DEEP ELECTRICAL STRUCTURE ACROSS BHUJ EARTHQUAKE EPICENTRAL ZONE, INDIA

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ABSTRACT

Knowledge on the deep crustal structure is one of the pre-requisites to understand the physical processes related to seismicity, in general, and more so in earthquake epicentral zones. Although Kutch rift junction region is well known for major earthquakes, the deep crustal structure is poorly understood. The recent devastating Bhuj earthquake (Mb 7.9) has diverted the attention of Earth scientists to focus the studies in this region. To map the basement features in this complex geological terrain and also to study the deep electrical resistivity signatures, a wide band magnetotelluric study in Bhuj earthquake epicentral zone has been carried out with 20 stations along 3 profiles. These profiles pass through the well-known structural features such as Katrol fault, Kutch main land fault (KMF) and also the reported epicentre near Bachau. The results of the present study have brought out undulating basement in the region with an estimated depth of about 1 km in the north and dips to nearly 5 km towards south. The deeper structure along these profiles has exhibited distinct variation in the electrical resistivity character towards the northern part as compared to south with KMF as the boundary between them. This indicates a block structure in the region with different electrical resistivity character at deeper levels and might have greater influence on the development of seismic activity in the region.

EM9-2

ELECTRIC AND MAGNETIC FIELD VARIATIONS ASSOCIATED WITH THE 1999 IZMIT EARTHQUAKE

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On 17 August 1999, a large earthquake of Ms=7.4 occurred in the Izmit area located in the western part of the North Anatolian Fault Zone, Turkey. As part of our multidisciplinary study of fault activity in this area, which we have continued since 1981, we started MT surveys in August and when the Izmit earthquake occurred, MT measurements were in operation at four sites located just over the focal area of the Izmit earthquake, in addition to one remote site. Thus we could obtain an extremely valuable set of electric and magnetic field data before, during and after the earthquake. In particular, during the earthquake, remarkable electric and magnetic field variations were observed at all the sites. We have interpreted such signals in terms of the seismic dynamo effect, although our interpretation must be supported by more examples. As for the onset time of these signals, the original data seemed to indicate that the signals arrived at the sites simultaneously with seismic waves. In this paper we show the results of our further analyses of the original data including the data acquired from our observations during aftershock activity. We found that the electric signals appeared simultaneously with the arrival of seismic wave, but in the case of the mainshock, the magnetic signals seem to have arrived some parts of a second earlier than the electric signals. Such earlier arrival of magnetic signals provides a piece of evidence supporting the seismic dynamo effect, resulting from the generation of electromotive force due to coupling of ground motion with the Earth s magnetic field, in an inhomogeneous resistivity structure in the ruptured fault area, as disclosed from the MT data intrepretation.

EM9-3

MT PROFILE IN THE TECTONICALLY ACTIVE REGION OF ASWAN, EGYPT

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Magnetotelluric (MT) measurements are widely used to explore the electrical conductivity structure of the Earth's crust. It is of considerable importance to investigate the geological structure around active faults, especially for estimating the fault activity. The aim of this measurement is the detection of the electrical anomalies that can be directly linked to the seismic activity. We applied this method to the active fault in Lake Nasser area to reveal geological structures and the stress field covered by thin Quaternary formations.

MT measurements were carried out in the period range 0.001- 420 s at 9 sites of a NS profile crossing the Kalabsha fault, the main active fault in which the 1981 main shock (M 5.5) occurred, not far (60 km) from the Nile High Dam, on the western bank of Nasser Lake, Aswan. The MT data were analyzed by the 2D simultaneous inversion (REBOCC) of both polarizations, and the resulting model was compared to the local seismicity map. The resistivity model clearly reflects the geological and tectonic stresses prevailing in the Aswan area. The electric resistivity distribution is explained in terms of stress-modulated rock porosity.

ULF ELECTROMAGNETIC PHENOMENA CONNECTED WITH VRANCEA (ROMANIA) SEISMIC EVENTS

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Regular ULF electromagnetic measurements have been carried out at the Geophysical Observatory Surlari (GOS), in the course of the 2000-2001 years, in connection with normal seismic activity occurred in the Vrancea zone. The GOS is located on the natural Polygon of Geodynamics Caldarusani-Tulnici, in the nearness of the Intramoesian active fault and at about 140 km far from the seismogenic slab. In this paper, the seismicity of the Vrancea area, the high sensitive (magnetotelluric and magnetovariation) equipment and a specific electromagnetic (EM) methodology are presented. The main purpose of the EM observations is to investigate the geoelectrical conductivity changes induced by the intermediate depth earthquakes under measuring point, by using a normalized parameter $|Bzn| \cong (\rho_{\|} / \rho_z)^{1/2}$ (square root of the ratio between the resistivity parallel to the geological strike direction and the vertical resistivity), which should be stabile in time for a given 2D structure, under non-seismic circumstances. Approximate field solutions (finite element code) for two kind of 2D geological conditions (sloping interface and vertical contact models) to illustrate the phenomenon discussed above, as well the type of the geological structure and its strike direction were estimated. Also, it was shown that within the intervals June-October, 2000 and January-March, 2001, the distribution of the Bzn parameter, versus time, sharply increases with 1-3 days before a seismic event of magnitute higher than 3.5, as a result of the stress and conductivity changes inside and near by the earthquakes foci zone.

EM9-5

CRUSTAL RESISTIVITY STRUCTURE IMAGED BY MAGNETOTELLURICS METHOD UNDER KUSATSU-SHIRANE VOLCANO, GUNMA, JAPAN

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Abstract

We performed wideband magnetotelluric (MT) measurements in order to investigate the deep resistivity structure of the Kusatsu-Shirane Volcano, Gunma, Japan. Kusatsu-Shirane is one of the active quaternary volcanos that are chained in the central Honshu island of Japan. MT is preferred as a method for investigating the crustal structure of the volcano, because it is an efficient method for detecting the presence of fluid in a media by monitoring the resistivity. The MT measurements were done in three surveys in the summer of 2001. Considering the deployment difficulties of the instruments, especially for the high areas, 3 magnetotelluric and 41 telluric-only, in total 44 stations were installed forming a grid (1.5 km x 1.5 km) as even as possible. After the surveys were over remote reference technique was applied to the data in order to get rid of local magnetic noise effects. Before the two-dimensional inversions, strike directions were determined by using McNiece and Jones (1996) code strike , which gave a result of almost North-South direction. This code also eliminates the galvanic distortion effects. Two-dimensional inversions were performed in six profiles by using the code developed by Ogawa and Uchida (1996) which is based on Akaike's Bayesian information criterion (ABIC). The frequency range for the inversions was between 85 Hz and 0.07 Hz, which is enough to resolve upper-crust structures. For all profiles TM, TE and TM+TE modes were calculated and plotted. Because of the two-dimensionality of the area the most reasonable results appear to be got from TM+TE mode. Results show that there is a shallow conductor (~1 km) above the resistive basement, which is coinciding with the main gas vent. The resistivity is relatively high on the deeper parts of the profiles. The seismicity (N-type earthquakes) of the area shows that the micro-earthquakes occur on the edge of the resistive basement.

EM9-6

ON SELF-POTENTIAL VARIATION COINCIDENT WITH THE 2000 SUMMIT ERUPTION ON MIYAKEJIMA ISLAND, JAPAN

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Since microearthquakes were activated on Jun. 26, 2000, a series of volcanic activities have taken place on and around Miyakejima island on the Izu-Bonin arc: 1) sea floor eruption on Jun. 27, 2) rapid subsidence of the summit area on Jul. 8, 3) successive deepening and widening of the subsidence area from Jul. 8 to Aug. 18, in which period repeated stepwise changes of tilt and coincident long period earthquakes occurred, 4) the most intense summit eruption on Aug. 18, and 5) subsequent voluminous SO2-gas emission from the summit, which continues up to now. Intermittent summit eruptions occurred from the subsidence on Jul. 8. In order to elucidate physical processes of the volcanic eruption, we monitored long-baseline voltage differences throughout the island by using telephone line network. Coincident with the summit subsidence, stepwise decrease was observed in the voltage difference of a site on the SW foot of the central cone minus coastal sites. Almost all the repeated tilt-step events, i.e. abrupt uplifts around the summit area, were accompanied by voltage difference variations, very similar to the velocity waveform of the ground motion. Sense of the potential variation was again negative for the inland site and remarkable linear correlation was detected between intensities of the voltage difference variation and the velocity variation. During the summit eruption on Aug. 18, potential of the inland site first decreased and subsequently increased as much as 160mV and kept the level until Sep. 4, when the measurement stopped due to power cut. All those negative potential variations can be interpreted as due to electric currents generated by forced injection of water from the pressure source into the surrounding medium (electrokinetic phenomena). The last positive variation implies that any definite change occurred in the hydrothermal system of the volcano.

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EM9-7

The electrical structures of the crust and upper mantle in Haiyuan earthquake area

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Haiyuan earthquake (M=8.6. 1920) occurred in northeastern border area of Tibet Plateau (TB). The area is a conjunctional region of Tibet Plateau (TB) and North China Block (NCB) through there the North-South Seismotectonic Belt (NSSB) passed. The tectonic style is quite different between eastern side and western side of North-South Seismotectonic Belt (NSSB).

The magnetotelluric measurement has been recently carried out along some profiles in the area. The study aimed at investigation of the crust and upper mantle structure. MT observation was done at 62 sites along profile A of about 950km long in northeast direction. The MT data were processed by robust data processing technique and then analysed by impedance tensor decomposition. The RRI 2-D inversion method was used in the profile and 2-D electrical structure was obtained.

The 2-D electrical structure around the Haiyuan earthquake foci shows four faults: Nanhuashan faults, Qingshuihe faults, Yantongshan faults and Guyuan faults developed from southwest to northeast. The crust was divided by four faults forming different blocks. The resistivities are different for different blocks.

The Haiyuan earthquake foci were at the electrical boundary area. The resistivity is higher to the west of foci than that to the east of the foci. There was lower resistivity layer at upper crust for east side of foci. The inhomogeneity of electricity clearly appeared around the foci.