Integrated geophysical and seismo-electrokinetic approach to solve geology and groundwater model on a small area in the Waterberg, South Africa

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This research has been done to obtain a geological and groundwater model, by using several geophysical methods. The main purpose was to establish the relevance of seismo-electrokinetic (EKS). The geophysical methods that were applied and used along this profile was resistivity (DC), shallow refraction seismics, magnetic gradiometry, electric self-potential, frequency domain electro magnetics (FDEM) and seismic electro-kinetic soundings. Each method contributed towards the solution of these problems. The seismic technique provided a cross–section interpretation of the profile, indicating the thickness of the weathered layer. The results obtained by the D.C. resistivity show the high resolution that can be obtained by this method. The magnetic gradiometry method must be regarded as a supplementary method to obtain additional information about depth and structures of the basement. The results of seismo-electrokinetic soundings show that there are no alternatives to EKS for the exploration of ground water at the shallow depths.

The point-spread function measure of resolution for the 3D electrical resistivity experiment

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The solution appraisal component of the inverse problem involves investigation of the relationship between our estimated model and the actual model. However, computation of the model resolution matrix is difficult for 3D problems with large realistic model domains. We tackle the appraisal problem for 3D electrical resistivity tomography (ERT) via the linearized point-spread function (PSF) that quantifies our parameter-specific resolving capability. We implement an iterative least-squares equivalent solution of the PSF for the 3D ERT experiment using on-the-fly calculation of the sensitivity via an adjoint equation with stored Greenś functions and subgrid reduction. We analyze the PSF for a judicious selection of model parameters to quantify the truly 3D resolving capability of an ERT field experiment. We utilize the PSF as a measure for judging localized reliability, for assessing limitations of feature discrimination, for comparing different survey geometries (survey design), and for the prediction of inversion artefacts.

Groundwater evaluation based on series and parallel impedances in the AMT frequency band

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Four AMT profiles were designed to investigate the extension of seawater intrusion in a coastal aquifer close to Ensenada, Baja California, México. We use the four elements of the impedance tensor to calculate series and parallel (s-p) invariant impedances. The s-p responses and a Gauss-Newton regularized inversion were used to obtain 2-D models of the underground electrical resistivity distribution. The extension of the seawater contamination is clearly observed as low resistivity anomalies in the resulting models. The depth to the basement as well as several structures revealed in the geoelectrical models are in agreement with available geological and geophysical information. From de resistivity model and assuming constant porosities and cementation coefficients in Archie's law, we attempt the asses the water quality at different points along the profiles. As expected, the results of this analysis show poor quality waters in the whole aquifer. The worst TDS values (30000 ppm) close to coast line with come improvement toward the east (1000 ppm). The fluid resistivity values inferred from the geoelectrical models are in good agreement with those measured in several wells in the area. The 2-D inversion of s-p impedances proved to be a valuable tool to investigate lateral variations of the subsurface resistivity at shallow depths. The straightforward calculation of s-p impedances provides a suitable alternative of using the full tensor information in AMT applications, substantially improving interpretations based on only one polarization mode.

Looking down to look up: Results of a DC resistivity study of the grounds of Birr Castle, Ireland

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The telescope at Birr Castle, in virtually the dead centre of Ireland at Offaly, was the largest telescope in the world for over 70 years (1840s onwards). Irish astronomers wish to continue this historical tradition and install a modern radio telescope in the grounds of the castle. However, stability requirements necessitate anchorage of concrete pillars to basement, at an unknown depth below the overburden. A DC resistivity survey was conducted in August, 2005, to determine depth to basement, with a Campus Tigre resistivity metre and multicore cable. Measurements were made every 5 m, with 28 electrodes deployed simultaneously. The data were modelled using the Res2dinv program, and the results indicate that basement is at a depth of 9-14 m with an easterly dip.

Magnetotelluric and aeromagnetic investigations for assessment of groundwater resources in Parnaiba basin in Piaui state of NE Brazil.

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ABSTRACT: Regional groundwater aquifer mapping has been made with 22 wide-band magnetotelluric (MT) soundings in the period range of 0.001 sec-1000 sec along two profiles on the marginal arcs of the intra-cratonic sedimentary Parna¨ˆaba basin in North-East Brazil. One of the MT profiles cuts across the lithological contact between the thin sedimentary Parnaiba basin in the NW and the crystalline region in the SE, and the other lies only in the aeromagnetically surveyed sedimentary region. Aeromagnetic data reveal several subsurface small-scale faults that are conducive to be potential groundwater resource regions. Two-dimensional inversion of MT data of both profiles shows that the mapped sedimentary basin is conductive (resistivities of about 100-150 Ω m) and shows up as a thin graben having maximum thickness of about 1000m beneath both profiles, located to be at shallow depths (about 500m). Three localized high conductors (of resistivities < 10 Ω m); two in sedimentary region and one in crystalline region, have been identified. Based on the facts that the study region falls on sedimentary cover having low-very low permeability and in accordance with the subsurface lithology in and around the study region, these mapped high conductors are believed to be aquitards, representing porous but impermeable shales and siltstones, surrounded by zones of moderate resistivities (50-250 Ohms), mainly composed of highly-porous coarse-to-fine sandstones, quartz pebbles and conglomerates, which largely signify zones of potential aquifers. The aquifer zones are believed to have links with the recharge area (possibly Parnaiba River) flowing at a distance of about 300km NW from the study region. We discuss results of MT and aeromagnetic data in the light of hydrological features of the study region.

Detecting saline/fresh water interface in Northern Israel with an integrated TEM approach

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One of the main groundwater resources of Israel, namely the Sea of Galilee is threatened by salination. Regarding the deep-seated saline sources which constitute the saline end member, these are attributed either to trapped brines or to intruding seawater. Two different Transient ElectroMagnetic setups were used to derive the fresh to saline water interface in the area between the Haifa bay and the Sea of Galilee. Short offset (SHOTEM) setup in central loop configuration was used to infer shallow structures. The deeper part of the subsurface was resolved using multicomponent long offset (LOTEM) measurements. The geophysical interpretation combining all measured data sets indicates that intruding seawater may play a relevant role in the salination of the Sea of Galilee.

Investigations of landfills using the radiomagnetotelluric method

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Investigation of landfills with their revealing, contouring, study of the internal structure and detection of pollution leakages is the very important task at the solution of environmental problems. The landfills may impose a big risk for the environment due to the pollution of ground waters. The old buried landfills are hazardous for office and apartment houses construction. The radiomagnetotelluric (RMT) method has good perspectives for investigations of landfills. In 2002-2005 investigations in the framework of the EU Copernicus project were carried out by St. Petersburg State University and MicroKOR Ltd. (St. Petersburg, Russia) together with Cologne University (Cologne, Germany). As result a new four-channel RMT-F instrument for the measurements of electromagnetic fields of radio stations in the frequency range of 10 to 1000 kHz has been developed. Both amplitude and phase measurements are realized in the instrument. Small weight of the RMT set and short time of measurements at one point allows carrying out about 60 sounding points per day by a field crew consits of two persons. The great advantage of the equipment is the possibility of usage of ungrounded (capacitive) electric antennae that permits to carry out survey on the surface of concrete, asphalt, gravel, and also in winter time on surfaces covered by ice and snow. In order to estimate the possibility of the RMT method and the new RMT-F equipment two different waste sites have been selected in Spain. The first one is the landfill of domestic wastes and the second one - the landfill of the coal ashes from power plants. The RMT-F equipment was successfully applied during the field measurements. The results of data processing and interpretation show that the landfill's bodies are allocated very contrastingly compare to uncontaminated territory. The landfill's boundaries are contoured by the RMT method confidently and internal structures of the landfills are studied in detail. Leakages from the landfill of domestic wastes were revealed and contoured.

Motionally induction voltage in the Ria de Aveiro lagoon (Portugal)

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Techniques based on motional induced voltage, which is induced by the water flow across earthś magnetic field, has motivated interest of oceanographers, regarding studies of large scale ocean flows. The major part of these experiences have been applied to large-scale ocean studies. Here we present the results of the implementation of these techniques to smaller scales systems like the one of Ria de Aveiro lagoon (Portugal). The electrical potential differences measured in the terminals of a submarine cable crossing the channel at the entrance of the lagoon and in one on-shore electric dipole allow the estimation of the water flow at this place.

3D electrical imaging of near-surface targets

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We present the results from a geophysical prospection at a historical Jesuit Mission, located in San Ignacio (Misiones-Argentina), declared World Monument some years ago. We studied different sectors looking for buried structures; the total area under study covered 36 ha, we will show in this work the results obtained in a sector which at present is at risk of being damaged by a wrong management of the historical resource. In order to optimize the data acquisition and the preliminary in-situ analysis of the results, we first performed an electromagnetic survey using a multifrequency electromagnetic induction device (GEM-2) to have a first insight of the near surface electrical distribution. From 2D and 3D visualization of data, different targets were identified as possible historical structures. Around these anomalous zones, we performed different dipole-dipole profiles, forming high resolution grids for later 3D inversions. Contour maps at constant electrode spacing as well as 3D visualization of data, allowed an accurate prediction of the location of the anomalies. Further inversion of the electric and electromagnetic data completed the characterization of the anomalies.

Dc soundings with wenner array for detecting contamination by intensive livestock activity.

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Intensive livestock activities may generate contamination on soil and groundwater, because of animal waste effluents. The DC and electromagnetic exploration applied to environmental impact by livestock activities is scarce. At dairies, the area of corrals were reported as the most affected zones. At the Rolling Pampa, in Argentina, intensive livestock activity is increasing, so it is important to generate diagnosis of contamination problems in order to mantain environmental sustainability. The aim of this work was to detect contamination critical zones at a dairy, using resistivity soundings. Twelve Wenner soundings were carried on with a Scintrex resistivimeter and data were inverted (Oldenburg, 1994) obtaining 2D resistivity models. IP surveys at the corral and at a background position were also made to test the sensitivity to detect anomalies associated with animal effluents. Analysis of depth of investigation, for which models are still supported by data, was applied following Oldenburg and Li (1999) approach. Geological information, soil and groundwater samples were used for the interpretation of the results. At a plot without animals (background site), free groundwater level was at 1.35 m depth and resistivity value for non saturated zone (NSZ) was 20 Ω m, which were in agreement with soil sample measurements. Groundwater conductivity was 1390 μS/cm coinciding with well information. High conductivity anomalies were found at the soundings carried on near the effluent channel, due to leakage. At the corral, the NSZ and groundwater resistivities were lower (three times) than the ones encountered at the background site, reflecting the presence of seepage of the animal depositions. Concentration of nitrates and chlorides in groundwater at the corral are three times and twice, respectively, greater than that of the background site. The corral was the most critical situation while the traffic lane of animals and the feeding area do not represent a risk factor in contamination, due to a good strategy of animal rotation compared with other dairies. The resistivity measurements turned out to be a good diagnosis of critical areas for future monitoring samplings.

Distribution of electrical conductivity in soil and groundwater at a dairy by means of dipole-dipole soundings at the South of Santa Fe Province (Argentina).

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Dairies constitute a punctual source of contamination of soil and groundwater, affecting their quality and indirectly, since this is the source of animal drink, the milk production. The South of Santa Fe province is a zone of high concentration of dairies, so the objective of this work was to analyze the effect of animal activity on soil and groundwater electrical conductivity. Eight dipole-dipole DC soundings were carried on with a Scintrex resistivimeter and data were inverted (Oldenburg, 1994) obtaining 2D resistivity models up to a depth, for which models are still supported by data (Oldenburg and Li, 1999). Geological information, soil and groundwater samples were used for the interpretation of the results. At a plot without animals (background site), soundings showed resistivity values of 70 Ω m for non saturated zone (NSZ) in agreement with soil samples. Free groundwater level was found at 2 m depth coinciding with well information. The traffic lane of animals had lower NSZ resistivity near the milking house. At the feeding area, NSZ resistivity was lower (EC 910 μS/cm) than the background site, being correlated with greater concentrations of nitrates and phosphorous obtained from a log profile. Free groundwater level was affected by the leakage. At the surroundings of the lagoon of effluents, a decrease of resistivity in NSZ and groundwater was found, at some area where seepage or overflow have occurred. There was no evidence of contamination at the well in the milking room. DC soundings were sensitive enough to evaluate anomalies in the distribution of electrical conductivity in soil and groundwater produced by animal effluents. They allowed a quick comparison between the same situations at dairies placed at different geological and soil environments and different animal management.

Geophysical studies under a cement yard in an

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An archaeo-geophysical study of the San Ignacio Mini archaeological site in N-E Argentina was performed. We present the results obtained in a sub-sector where the constructions of possible interest where expected to be under a cement yard of recent data. Electromagnetic Induction and resistivity soundings were performed. To apply the resistivity method, 20 cm- deep holes were drilled in the cement. A model was developed of the geoelectric method in which the current is injected below a conducting layer to interpret the obtained data. In this work we present the method used to perform the soundings, the model proposed to adapt the geoelectric method, and the obtained results. We compare the results obtained from the EMI prospecting with the ones obtained through the geoelectric method.

Combining 3-D MT and 3-D DC sounding to image aquifers in fractured basalt bedrock

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We have collected 18 magnetotelluric (MT) and controlled source (CSMT) soundings to determine the structure of the Djibouti aquifer, in fractured basalt bedrock, to complement about 300 shallow DC soundings carried out over the last 10 years. Three-dimensional modelling of the MT and CSMT data are being performed while a full 3-D inversion of the DC-data is developped. Preliminary results are presented to summarise the expected results of the study. In the model, the shallow subsurface (top 130m) is resistive and relatively heterogeneous. Below that, to depths of about 1.4km, materials is on average more conductive, with resistive anomalies. A multi-scale heterogeneity is detected in the model and correlated to geology and hydrologycal data.

Imaging the electrical structure of the subsoil around a chemical plant through the inversion of dual-coil frequency domain electromagnetic data.

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Dual-coil, frequency domain, electromagnetic induction data is usually interpreted by direct observation of the plan-view maps of the in phase and quadrature components, measured at different frequencies. This allows to detect and localize buried anomalous structures, but not to characterize them. This information only can be obtained by applying numerical modeling techniques. In this work, first we laterally delimited buried waste deposits using the usual approach, and then, we obtained electrical images of the subsoil below the measured profiles by applying a 1D inversion method based on finite differences. In this manner, we could determine the electrical conductivity of the deposits, and their depth and thickness. Excavations performed later in this site confirmed the results of our geophysical study.

Electromagnetic imaging of gold mine tailings in Nopiming Provincial Park, Manitoba, Canada

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Electromagnetic surveys using EM38, EM31, and EM34 instruments have been done at the Central Manitoba, Ogama-Rockland, and Gunnar mine-tailings in Nopiming Provincial Park, Manitoba, Canada. The objectives of the surveys were to map the thickness and electrical conductivity of the tailings; to map variations in pore-water salinity; and to compare the geophysical responses of different tailings. Data have been modelled using methods including 2-D and 3-D regularized inversion based on a quadratic programming and integral equation approach. Results show that conductivity variations between and within tailings piles reflect variations in the tailings chemistry and delineate zones of acid mine drainage.

An evaluation of the GPR and EMI methodologies to characterize burial structures in the NW region, Argentina.

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Identification and classification of burials in the NW region of Argentina have been recently planned to study the funeral practices during the periods in which the archaeological sites developed. In this context, we theoretically evaluate the possibilities of the GPR and EMI geophysical methods to detect these kind of burials. Numerical simulations with both methods are performed for different geometries and values of the constitutive parameters of the burials, and also for various frequencies of the emitted signals. We evaluate how to enhance the interpretation by applying processing techniques, such as migration for GPR data and inversion of EMI data.

Geoelectrical and ground-penetrating radar investigations at a waste disposal site and its environment.

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Several geoelectric studies, horizontal profiling and vertical sounding using dipole-dipole and Schlumberger electrode configurations respectively and GPR profiles (antennas 150 -500 MHz) were performed within and outside an urban solid waste in the Entre Ríos Province, Argentina. The 2D model obtained within the landfill shows a shallow layer with a thickness of 2 - 3 m and a resistivity range from 100 to 1000 ohm-m. The second layer is about 4 - 5 m thick and presents low values of resistivity between 3 and 6 ohm-m, which are indicating a contaminated zone that is located below the water table. The third layer has a thickness of more than 10 m and a resistivity of around 15 Ohm-m. The 2D modeles obtained outside the landfill boundaries also show zones with low resistivity produced by leachate plumes. The GPR profiles have identified the upper limit of the contaminant plume by the absence of reflectors or very weak signals. In such zone the 2D resistivity model shows the presence of high electrical conductivity materials, which do not allow propagation of the radar waves deeper. In addition, from electric conductivity values of the most conductive sections were predicted leachate geochemical parameters applying empiric relations.

3D DC resistivity survey in an active mine shaft

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A 3D DC resistivity survey was used to map the distribution of water surrounding a mine shaft in an active underground Canadian potash mine. By placing electrodes in three lines down the length of the shaft, a 3D array of sources and receivers was deployed. This provides a very narrow concentrated sensor array in which to investigate the large region surrounding the shaft, creating a large, poorly constrained inverse problem. With the application of survey design techniques this limited array geometry can be used to recover the 3D conductivity distribution. Both the forward modelling and inversion require the inclusion of the 3D shaft geometry, requiring a fine discretization of the subsurface resulting in computationally large problems.

Groundwater monitoring using audiomagnetotelluric data

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Six AMT surveys were conducted to determine the geometry and its seasonal variation of an unconfined aquifer in the Mt. Amiata volcano, Tuscany, Italy. Data show very little evidence of lateral variations, and 1D modeling results were interpolated to represent the resistivity distribution at depth. The top surface of the saturated volcanics show a sort of conical shape, following the topography of the volcano, whereas the bottom surface appears much more complex. The main features defined by the bottom surface, however, fit well with the main geological characters of the area and the volcanological data. AMT data didn't show any clear evidence of a seasonal change of depth of the top of the aquifer, although they suggest a seasonal increase of aquifer thickness in a few areas.

2D and 3D resistivity inversion at a large urban solid waste in Buenos Aires Province, Argentina

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This paper presents the preliminary geophysical results of a multidisciplinary project at an urban solid waste in Buenos Aires Province, Argentina. Multi-electrode resistivity data were acquired inside the landfill areas along parallel survey lines. 2D and 3D inversion of data show sectors with large resistivity contrast within the wastes. The conductive anomalous zones were interpreted as accumulation of leachate because the electrical conductivity of landfill leachate is often so much higher than that of the natural groundwater. These bodies of leachate present low values of resistivity between 2 and 5 ohm-m and are located discontinuous bellow 5 m depth. The predicted electrical conductivity of leachate is around 2570 mS/m and this value is of the same order of specific conductivity measured in leachate samples (3000 mS/m). The large amount of leachate observed is mainly function of low gradient of the landfill area, the meteorological and hydrogeological factors and the effectiveness of the capping. These results are a useful contribution to check environmental impacts caused by the solid waste disposal in this area.

Mapping hydrogeophysical structures with time-domain electromagnetic methods: Resolving small-scale details with large loops and three-component measurements.

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The application of novel, 3-component, time-domain electromagentic surveys to the problem of mapping structural controls on shallow aquifer flow is examined here. Two survey designs were considered for a test site in central New Mexico (USA): a constant-offset azimuthal survey centered a small, fixed transmitter loop; and, a large loop survey where the loop interior is sampled on a dense, regular grid of receiver locations. Using symmetry arguments, results of the azimuthal survey are shown to be compatible with the dominant fracture orientation mapped by surface geology. Analysis of dense-grid experiment reveals elongated and migrating eddy current paths, likely due to the observed fracture-anisotropy.

Modeling the global scale electromagnetic response of a 3D Earth: Staggered finite differences over quasi-regular triangular grids

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A new algorithm for mapping the 3D electromagnetic response of a fully heterogeneus Earth is proposed and demonstrated. The method is based on the staggered Yee grid of magnetic field components along the edges of nested shells of spherical triangular grids. This discretization allows for direct computation of long-period magnetic fields induced by arbitrary source distributions over a given 3D conductivity model defined on the Voronoi cells of the mesh. Most importantly, however, the discretization avoids the problem of unnecessarily high node-density near the poles - an inherent feature of the tensor product, lat/lon Yee grids on a sphere.

Dc geoelectrics over a pluridirectional fissure system in a karstic area

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A lot of publications are known about a direct geophysical investigation of unidirectional fissure systems ubsurface, but there have been no reports about the problem of pluridirectional fissure systems. The few surface geophysical methods, which could be potentially used for this purpose, have numerous, probably unresolvable difficulties. In this paper we present an attempt to map the pluridirectional fissure system in a buried limestone body, by combining geoelectrical profiling and geoelectrical azimuthal measurements. Results received by using both the so-called null-, and traditional arrays were jointly interpreted. In case of profiling, the null array was used only to verify the results obtained from traditional approach, while in the azimuthal measurements the null array plays a basic role in the interpretation. The humidity of the fissures affects the measured results significantly, and in a meaningful way.

Geophysical investigation of salt water intrusion in Santiago Island (Cape Vert) using TDEM

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Cape Vert is a volcanic archipelago in the North Atlantic Ocean, near the west coast of Africa. Under the continental Sahara desert influence, climatic conditions are semi-arid to arid, with unreliable and erratic rainfall that leads to prolonged drought periods. Groundwater resources are the main source of natural fresh water for inhabitants, acquiring a vital importance for the sustainable development of the region. Detailed geophysical studies have been carried out in three areas of Santiago, the biggest and most populated island of the Cape Vert Republic. A survey with more than 130 transient electromagnetic soundings (TDEM) was accomplished, mainly to characterize the aquifers salt water intrusion. The electric conductivity values 50 m below mean sea level are very high ones, and several hypotheses are in order to explain such values. Measured oceanic water salinity is not enough by them self. Temperature, pressure and basiltic metassomatism mechanisms altogether can explain the observed figures. The results show that the contamination of the aquifers is made mostly by its deep part.

Airborne electromagnetics at buried valleys: frequency or time domain?

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In frame of an European project for the investigation of buried valleys acting as groundwater reservoirs we had the first possibility to generate datasets of two different airborne electromagnetic methods in the same area: the HEM system of BGR and the SkyTEM system of the University Aarhus. So it has been possible to compare the results and to discuss the advantages, disadvantages and limits of each method. The survey area was a part of the Cuxhaven-Bremerhaven valley. The results of helicopter-borne electromagnetics (HEM) and airborne transient electromagnetics (SkyTEM) are consistent. HEM clearly outlines both lateral extent of and depth to clay layers covering the buried valley. The highly conducting clays and silts, however, limit the penetration of the EM fields and thus the depth of investigation. Where thick clay layers exist, HEM often fails to penetrate them. Transient electromagnetics additionally helps to outline the thickness of the clay and to detect a conductive layer at about 180 m depth outside the valley. Airborne EM surveys in general have the advantage of a fast electrical resistivity mapping with a high lateral resolution. On one hand the cost-efficient and fast HEM method in frequency domain compete against the more expensive time domain systems with higher investigation depth. Ground geophysical surveys are, on the other hand, often more accurate, but they are definitively slower than airborne surveys. It depends on targets of interest, time, money and man power available which method or combination of method will be chosen.

Removal of near-surface effects in 2D Schlumberger resistivity for improved characterisation of covered landfill sites: a TEM-based approach

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It is known that the presence of near-surface heterogeneities can cause electrical static shift which limits the predictive accuracy of linear dc resistivity surveying employing the Schlumberger array. This paper investigates the removal or minimization of near-surface effects on Schlumberger dc resistivity soundings in a landfill environment using collocated dc and TEM soundings. Initial joint analysis of Schlumberger and TEM sounding curves from two linear profiles at a landfill site provided dc sounding curves corrected for electrical static shift. Conventional two-dimensional (2D) smooth model inversion studies of the static shift corrected data and the uncorrected resistivity data (as in conventional practice) have been undertaken for comparison. The 2D results suggest that the resistivity models from the corrected data show improved lateral continuity of resistivity structure and that the actual resistivity values also show improved correlation with the data furnished by alternative (horizontal-loop) electromagnetic and borehole hydrochemical measurements.

Assessment of electromagnetic environment for pipelines

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Geomagnetic induction produces telluric current in pipelines which cause variations of the pipe-to-soil potential (PSP), thus compromising corrosion protection and reducing service lifetime. Magnetotelluric surveys can be used to identify locations along pipeline routes where spatial increases in geoelectric field modify the local natural electromagnetic environment causing large PSP variations. Simultaneously measured geoelectric field fluctuations and PSP variations along a pipeline route in eastern Canada were found to be greatest in the vicinity of several resistive intrusive bodies. Results from an on-going combined MT – PSP investigation are presented.

Audiomagnetotellurics: A Tool For Hydrogeological Framework Studies

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Audiomagnetotelluric (AMT) data acquired along six profiles on the western margin of Spring Valley, Nevada, USA are used to define subsurface fault structure and possible hydrological connectivity between the northern and southern parts of the valley. In this part of the country, ground water is organized into extensive regional systems where it can flow between adjacent topographic ranges and basins. Primary aquifer units include Paleozoic carbonate rocks, Tertiary volcanics, and Cenozoic basin-fill units. Each AMT profile is 2-3 km long with the exception of a 12 km long transect across southern Spring Valley, which delineates detailed structure within the basin. These AMT profiles, in addition to gravity and ground magnetic studies, help characterize the subsurface structures and framework influencing ground-water resources.