epicentral distance, and the magnetic perturbation amplitude averaged over a period before and after the main earthquake (main shock). That is, the magnetic perturbation amplitude had a positive correlation with the earthquake magnitude, and a negative correlation with the epicentral distance..

Keywords: earthquake, precursor, short term, ULF band

SEM22-P15 Room:Convention Hall Time:May 25 15:30-16:45

Characteristics of electromagnetic data at Marumori in Miyagi prefecture before and after Tohoku M9.0 earthquake (2)

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Detection of electromagnetic signals associated with earthquake has been conducted in many years. Electromagnetic inductive effect, produced by electromagnetic variation in ionosphere or magnetosphere, is mainly included in observed electromagnetic data in the earth surface. The inductive effect is made by solar activity which varies widely cyclic or irregularly, and the observed electromagnetic data also vary widely. This fact sometimes leads to make mistakes identifying the signals associated with earthquakes. Therefore, when we discuss about electromagnetic signals associated with earthquakes, the signals must be distinguished from electromagnetic inductive effect.

Recently, we attempt to remove the inductive effect on time-series electromagnetic data by using MT frequency response function. This method is able to estimate inductive effect on time-series electric data from magnetic data, or magnetic data from electric data. If the inductive effect on observed electromagnetic data can be removed by the method, the signal should be clearly picked out. We will present the results of the analysis of MT time-series data in Marumori town, the southern part of Miyagi prefecture from the middle of Nov. 2010 to the end of Apr. 2011.

Keywords: The Tohoku M9.0 earthquake, electromagnetic changes, frequency response function, MT induction effect