Journal of Georgian Geophysical Society,
Issue (A), Physics of Solid Earth, v.17a, 2014, pp. 47-52

SOME METHODS OF ANALYZE GEODYNAMIC IMFUCT ON THE DEEP AQUIFARE

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Abstract

During hydro-geodynamical observation on the territory of Georgia has fixed various anomalies in water level before earthquakes. Revealing of the mechanism of interrelation between the deformation processes, forestall strong earthquakes, and a hydrodynamic variation of underground waters, would allow to explain such preliminary behavior of hydrodynamic effects and to develop scientifically proved methods of the forecast of earthquakes. For a select of a correct method the comparative analysis of various methods of processing has been carried out in view of all possible working factors. One of methods based on the idea, that aquifer property (porosity and conductivity) is changing during the geodynamic strass. According Results during normal period it change according tidal variation and has "background" value, but during the seismic event changed the porosity, as indicator of tectonic activity.

Introduction

From the end of the last century have developed a special network of hydro-geodynamical (water level, Atmosphere pressure and air temperature) observation on the territory of Georgia. 15 deep boreholes located basically on the main geo-structure and open deep aquifers. These wells as sensitive strain meters recorded all kinds of deformation caused by exogenous (atmospheric pressure, tidal variations and season variation), as well as endogenous processes. Observations were carried out using the specialized equipment, providing measurement of deformation up to 10-9 degrees (1-3).

During observation have observed various anomalies in water level before earthquakes, besides in most cases, on enough distant places from an epicenter.

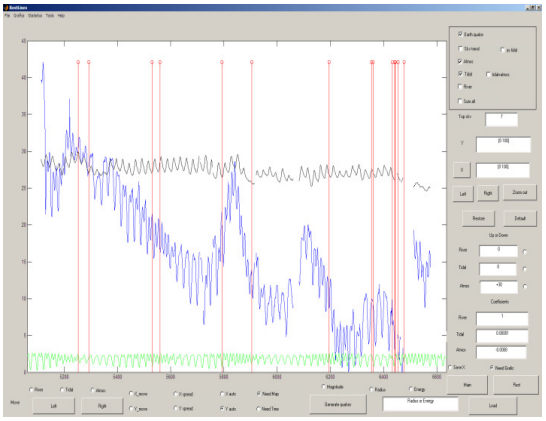


Fig. 1 Graphic of a tidal (the bottom line), an atmospheric pressure (The top line) and the underground water level (an average line) variations in time. Vertical lines show earthquakes having place for this period.

Database creation and analysis

Many scientific works have been dedicated to research of the nature of these anomalies. Despite lacking unequivocal understanding of this process, the hydrodynamic data are admitted as the most informative for the forecast of earthquakes (4-6). Revealing of the mechanism of interrelation between the deformation processes, forestall strong earthquakes, and a hydrodynamic mode of underground waters, would allow to explain such preliminary behavior of hydrodynamic effects and to develop scientifically proved methods of the forecast of earthquakes.

To solve this problem some scientists tried to add here anomalous violation in a hydrodynamic regime with the deformation processes proceeding directly in the epicenter, but could not explain "long-range action" of anomalies (7-9). Others held the opinion, that anomalies are formed directly in aquifer of the borehole and are reaction of water bearing horizon on all kinds of deformation processes, including seismo-generative ones. Therefore in parallel with studying hydrodynamic characteristics of aquifer of the boreholes (porosity, conductivity, etc.), scientists analyzed reaction of water bearing horizon on deformation both endogenous, and the exogenous origins (2-4).

At the analysis of materials, scientists individually selected methods of mathematical statistics, but all of them had one thing in common: after removal of the trend caused by exogenous factors (tidal the variation of the ground and atmospheric pressure), used frequency filters that in our opinion, deforms a required endogenous signal. The residuary values were analyzed for revealing correlation with seismic events.

For a select of a correct method the comparative analysis of various methods of processing has been carried out in view of all possible working factors (1, 2, 3). One of methods based on the idea, that aquifer property (porosity and conductivity) is changing during the geodynamic strass. According investigation of Russian scientists (10) can calculated amount of aquifer porosity by equation:

$$dh = dP/\rho g = \Delta * K_w/(n\rho g)$$

where:

n – *porosity;*

Δ – *amplitude of tidal variation* ($3*10^{-8}$);

K_w – *volume module of elasticity of water* ($2.25*10^9$ *Pa*);

ρ – *density of water* ($10^3 kg/m^3$);

g – *acceleration of gravity* ($9.8\ m/s^2$)

By this equation calculated static value of porosity for Georgian network boreholes. Amount of it are depends from many factors such as depth of a borehole, its design, an originality of a geological and hydro-geological structure water-bearing horizon, value of the gas factor, etc.

Tab. 1 Data of porosity for difference boreholes

Boreholes name	Amplitude of water level reaction on the tidal, cm	Porosity, %
Kobuleti	4	17
Marneuli	7-9	7.6-9.8
Lagodexi	5-7	9.8-13.6
Borjomi70	15-16	4.3-4.5
Borjomi47	12-14	4.9-5.7
Borjomi67	11-12	5.7-6.2
Gori	3	22.9
Nakalakevi	7	9.8

Change of value of porosity will be depends from the strass variation and all geodynamical in fact around aquifer.

In order to fix influence of the tectonic factor on the aquifer, during preparation strong earthquakes, was prepared special program in MatLab area. This program can show porosity amount variation in time. The program gives possibility to show porosity amount variation in time, by comparison of data of tidal and underground water level variations (fig. 2).

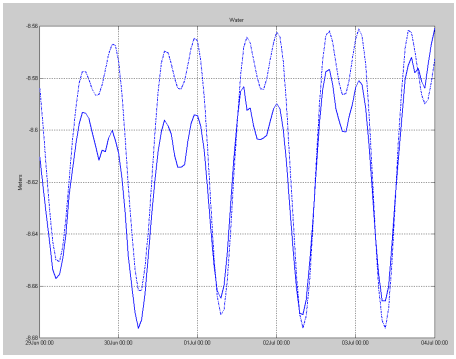


Fig. 2 Tidal (dashed lines) and the underground water level variations on the Marneuli borehole in 2012.

In order calculate value of porosity, has been made the calculation between the water level and the theoretical value of the tidal variations according equation.

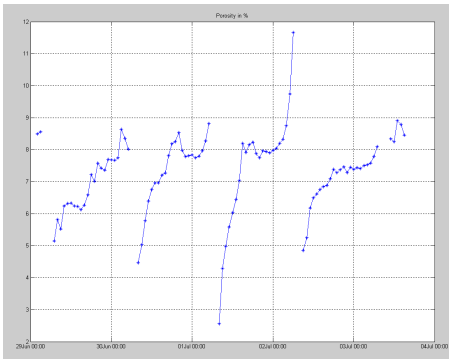
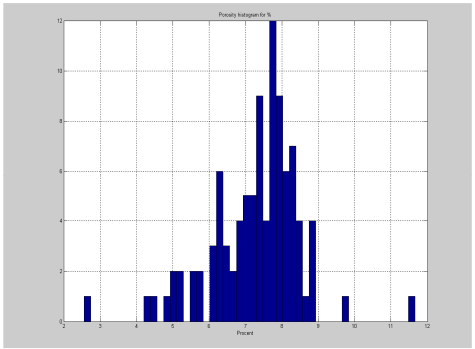


Fig. 3 Variation of Porosity on the borehole Marneuli in 2012.

Porosity value was changed according stress variation caused by tidal influence and has background value. Has been built histogram of variation porosity for this period.



. Fig. 4 Typical histogram of porosity for Marneuli, 2012

Figure show normal distribution of parameter for this period (6-9%).

On the Marneuli boreholes, every minute recorded water level, atmosphere pressure and temperature value. There are observed the significant violation of water level before and during the period of seismic events (fig. 5).

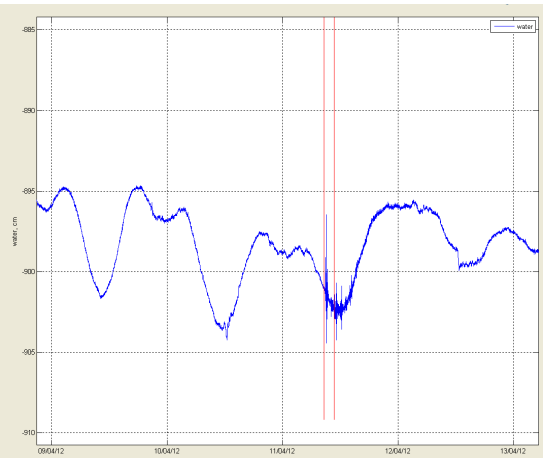


Fig. 5 Variation of water level on the Marneuli boreholes during Sumatra earthquake (11 April 2012)

Period anomalies, porosity value changed compare with background value.

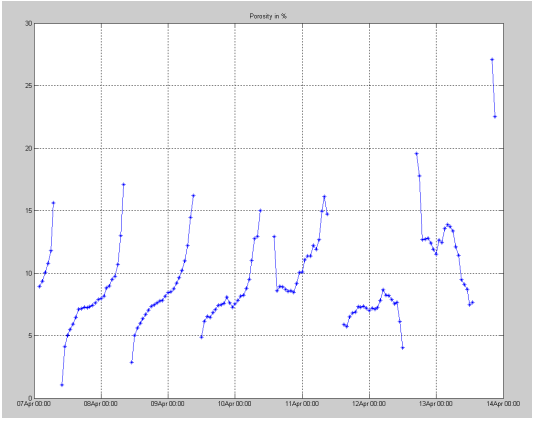


Fig. 6 Variation of porosity value on the Marneuli boreholes during Sumatra earthquake (11 April 2012)

In the Histogram fixed second pick related with anomaly value of porosity. Typical porosity equal 6-9%, after earthquake porosity equal 11-13%

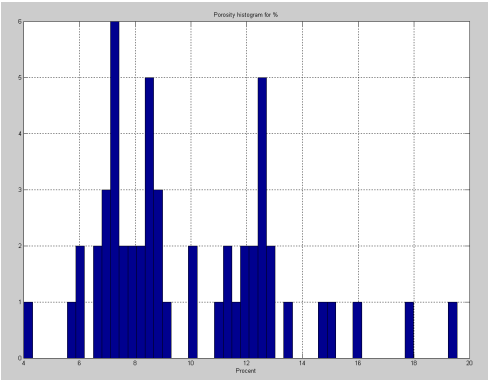


Fig. 7 Histogram of porosity value on the Marneuli boreholes during Sumatra earthquake (11 April 2012)

Conclusions

Results have shown that variation of porosity of aquifer is caused by stress. During normal period it change according tidal variation and has "background" value. Variations during the seismic event demonstrated change of the porosity value above "background" (tidal variation), as indicator of tectonic activity.

Acknowledgments: The authors thank the Rustaveli National Scientific foundation for financial support of the project #156/13 "Spatial and Temporal Variability of Geodynamical Field and Its Influence on the Deep Aquifers and Geomagnetic Field".

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Методика оценка геодинамического влияния на водоностные горизонты

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Резюме

Во время гидродинамических наблюдений на территории Грузии до землетрясений было зафиксированы различные аномалии уровня воды. Выявление механизма связи между деформационными процессами и гидродинамическими изменениями подземных вод могут позволить объяснить такие гидродинамические эффекты и выработать научно обоснованные методы предсказания будущих землетрясений. Для выбора нужного метода был проведен сравнительный анализ различных методов обработки с учетом различных влияющих факторов. Один из методов основывается на идее, что свойства водоносного слоя (пористость и проводимость) меняются во время геодинамического стресса. Во время спокойного периода они меняются под влиянием гравитационной составляющей и имеют "фоновое" значение, однако во время сейсмической активности меняется пористость, тем самым являясь одним из индикаторов сейсмической активности.

ღრმა წყალშემცველ ჰორიზონტებზე გეოდინამიკური გავლენის შეფასების მეთოდი

მელიქაძე გ., კობზევი გ., ჯიმშელაძე თ.

ივ.ჯავახიშვილის სახ.თბილისის სახელმწიფო უნივერსიტეტი, მ.ნოდიას გეოფიზიკის ინსტიტუტი

რეზიუმე

საქართველოს ტერიტორიაზე განლაგებულ ღრმა ჭაბურღილებზე დაკვირვებებისას დაფიქსირებული იქნა მრავალი ანომალია მიწისძვრის წინ. მიწისძვრის გამომწვევ დეფორმაციულ პროცესებსა და მიწისქვეშა წყლების ჰიდროდინამიკურ რეჟიმს შორის დამაკავშირებელი მექანიზმების დადგენა ხელს შეუწყობდა ამ მოვლენის ახსნას და მიწისძვრების პროგნოზირების მეცნიერულად დასაბუთებული მეთოდიკის შემუშავებას. კორექტული მეთოდიკის შერჩევის მიზნით ჩატარდა სხვადასხვა მეთოდების შედარება ყველა შესაძლო ფაქტორის გავლენის დასადგენად. ერთ-ერთი მეთოდი ეფუძნება მოსაზრებას , რომ წყალშემცველი ჰორიზონტის თვისებები (ფილტრაციის კოეფიციენტი, ფორიანობა) იცვლება გეოლოგიური დაძაბულობისას . შედეგების მიხედვით ეს თვისებები იცვლება მიმოქცევითი ვარიაციების შესაბამისად და აქვს “ფონური” მნიშვნელობა, ხოლო მიწისძვრის პერიოდში იცვლება და წარმოადგენს ტექტონიკური აქტივობის ინდიკატორს.