Title: The electroseismc and seismicelectric methods

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Abstract

The electroseismic and sismoelectric methods has been used in geophysical research for the detection of minerals and oil and to detect plumes of contamination in groundwater and soil.

Will be raised three articles made at different times, with the aim of demonstrating that the use of these methods has been used for various areas of research within the geophysics.

This article gives a brief history , since the methods will be used in the research of Ph.D. that is being developed.

Introdution

The electroseismic and seismicelectric methods has been used in the geophysical research for the detention of minerals and oil, as well as detecting pens of contamination in freáticos sheets and the ground.

These methods very are used by the Canadians, Australians and Russians and little are known in Brazil.

Three articles made at different times will be focados, with the objective to demonstrate that the use of these methods comes being used for diverse seek areas, inside of the geophysicist.

This article makes a briefing has rescued of this history, a time that the methods will be used in the research of Ph.D. of that however this being developed.

Method

Martner et al. (1959), it places that the effect manifest electroseismic as a generated electric potential in the subsoil for the ticket of seismic waves. It is possible that it detected in the surface of the ground with pairs of electrodes. The decurrent time of the tension distinguishes the effect clearly, wants from potential ionization produced at the moment of the explosion or to produce seismic effect electric coincident with the arrival of the seismic waves in the surface of the ground.

When an explosive is detonated in a well, has at least three electric effect associates, but distinct. One of them is the potential ionization that occurs at the moment of the detonation, and that it is generated in the hot gases of the explosion. Two other effect are associates with the ticket of seismic waves through the material around the well. One of them, known as electric seismic effect, is an electric potential generated by the arrival of the seismic waves in the surface of the land. This effect, discovered for Blau and Statham, was explanado by Thompson as a tension caused for the “variation of the resistivity of the land with elastic deformation ". The other effect, less widely known, is the electroseismic effect. It is characterized by an electric chain generated by resistivity, before the arrival of the seismic waves in the waves in the surface of the ground. This effect first was told LBY Ivanov, and indicated for it as the “seismicelectric effect of according to type” or and-effect. It published the results of experiments in 40 and 50, alleging that this effect can be caused by a phenomenon electric filtration in the ground humid. Frenkel presented a mathematical treatment of this hypothesis based on the theory of potentials of filtering of Helmohltz.

Russel et al., 1997, displays that the seismiceletric effect occurred when the seismic waves generate electromagnetics signals in reply to he estresse it induced in the materials of the Land, where at least four types of these signals they are used by the geophysicists, namely:

(1) the modulation by seismic stress of resistivity of the earth through steady currents flow;
(2); seismically induced electrokinetic effects analogous streaming potentials;
(3), the piezoelectric; and
(4) highly nonlinear processes that generate high audio frequency and radio frequency impulsive in sulfides.

The seismicelectric method had beginning in the decade of 1930 and has intrigued researchers in diverse countries with passing of the decades. Researchers of old Soviet Union e Russians have been most active in this area since the decade of 1940 and are responsible for the first measurement of from piezoelectric quartz veins. In the end of years 1970, G.A. Sobolev discovers uncommon answers of radio-frequency to leave of ore of sulfide.

This effect originally was related as PRRER, but recent publications prefer term RPE.

It was verified that it has a double electric layer in the interface between solids and fluid in a saturated porous rock and the fluid (Morgan et al. (1989); Pride (1994); Pride and Haartsen (1996)). When the fluid is an electrolyte, also has free movements of the same ones. When a seismic wave if propagates in an environment of saturated porous fluid-rock, the seismic wave generates the relative movement between the fluid and first rock.

Consequently, the movement of this induces an electric field. The electric field will be an electromagnetic wave when the seismic wave propagates through an interface that is not continuous in the acoustic, electric, or mechanical properties (Mikhailov et al. (2000), Zhu and Toksöz (2003, 2005)). This process is called a sismoelétrica conversion. On the other hand, if it has an electric field of the water or of the saturated porous fluid-rock, the alteration in the fluid is caused by the movement of the fluid. This relative movement between solids and fluids generates a seismic wave. This process is called eletrosismica conversion. The seismicelectric and electricseismic conversions are related with the condutividade of fluid, the porous rock, permeability, porosity, etc.

The measurements seismoeletric and electroseismic are made in the surface of the Land or in a puncture it can supply information on the subsurface properties (Mikhailov et al. (1997), Zhu and Toksöz (2005)).

The electroseismics experiments of laboratory (Zhu et al. (1994, 1999); Reppert and Morgan (2002)) with scalings layered and well model had shown that the electric waves are induced with electrodes embedded in a fluid-formation saturated or a well.

Deckman, et. all. (2005) it determined the eletrocseismics coefficients of coupling with a simple measurement of cells in laboratory. The scales of electroseismics measurements (Thompson (2005), Thompson et al. (2005)) they detect possible natural gas accumulations .

The demonstrated results had presented natural gas to a depth of less than 1000 meters.

Reppert and Morgan (2002) had studied the theoretical frequency of the dependence of the electroseismic conversion in a porous way and the derivatives of the frequency-dependent of the electroseismica voltage and it Coefficient of coupling:

$$\frac{\Delta P(\omega)}{\Delta V(\omega)} = \frac{2\varepsilon\xi\kappa}{a}\left(\frac{J_1(\kappa a)}{J_0(\kappa a)}\right)\left(\frac{2}{\kappa a}\frac{J_1(\kappa a)}{J_0(\kappa a)} - 1\right)$$

$$\kappa = \sqrt{\frac{-i\rho\omega}{\eta}}$$

where $\Delta P(\omega)$ e $\Delta V(\omega)$ they are the seismic pressure and tension electric in the angular frequency ω, ε it is the dielectric constant, ξ zeta is the potential, *[[a]]* it is the ray of the pores, J it is the function Bessel, ρ e η they are the fluid density and viscosity, respectively.

Examples

Martner et. all, carried through a series of assays using the electroseismic, associating it it the effect of resistance of the base of the layer to the produced electrocseismics impulses, also inquiring the factor of weathering of the layer in study.

Russel et. all, 1997, make three types of studies of cases to demonstrate application of the seismoeléctric in the field of the flat geophysicist, namely:

- ✓ the detention and delimitation of rich ore bodies in zinc in the Lynx Mines, British Columbia, Canada;
- ✓ the delimitation quartz mining in the gold fields in Bendigo, mining district of Victoria, Australia;
- ✓ and of the mapping of a border between the road and the glacial land underlying evenness until the Malcolm Knapp Research Forest in Haney, BC, Canada.

Zhu, et. all, carried through the first study of the generated acoustic field next to electrodes livened up for an electric pulse of high voltage. These acoustic measures in field, were carried through with and without a sample in a rock water reservoir to confirm that the electroseismics signals are generated in porous samples.

The above-mentioned authors, in its articles make the descriptions of as the experiences had been carried through e they tell some that had not gotten success. The results of these experiences will be given to follow.

Results

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Results

Martner et. all, 1959, in its assays that the experiments have demonstrated that an electric potential, the call electroseismic pulse, generated in the base of the layer resists many times the ticket of seismic waves.

The pulse detected with a pair of electrodes, he is more effective in the electrode that if finds next to the source of seismic waves, whereas the electrode more away serves as reference for the electric writings of the circuit.

The interval of time between the first electroseismic pulse and the seismic pulse in the hole where if it finds the seismograph is equal to the time of trip of the seismic waves vertically through the layer next to shotpoint.

The electroseismic pulse also can be used to determine the moment of moderate weathering to leave of the distances of shotpoint in some localities, however in other localities the interference of the pulse generated for the next eletrosismica to shotpoint.

Russel, et. all (1997), places that the effect seismoeléctric of bigger interest ambient geology and applications, are those attributed the electrokinetics phenomena.

The electrokinetics signals of two types, as much related with the load of separation associated with a seismic wave in the porous ways, had been evidentes in the data generated in Haney, BC. The possibility to detect the limits of the formations with different permeabilities pores or fluids will go to continue to lead inquiry in this area.

The studies of case in Humboldt and Lynx Mines illustrate seismoelectrics applications in the mineral exploration. The results in Humbolt had demonstrated that the Russian veins quartz could have been detected by the reply of the piezoelectric ones.

The data of the Lynx Mines show to the great high frequency seismoelectrics signals produced by sulfides e it was possible to demonstrate the delimitation of the zone. Of a ore of sulfeto the three cases studies, had been successful through reasonable interpretations geologic from measurements of field.

Zhu, et all (2007), it concludes that the electric chains for being a generated acoustic signal next to the electrodes, must be to separate from any electroseismic signal related the measurements in porous way.

The noises generated in the measurement had been tested, and had been placed different samples in a variety of distances of source to confirm that the recorded signals had been based on the seismoelectrics and electroseismics conversions.

The electroseismics and seismoelectrics signals can effectively be separate of the enormous source of influences and other noises of deep.

The electroseismics and seismoelectrics conversions in different samples of rocks with the system of water measurement had been investigated in the reservoir in the interval of frequency of 15 kHz the 150 kHz.

In the electroseismic experiment, the electric field generated by an only pulse sine induces a seismic wave in samples of saturated porous water rocks.

In the seismoelectric experiment, the seismic waves generated by a hydrophone livened up with the same only pulse sine induce an electric signal in the samples.

They had been measured the reply of the frequency of the electroseismics and seismoelectrics conversions and compared them with the theoretically foreseen coefficients.

The results of the measurement they had demonstrated the possible relation enters the size of the pores and the coefficients of frequency-dependent.

The experiences and system of measurement had supplied a method to continue to investigate of the properties of the electroseismics and seismoelectrics conversions in a rock it shows, such as the relation between the conversion and the fluid, conductivity, temperature, pH, etc.

Conclusions

The electroseismics and seismoelectrics methods, although little known in Brazil, comes being developed and used for the geophysicists the much time.

It can be observed the diversity of studies and places where these methods can be used, since the research for the delimitation of a mining even in ambient studies, thus demonstrating the versatility of these methods.

Care when making must however be taken the surveys in field and the interpretations of the found data, a time that if makes necessary the separation of waves that they are generated by the proper device.

It has a vast bibliography that it helps to the understanding of these methods and the cares that if must have when making a type of study as this.

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