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Contenu

Porosity estimation based on seismic wave velocity at shallow depths: Abstract

Jong-Sub LEE, Hyung-Koo Young, June 2014.

In this study, seismic wave velocity and porosity are used for the estimation of dynamic behaviors in the earth, including seismicity and liquefaction. A combination of seismic wave velocity and porosity in a compound method can be used to increase the resolution of subsurface observations. The three methods develloped in this study to obtain porosity through analysis of seismic wave velocity are the Wood method, The Gassmann method ans the Foti method. All three will be explain next.The results shows the Gassmann method has high reliability. The porosity based on the Wood method has a difference with dispersive bandwidth. The last one, the Foti methods have a slight gap with low dispersive values. An error norm technique was applied to define the reliability of each method. The influence of shear wave velocity in each method is limited and can be considered as small. Porosity may be estimated by examination of seismic wave velocity but the consideration of the differents factors of consequence in the three methods is not negligible.

Literature

Jong-Sub LEE, Hyung-Koo Young, June 2014. Porosity estimation based on seismic wave velocity at shallow depths. Journal of Applied Geophysics 105 (2014) 185–190

Alexandre PAYET

Abstract of the paper « Prospecting for clay minerals within volcanic successions : Application of electrical resistivity tomography to characterize bentonite deposits in northern Sardinia (Italy), »

V. Longo, V. Testone, G. Oggiano, A. Testa, *ScienceDirect*, 2014.

Electrical resistivity tomography (ERT) is applied to prospect for and characterize bentonitic clay in northern Sardinia. The alteration of these rocks is generally controlled by faults which control the local circulation of hydrothermal fluids. Ten vertical profiles (three perpendicular to the fault and seven parallel) and sixteen horizontal profiles have been considered. To characterize the different resistivities, vertical profiles had been compared to borehole and stratigraphic columns. Thus, from the surface to the depth, it can be found: overburden - bentonitic clay - pyroclastics.

ERT resolution depends on the layer thickness, eight models dealing with the variation of overburden's thickness are introduced. Thanks to the ERT data, the measure of the volume of conductive layer, obtained from the RockWorks software, is 73.453 m3 and an estimate of extractable material is 111.648 t. The calculated volumes from both methods are comparable, confirming the high quality of the geoelectrical data. So a second ERT investigations (2 D) is used to locate the layers, their thickness and the lateral continuity of the clayed body. It also relates the faulting and the stratigraphy. It can be used for mineral exploration where a high conductivity contrast exists between the mineral deposits and the host rock. A line-based third ERT data acquisition (3D) enables to estimate the available clay reserves. This is low-cost, non-invasive and rapid method. The interpretation of ERT results can be optimized by a synthetic modeling of the electrical resistivity imaging technique.

Laurie MALHEIRO

High-resolution shallow marine seismic surveys off Busan and Pohang, Korea, using a small-scale multichannel system

Ho-Young Lee, Keun-Pil Park, Nam-Hyung Koo, Dong-Geun Yoo, Dong-Hyo Kang, Young-Gun Kim, Kyu-Duk Hwang, Jong-Chon Kim (in Science Direct, Received 23 December 2002; accepted 12 March 2004, Journal of Applied Geophysics 56 (2004) 1 – 15)

The scientists conducted a high-resolution seismic survey in the southern part of East Sea Korea. The aim of this survey is to explain the small-scale multichannel high-resolution shallow marine seismic surveys. Indeed, it is was designed to improve the quality of high-resolution seismic data. High-resolution shallow marine seismic surveys have numerous applications (exploration of marine resources, mapping of shallow sedimentary layers, engineering applications).For data acquisition, are used, the seismic vessel with lines of seismic data and high-resolution channel streamer cables to receive high-frequency reflected wave, a single air gun as a seismic source, a PC for analyze, record, process and interprete the seismic signals (gain recovery, deconvolution, frequency filtering, normal move out (NMO) correction, common mid point sorting (CMP), gun delay correction, static corrections and resolution and signal to noise (S/N) have been used). The data interpretation has highlighted, a number of fold, fault structures and detailed geological information with high horizontal and vertical resolution: 1 or 2m thick sedimentary layers. This method has advantages: high data quality, precision, digital, can be improved by the application of oil exploration techniques or coupled with single channel analog method, and disadvantages as the high cost (compared to the conventional shallow single-channel seismic survey) and little scale. Deconvolution and static corrections enhanced the data quality and multichannel data increased the resolution.

Emilie GALHAUT

Geophysical exploration for Achaean gold: a case study from the Southern Cross Greenstone Belt, Western Australia

This article published in 1992 by the "Journal of Applied Geophysics" presents a study conducted in the Achaean Yilgarn block of West Australia. This area is divided into three granite-greenstone land and two high-grade gneiss complexes. This study was conducted in one of the granite-greenstone terrain called "The Southern Cross Provinces" (SCP) and especially in the greenstone belts consisting of meta-volcanics, iron formation (IF) and meta-sediments.

Gold deposits in the area are hosted by the iron formation. In the area Burbidge, IF mineral assemblage consists of quartz, cummingtonite-grunerite, magnetite and pyrrhotite-pyrite aggregates. In the SCP, the stratigraphic contacts within the Belt are generally steeply dipping and are interpreted to relate to early upright folds. The Iron Formation of the eastern limb is delineated at outcrop by the presence of a gossan. On the western limb only extends to the surface through the lateritic weathering profile in the north area.

This study was based on pre-existing geophysical data. Indeed, interesting information on the disposition of the iron formation has been extracted from the aeromagnetic surveys, ground

magnetic data and geochemical data. From these data, new geophysical studies were conducted. Indeed, studies of soil magnetic, gravity, magnetic susceptibilities and petrophysical measurement were realized in the area Burbidge.

From these acquisitions, a two dimensional forward modelling of gravity and magnetic data from the 3300N traverse was undertaken. The anomaly has been modelled in terms of a tabular Iron Formation body about 55m wide, dipping at 81¨° to the west, with the center of the top some 100m below 4064E.

Then, concluding remarks was deducted from this survey. Coincident anomalies in ground-magnetic, gravity and laterite/gold geochemistry surveys locate the along-strike continuation of a sulphides-facies Iron Formation on the western limb of the Caudan Antiform in the Burbidge area.

The geophysical anomalies are partly suppressed by deep (about 100m) lateritic weathering in this area. The equivalent sulphides-facies Iron Formation on the eastern limb of the structure displays a much stronger geophysical and geochemical response. This is interpreted as due to a combination of primary lateral facies-variation, and increased depths, and degrees, of weathering to the west.

The geophysical interpretation described herein was used as a basis for an exploratory drilling-program. Favorable intersections of weathered Iron formation were intersected in the positions predicted by the geophysical interpretation.

Quentin CORNUEL

“The electrical resistivity tomography method in the detection of shallow mining cavities. A case study on the Victoria Cave, Cartagena (SE Spain)”. P. Martínez-Pagán, D. Gómez-Ortiz, T. Martín-Crespo, J.I. Manteca, M. Rosique, 2013.

Mining areas which have suffered intensive mining activity represent an issue to governments in charge of the safety in these areas. The Electrical Resistivity Tomography (ERT) method helps to map potential shallow subsurface features in southern Spain, especially in the Victoria Cave**.** Four profiles of ERT were carried out on the Victoria Cave; apparent resistivity measurements were obtained by using a dipole-dipole electrode array and data were analysed and corrected in order to invert them and obtain a 2D distribution of electrical resistivity in the subsurface.

The inverted electrical resistivity sections and the geological information have shown two different units: an upper one exhibiting low resistivity values (< 400 Ωm) corresponds to Quaternary deposits and a lower one with high resistivity values associated with the Triassic carbonated rocks, apart very high values (more than 3200 Ωm) are caused by air-filled cavities.

To conclude, the ERT method helps to place caves with a good precision, to distinguish the different materials from the basement and it showed the position of both known and hidden subsurface cavities.

Camille CHEREAU

Electrical resistivity tomography monitoring studies at Balçova (Turkey) geothermal site

Drahor Mahmut G., Meriç A. Berge, Özde Bakak and Caner Öztürk

ERT monitoring is rarely applied to geothermal investigations. Time-lapse inversion is a technique that allows the hydraulic changes in the porous media of the subsurface to be monitored, and is sensitive to variations in the water content of the unsaturated zones. Results can be seen in a 2D and 3D manner. The aim of this study is to demonstrate the importance of ERT monitoring in near-surface investigations of geothermal sites.

Situated in the west of Anatolia, Balçova is reputed for its geothermal sources. Those sources are due to movements between small fragments and a volcanic arc in the south, product by the collision between Eurasia and Anatolia. The hot springs form along the major fault system

Two models were done. One synthetic, before the field study. It shows the injection process inside the shallow aquifer system. The resistivity changes related to time were executed by forward and inversion modeling stages using Res2Dmod and Res2dinv (Geotomo softwares). Results were remarkable from the injection in Wenner-Shlumberger and dipole-dipole but were not visible in Wenner. Changes between standard and time-lapse inversion couldn't have been confirmed. Wenner and Wenner-Shlumberger configurations could be linked after six iterations in the standard and time-lapse inversion approaches. From 55m to 70m, a middle resistivity zone could be an effect of the Agamemnon-1 fault, well-known in the sector.

As far as they know this study is the first which permit to have results with ERT on a shallow geothermal system. Synthetic modeling, combined with fields studies showed that time-lapse inversion provide more geologically and hydrogeologically realistic results than standard inversion.

Quentin GUELENNOC

Magnetic susceptibility and the spatial variability of heavy metals in soils developed on basalt

CERVI E.C., DA COSTA A. C. S. et DESOUZA JUNIOR I. G., Journal of Applied Geophysics (2014).

Topsoil magnetic susceptibility is a fast and inexpensive method for detecting polluted area. Heavy metals are mainly ferromagnetic, so their pollutions are easy to find this way.

But, when the soil is an alterated state of a basic rock, with a large amount of magnetic mineral phases, you have heavy metals together with iron-rich minerals naturally present. The problem you may have to deal with while operating on this kind of soils is that the logical high magnetic background values may hide lower levels of anthropogenic input.

In this report, *in situ* and vertical measurements of magnetic susceptibility together with spatial distribution analysis were used in Brazil in order to examine the applicability of this method to discriminate lithogenic to anthropogenic contribution in heavy metal pollution on different geological parent materials.

The highlights of this report are: topsoil magnetic susceptibility is efficient for distinguish lithogenic environments such as basalt and sandstone, lithogenic contribution is of primary significance for magnetic properties, correlation between heavy metals and topsoil magnetic susceptibility are related to the parent material, and backgrounds values suggest the nonexistence of anthropogenic pollution in the studied area.

Antoine MILLOT

Prospecting for clay minerals within volcanic successions: Application of electrical resistivity tomography to characterise bentonite deposits in northern Sardinia (Italy) (source: ScienceDirect)

The study area for this clay mineral prospecting exercise takes place in northern Sardinia. The main structures of the study area are:
- a sinistral E–W strike-slip fault with a normal component, which downthrows the welded ignimbrite on the northern block
- a N–S trending normal fault responsible for the relative uplift of the western block
- a normal fault oriented NE–SW, which further downthrows the southern block, allowing the preservation of the moderately welded pyroclastic flow.

The state of the rock shows partial hydrothermal alteration**.** This fact communicates that the porous unit was altered near the fault. This is the reason why fluid upwelling from depth is forced to spread horizontally from the fault, when a porous and permeable bed is confined between two less permeable formations.

To measure the electrical resistivity ρ (in Ω.m) of the subsoil it is possible to use the electrical survey method of exploration. This method allows us to understand the geological settings of the subsoil and mesures the electrical current transfer capacity of the natural environment.

For conclude, the extractable resources were estimated at 116,348 t, based on a covering surface of 10,206 m2, an average mineralised layer thickness of 7.5 m, the specific weight of the material (1.9 t/m3), and a safety factor (k = 0.8).

Matthieu COTTING

Experimental Study on Chromium Contaminated Sites by Geophysical Methods

In China, most of metallic waste providing from former industries, like chromium waste, were stacked without tratment or simply buried in the open ground. It creates pollution, because of the strong mobility of ions Cr6+. Indeed, the chromium penetrates into the soil and groundwater, forcing soil to produce a large amount of salt.

In this study, HPMS (high precision magnetic survey), HDR (high density resistivity) and IP (induced polariation) were combined into the research on investigating chromium waste, delineated the scope of the accumulation of chromium waste, depth and volume of the body.

The method demonstrated that the body is approximately a sphere, containing about 102m3 of chromium, and that the buried depth is about 5.8m. A drill has been set in the position (X45 ;Y45), giving an actual depth of 6.0m.

With HDR and IP surveys, it impossible to determine the presence of chromium waste. The array use is the Dipole-dipole. The national standard for chromium ion concentration of the groundwater is 0.05mg/L. In this case, the rate is 50mg/L. So the pollution is very serious. However, the investigation is not ideal, beacause the concentration of harmful substances can monitor groundwater, when the water of pollution is greater than 100mg/L.

In conclusion, the magnetic prospecting more accurately determine the spatiallocation of the chromium waste. The density electrical and induced polarization methods show that the soil under the chromium body is also contaminated.

Bibliography :

YE, T-F., GONG, Y-L, MENG, X-L, 2011. Experimental Study on Chromium Contaminated Sites by Geophysical Methods. The Second Conference on Mining Engineering Metallurgical Technology, volume 2, pp 223-228.

Philippe BOITIAU

"Integration of various geophysical data with geological and geochemical data to determine additional drilling for copper exploration"

Maysam Abedi, Gholam-Hossain Norouzi.

This article speaks about the realization of a mineral prospecting mapping (MPM). Authors say that there are several approaches to do this MPM, which can be categorized into two classifications: Data-driven Methods, and Knowledge methods. This paper just talk about the first method and test it ability to determine if an additional drilling is needed in a given study area. Authors integrated 13 layers of information to realize a mineral prospecting mapping. In these layers there are four layers for geology, two layers of geochemy, and five layers of geophysical. . In these layers, we can see a score for different lithology, this score reflects favorability for occurrence of mineral deposit of interest. With these scores, they define twenty one boreholes. Each of these boreholes was examinated by geoscientist expert to classify then into five different classes. The fifth class is the best class in which we will continue exploratory drilling operations. For the first class to the third, additional drilling will not be recommended. This paper compare next, prospectivity map generated by different data-driven methods. To conclude this article, various data-driven methods were applied to produce prospectivity map for Now Chun copper deposit. The result of this study indicated that the correct classification rate of the mineral prospectivity map based on twenty one boreholes drilled has the result for the radial based function (RBF) classification methods. This method is the best method to increase the resolution of decision making related to binary classification. So the data-driven method is able to reduce the amount of risk for manager of exploratory projects in continuing their task.

Benjamin CHAILLOU

Geophysical mapping of solution and collapse sinkholes

GEORG KAUFMANN | 10th October 2014

This article deals with the physically and chemically dissolution of karst rocks such as limestone, dolomite, anhydrite, gypsum and salt. There are two types of sinkholes. The first is solution sinkholes and the second is collapse sinkholes.

The methods used to detect characteristics stages of sinkholes are geophysics, such as gravity and magnetics methods. Solution sinkholes are generated by the differential dissolution of the ground where karst rocks are exposed at the surface or soil-covered. For the solution sinkholes, the geophysical method used is gravity. Indeed the gravity decreases as the cavity increases. Collapse sinkholes form when surface materials suddenly sink into a subsurface cavity.

The geophysical survey methods used in the field are gravimetric survey, magnetic survey, and electrical survey. The case studies are located in Germany, near Hannover, in the Harz Mountains.

Both solution sinkholes examined are not visible in the Bouguer gravity signal. This signal reflects the local lithological variations but Bouguer gravity can detect a sub-surface void being close to cause a collapse sinkhole, only once the sinkhole has formed. The structural models confirm and improve knowledge of the regional geological setup. The ERT profiles don't provide indication about sinkholes and reveal the different rock layers. And magnetics doesn't reveal signal of the collapse sinkhole but it reflects the local geological setup.

Christina THOUVENOT

3D inversion of magnetic data seeking sharp boundaries: a case study for a porphyry copper deposit from Now Chun in central Iran.

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This paper describes an application of 3D inversion of magnetic data to recover a susceptibility model from magnetic anomalies.

The case study is located within the Urumieh-Dokhtar (Sahand-Bazman) magmatic arc subdivision of the Central Iran zone where extensive Tertiary to Plio-Quaternary extrusive and intrusive units are exposed. In general, the main lithological units exposed in the Now Chun area comprise volcanic-subvolcanic complexes and intrusive bodies. Low magnetic intensity occurs over the sericitic alteration zones; and magnetic intensities increase gradually over the propylitic alteration zones.

A mineral prospectivity map of the Now Chun deposit was generated by a method called PROMETHEE II. This map has been prepared by using the integration of various information layers including geological, geochemical and geophysical data. This prospection study has allowed creating a 3D view of the copper concentration.

Based on comparisons observed between the recovered 3D susceptibility model and a 3D view of the copper concentration with a cutoff grade of 0.3%, low magnetic anomalies correspond to Cu mineralization and only some high magnetic anomalies which are matched with high potential zones of mineral prospectivity map can be related to mineralization.

In conclusion, the 3D inversion result of these magnetic anomalies contains useful information for identifying subsurface resources. This information could help design an economical grid of boreholes.

Quentin FAYARD

A Comparison of airborne electromagnetic data with ground resistivity data over the Midwest deposit in the Athabasca basin

Richard S. Smith, Rodney Koch, Greg Hodges and Jean Lemieux

The Athabasca basin subsurface contains Uranium deposit, which are often accompanied by graphitic conductors and alteration halos. In order to locate them, The Airborne Electromagnectic surveys are thought to be a better exploration tools than the actual Electrical Resistivity, faster and cheaper. This study aims to compare them. The Midwest deposit is a Uranium deposit, surrounded by alteration and overlying a graphitic metapelite. 3 airborne methods were used: two Fixed-wind

Time-domain ElectroMagnetic (FTEM), used on planes, and one Helicopter Frequency-domain ElectroMagnetic (HFEM).

The resulting section for the RESOLVE survey shows a shallow conductor, and another one around 150 m depth. Between them, vertical features also showing low resistivity can be seen. Those are inferred to be due to the alteration zone above the ore deposit. The TEMPEST and GEOTEM profiles are going deeper than the RESOLVE's one. However, the HFEM is more accurate, correlating very well with Ground Resistivity data, while the FTEMs display an important offset.

In the end, they used those data to model the answers of the subsurface to the electric stimulation on the receiver. It appears that the alteration would be barely noticeable, especially with the presence of highly conductive material (i.e. a lake) at the surface. Thus, the AEM method could be used to detect deep conductors and alteration zones, but would only work if there isn't anything at the surface.

John-lee DUBOS

Characterization of organic-contaminated ground by a combination of electromagnetic mapping and direct-push *in situ* measurements

This case study that involves the combination of EM mapping as a geophysical technique and direct-push *in situ* measurements using a membrane interface probe (MIP) with an electrical conductivity (EC) sensor at a contaminated reclamation site in central Japan. It highlines the fact that contamination of soils and groundwater by organic substances such as VOCs and Hydrocarbons has significantly increased in Japan lately and has become a public, industrial and manufacturing sites concern. Geophysical techniques are used to investigate issues and to map underground contaminants presence, such as detection and mapping of contaminant plumes, location and mapping of buried wastes or assessment of hydrogeologic conditions.

The results indicated oil contamination, benzene, toluene, and xylene (BTX) contamination on site, thanks to two different kinds of measurement, EM Mapping and Direct Push in situ measurements and laboratory of soil core samples were integrated to examine the relationship between the subsurface resistivity structure and the distributions of VOCs and oil contaminants. In this study, it has been demonstrated that the distribution of clayey soil zones illustrated by EM mapping is useful for the delineation of contaminant infiltration pathways. Combination of direct-push *in situ* measurements with EM mapping is essential to verify the interpreted resistivity structure and to determine the relationship between the resistivity and contaminant distributions.

Kévin COPIGNY