

The Catalca fault in Istanbul, imaged by VLF-R method

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Catalca Fault in Istanbul, lies in southern continuation with Western Black Sea Fault Zone. This fault is interesting to investigate, because Istanbul city has a risk of an earthquake occurrence of $M_i 7$ at North Anatolian Fault Zone in near future and understanding its character can be important. The Western Black Sea Fault Zone is also an interesting structure because of its key character of mysterious structural relation of the geological units in the west and east of the fault zone. Because the actual contact between these two units is covered by a horizontal Eocene-Oligocene sedimentary sequence. Another important feature of the region is the Catalca granite body having a lense-shaped geometry. Field study of granite body reveals linear margins that contain kinematic indicators of deformation, although vegetation and soil cover limit further details on the fault. A VLF-R survey was carried out along several profiles covering the granite and its contact with the sedimentary rocks mainly shaped by Catalca Fault. VLF parameters that are sensitive to vertical discontinuities were plotted. The faults are detected by low apparent resistivity values in the models and change of sign in real component of vertical magnetic field (H_z),

Fluids and melts in subduction zones: Unexpected results from the Central Andes

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The standard model of subduction predicts a good electrical conductor associated with the downgoing oceanic plate, the input of fluids into the asthenospheric wedge causing partial melting, and the rise of melts which eventually leads to the formation of volcanic arcs. These simple assumptions are challenged by recent magnetotelluric investigations in the Central Andes of Central Bolivia and northernmost Chile.

1) It was not possible to detect the subducted Nazca plate as good electrical conductor. Although this may in part be due to strong 3-D effects near the coast, a dipping conductor is also not compatible with data farther to the east where they become basically 2-D.

2) The volcanic arc is not associated with a good conductor at any depth (excluding a possible small-scale magma chamber below the volcanoes, which may have been overseen due to limitations of the experiment layout)

3) Instead, a strong conductor is modelled at upper mantle depths which rises well into the middle crust, an image that is strongly suggested by the standard model, but its location is 50-100km east of the volcanoes below the center of the Altiplano high plateau.

Consequences of these findings will be discussed in this contribution, which include the possible formation of a new volcanic arc, a scenario which has been experienced already several times during formation of the Andean mountain chain.

Resistivity structure across the dyke intrusion of Asama volcano

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Asama volcano, Central Japan, erupted on September 1st, 2004 after a major dormancy of 22 years. From the GPS measurement before the eruption, the dyke intrusion was inferred to the west of the main edifice at 1km below sea level. Then the deformation was followed by series of volcano-tectonic earthquakes which started at the eastern tip of the GPS-dyke toward the major vent. These were interpreted as geophysical signatures of the magmatic dyke intrusion. Our objective of the MT observation was to reconfirm the magmatic dyke. We had 15 MT sites aligned perpendicular to the dyke location. From the 2d modeling, we found a vertical conductor at 8km below sea level, further below the dyke location inferred from geodesy and seismicity.

Magnetotelluric study of Mt Ruapehu volcano, New Zealand.

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Mt Ruapehu is an active andesite cone volcano which marks the southern termination of the Kermadec volcanic arc. Results from 37 broadband (300Hz to 2000s) magnetotelluric soundings have been analysed using the phase tensor. This approach provides a way of determining dimensionality, allowing for distortion removal, and visualising data in a 3D situation. The analysis shows that beneath a high resistivity layer a few hundred metres thick there is a very low resistivity subsurface. The low resistivity is contiguous with the waters of the highly acidic Crater Lake, and thus is believed to be the hydraulically controlled upper limits of a zone of acid alteration overlain by dry volcanic rock and ash. Beneath the conductor a higher resistivity layer corresponds to the basement greywacke. There is no evidence in the MT data for the existence of a shallow conductive magma chamber associated with the recent (1995-96) eruptions. A shallow conductor lying on the eastern margin of the volcano appears to be associated with the eastern edge the Taupo Volcanic Zone of New Zealand.

Experience of measurements of tidal variations of apparent resistivity at the Bishkek test site

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Measurements of the rock electrical resistivity are widely used for controlling of the stress-strain state of rocks. It is based on the high sensitivity of the parameter to structural features of rocks, degrees of their water saturation and mineralization. We apply the audiomagnetotelluric (AMT) method to the measurements of electrical resistivity at monitoring of the stress-strain state of rocks and earthquake prediction. The reached high accuracy of the AMT method ensures registration small tidal variations of apparent resistivity. The stress-strain state of rocks resultant from the tidal effect is similar to one from deformation processes in rocks before earthquakes. Four-channel ACF-4M instrument is used in our experiments. It includes a digital measuring unit with the Ethernet interface and four synchronous 24-bit channels for measurements of signals of electrical (E_x , E_y) and magnetic (H_x , H_y) fields. The frequency range of the system is 0.1-800 Hz. Measurements are carried out in time series or spectrogram modes. The tensor measurements and program control of the equipment, the digital processing of input signals, the calculation and visualization of the spectral characteristics of measured signals are realized. The experience of measurements at the Bishkek test site (Kyrgyzstan) shows that tidal variations of apparent resistivity are observed in heterogeneous geological media. Any changes are not observed at sites with homogeneous basement or thick homogeneous sedimentary rocks at the upper parts of cross sections. The direct correlation between apparent resistivity and vertical tidal deformation (dH) was obtained. The amplitude of variations of apparent resistivity consists of 2-3%. The work has been carried out under support of the ISTC project KR-583.

CRUST ELECTRICAL STRUCTURE ALONG PROFILES IN GULANG AND HAIYUAN EARTHQUAKE AREAS OF THE NORTHEASTERN TIBET

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Along the QilianShan-Hexi Corridor-Haiyuan-LiuPanshan tectonic belt at the northeast margin of Qinghai-Tibet plateau, there had ever occurred the Haiyuan earthquake ($M_s=8.5$) in 1920 and the Gulang earthquake ($M_s=8.0$) in 1927. Two MT profiles across the two epicenter areas have been carried out. The electrical conductivity structures along the profiles reveal geometrical tectonic shape of and distribution of deep faults. Electrical structure inhomogeneous exists in the two epicenter and its vicinity. Comparing conductivity structure in Haiyuan with Guliang epicenter, the difference of deep conductivity structure is existed. It was the structure that provide a powerful evident for that Guliang and Haiyuan earthquake are different earthquake types.

A Magnetotelluric monitoring experiment in the subduction system of Chile

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Part of TIPTEQ (From The Incoming Plate to Mega Thrust Earthquake Processes) is a combined seismic-magnetotelluric-geodetic monitoring network. In the first phase, which started in November 2004, a network of three stations was installed in southern Chile, aligned along an EW profile extending from the Atlantic Ocean to the volcanic arc. The overall goal is to detect transient events which are related to the subduction system by means of recording and imaging the local and regional seismicity distribution and the long-term variability of geomagnetic transfer functions. Synchronous recordings of GPS and seismic broadband data (periods up to hours) will allow us to examine a wide spectrum of earthquake styles: between seismic (sudden-onset) rupture and continuous or a-seismic slip. Here, we present first results of the long term magnetotelluric (MT) experiment. The data were recorded in a standard 5 component MT setup using fluxgate magnetometers and non-polarizing Ag AgCl electrodes. A preliminary single site processing of the data in 14 day intervals results in apparent resistivity and phase curves in a period range between 10s and 10000s which are generally repeatable for each station. The influence of noise is evident showing great variability between individual time segments and across the station network.

A Magnetotelluric Profile Across the Eastern Rim of the Okataina Caldera, North Island, New Zealand

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24 magnetotelluric (MT) field sites were set up along a 30 km profile crossing the south eastern boundary of a large caldera near Lake Tarawera in the Central Taupo Volcanic Zone (TVZ) in the North Island of New Zealand. Results were obtained for the period range from 0.003-1000 sec and show a highly correlated pattern in their phase tensor elements. Up to 5 layers of alternating conductivity can be resolved and 1D, 2D and 3D regions can be clearly distinguished. Such features include a highly conductive zone within the first kilometre of the caldera, lateral curvature of its boundary and the resistive greywacke to the South East.

Recent examples of seismic dynamo effect for earthquakes and blasting

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Since our finding of the seismic dynamo effect for the 1999 Izmit earthquake, we have carried out MT and AMT observations during aftershock activity of some large earthquakes which recently occurred in Japan. As we expected, electric and magnetic field changes similar to seismic waves were always recorded synchronously with seismic wave arrival. The essential point is that these changes in EM fields are caused by electromotive force generated by the coupling between oscillation of conducting crust and the Earth's magnetic field. In our poster we show some typical examples derived in association with aftershocks and artificial blasting for seismic sounding, with some comments on why clear EM field changes are not observed before seismic wave arrival.

Magnetotelluric imaging of Duzce fault, Turkey

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Seismological studies revealed that during the 1999, Duzce Earthquake (Mw: 7.2), Turkey, the rupture velocities on both sites of the epicenter differed significantly. For the purpose of finding a relationship between this phenomena and electrical properties of the region wide-band Magnetotelluric (MT) data were acquired along two parallel profiles at the west and east of the Duzce Earthquake's epicenter, respectively. Both profiles crossed Duzce Fault and the basin in the north and North Anatolian Fault in the south, with twelve sites in each. As a result of Groom and Bailey (1989) decomposition, geo-electric strike was found to be N72°E, consistent with the geology. MT data were analyzed by two-dimensional inversion modeling using the code developed by Ogawa and Uchida (1996).

Extremely-far remote reference of AMT and MT data for volcano study in Jeju Island, Korea

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Jeju Island is a Quaternary volcanic island located in southern Korea. We conducted MT and AMT surveys in 2004 and 2005 for investigation of the volcanic structure and groundwater/geothermal resources in the island. To overcome artificial electromagnetic noises, which often make MT measurements disastrous in Korea, we set a remote reference site at Ogiri, southern Kyushu, western Japan, for both MT and AMT. We also utilized the stationary MT data obtained at the Esashi and Wakuya observatories of the Geographical Survey Institute (GSI), eastern Japan, for the 2005 survey. Distances from the survey area to the remote sites are approximately 500 km to Ogiri and 1500 km to Esashi and Wakuya. For MT, the reference within Jeju does not produce acceptable data, while the reference with Esashi and Wakuya can remove most noises. The reference with Ogiri was the best in the final data quality of the MT data. For AMT, reference processing with a site in Jeju is better at a high band of AMT data, say above several hundreds hertz. However, reference with Ogiri is more effective when we use frequencies below 1 kHz for interpretation. Preliminary 2D inversion models indicated that the body of the island consists of high-resistivity lava formations. However, we have also recognized that thick low-resistivity Tertiary sedimentary layers are widely distributed below the volcanic body of the island at a depth greater than approximately 100 m below sea level.

Upper mantle upwelling, lower crustal magmatic underplating, and lithospheric

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The Great Basin-Colorado Plateau Transition Zone runs north-south for a distance of ~600 km over the length of Utah and is a world-class, active rift shoulder. A ~450 km long, dense and broadband MT transect along latitude 38.5S was collected by the University of Utah and subject to 2-D inversion. A strong lower crustal conductor below the GB and the TZ is interpreted as basaltic underplating and hydrothermal fluid release. In the incipiently-faulted TZ, nested concave-up conductors resemble low-angle detachments of early continental breakup and support the “jelly sandwich” lithospheric rheological model. Upper mantle resistivity is markedly anisotropic with that across strike nearly 10 times that along strike, perhaps due to aligned hydrated olivine or melt fissures.

Wide-band magnetotelluric soundings on Mizuho Plateau, Enderby Land, East Antarctica

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We carried out wide-band magnetotelluric soundings on Mizuho Plateau through JARE-46 (the 46th Japanese Antarctic Reserch Expedition) in 2005 in order to elucidate the evolution of the continent of eastern Enderby Land, Antarctica. The survey campaigns included three weeks trip based on Syowa Station and we acquired data at 16 sites along the way to Mizuho Station using MTU-5 system (Phoenix Geophysics). Titanium plates with pre-amplifiers were used as electrodes to mitigate the influence of high contact resistance in the snow around -40 degrees centigrade. The apparent resistivity at shallow depth are up to 100k ohm-m because of the ice sheet. We report the aspects of the data and the preliminary result.

MT static-shift removal and DC survey approaches: synthetic and experimental data

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MT data acquired in complex areas are often affected by static-shift phenomena. This real scaling factor is determinable with active near-surface measurements. Since DC soundings are themselves affected by static-shift, Meju (2005) suggested to use TEM soundings while Spitzer (2001) derived a quantitative relationship between MT and DC static-shift factors. This work deals with several DC approaches for static-shift correction. Synthetic models study demonstrates that even if single DC resistivity soundings are affected by static-shift, Electrical Resistivity Tomography survey allows recovering the bedrock resistivity values in the interested penetration depth. Furthermore, an application in Etnean area is shown.

S10-15

The research of electric field of the Earth in Baikal rift zone due to the earthquakes.

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A net of observation sites has been launched around Lake Baikal. The variations of horizontal and vertical (in the holes) components of the Earth's electrical field in the diapason of periods from the first decimals of seconds till 24-hour and more have been studied. The variations caused by external ionosphere source are used for the studies of geoelectrical heterogeneity of the media. To cope with this electrical tripper was introduced as for the geomagnetic field. Its frequency has been studied. Along with this magnetotelluric impedance has been observed with the help of distant geomagnetic observation sites. Based on the data on electrical tripper and magnetotelluric impedance anomalous effects which may be connected with the earthquakes with have been revealed. Along with this the methods of electrical field allocation which may be caused by internal electrical sources have been included. In its behavior the variations with intensity from the first hundreds mV/km related to the earthquake moments with have been found out. Possible nature of the revealed anomalous changes of electric tripper, magnetotelluric impedance and intensive anomalies from internal sources of electric field have been studied.

A two dimensional resistivity structure beneath the seismic gap in the eastern part of Shimane prefecture, San-in region, Japan

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Recent several years, the research group investigated a deep crustal resistivity structures in the survey lines that traverse linear seismically active zones, including the epicenters of the remarkable inland earthquakes in the eastern area of San-in region. As the results, it was found that conductive parts exist in the deep crust under the seismic blocks that correspond to resistive parts, along with the seismically active zones. As the investigations carried out so far limited to the seismic area, we cannot answer whether the above feature can be seen only in the active zones or not. Therefore we thought that a comparative study in the seismic gap of Shimane prefecture, which is adjacent to the seismic area of the Western Tottori earthquake in 2000, should be required. In this paper, we present a two dimensional resistivity structure beneath the seismic gap in the eastern part of Shimane prefecture, San-in region, Japan.

Recent Magmatism at Mt Gambier and Mt Schank, South Australia: An MT, Geochemical and Petrological Study of a Continental Mantle Plume

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Mount Gambier and Mount Schank are volcanoes associated with the most recent (<10,000 years) mainland Australia basaltic eruptions. A mantle hot spot origin is assumed for this young, intra-plate volcanism. Seventeen new long-period MT sites have been collected in May 2006 to image the electrical resistivity of the upper mantle, and geochemical and isotopic data are being used to constrain magma sources, fractionation and storage location within the crust. These two approaches will be combined to create a geological model of the volcanic system, from source to surface.

Magnetotelluric sounding (MTS) in the Fayoum-Cairo district, Egypt

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The Fayoum-Cairo district lies in the SW Cairo which is affected by several earthquakes. According to Egyptian Network Seismology of (NRIAG), the last one which occurred in the 31 July 2005 (Magnitude = 4.2 in Richter scale). Magnetotelluric soundings (MTS) offer opportunity to detect crustal fluids along faults due to their high electrical conductivity anomaly. The targets of our measurements are various. We would like to determine the location of active fault(s), to study the connection of the Fayoum-Cairo seismicity to MT resistivity structure. MT profile was carried out across the area in order to investigate deep resistivity structure and RTP aeromagnetic anomaly map to delineate shallow Structure.

Magnetotelluric Study of Mount St. Helens Washington, USA: Phase Tensor Analysis Preliminary Results

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Mount St. Helens is a quaternary stratovolcano located in south-western Washington, USA, lying along the western front of the Cascade Range between Mt. Hood to the south and Mt. Rainier to the north, Mt. St. Helens is located in a region of transition both geologically and geophysically. Phase tensor and induction arrow analysis from 37 broadband magnetotelluric (0.01 – 2000 s) sounding sites show the regional conductivity structure in a 1000 km² area around the volcano is 3-D at all period scales. Phase tensor analysis indicates that Mount St. Helens lies on the boundary of a large regional conductor to the north east of the volcano which begins at a depth of 25 km and extends into the lower crust.

The electrical resistivity structure across the San Andreas Fault zone near the SAFOD site – a regional magnetotelluric study

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Magnetotelluric studies (Unsworth et al., Bedrosian et al.) played an important role to pin-point the location of the San Andreas Fault Observatory At Depth (SAFOD) – a major Earth Science initiative to study the in-situ physical and chemical conditions of the San Andreas interplate transform fault (SAF). The electrical conductivity models from these studies suggested the presence of fluids, causative for the so-called fault zone conductor (FZC) below Middle Mountain, in regions with abundant seismicity (i.e. where the fault is creeping) and provided complementary information to the seismic velocity structure and other geophysical site characterization studies. However, these images were limited to a few kilometres in depth due to short profile lengths. In spring 2005, we acquired a huge volume of new magnetotelluric (MT) data in the vicinity of the SAFOD site. Overall, we recorded at 45 combined long-period / broad-band stations distributed in an area of 50 square km in the vicinity of the SAFOD site and an additional 41 broad-band stations coincident with a 50 km long seismic reflection/refraction profile. We present resistivity models of the crustal lithosphere obtained from 2D inversion of the profile data. These models image a number of conductive and resistive anomalies in the heterogeneous upper crust, which are related to the sedimentary sequences, the Franciscan subduction complex and terranes of Salinian granite. We show that the observed seismicity in 2-10km (i.e. below the FZC) is connected to a near-vertical lithological contrast in the vicinity or directly within the SAF zone, but not to a pronounced conductivity anomaly. We do image, however, a broad conductivity anomaly below the Parkfield Grade (the highest mountain in the area), located two to eight kilometers east of the active SAF. This conductive zone dips southwestward and joins the downward continuation of the SAF at approximately 10-15km depth. The lower crust is anomalously conducting in a 20 km wide window centered at the SAF. We interpret the MT image in terms of the general lithological setting, of major tectonical features and of possible fluid migration paths from the lower crust (upper mantle) in the shallow SAF.