EVALUATION OF WATER LEVEL OBSERVATION TECHNOLOGY ON THE TERRITORY OF GEORGIA

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Abstract

Approach to methodology of earthquake's forecasting developed and evaluated since 1980 up today. At first was developing a hydro-chemical network on the territory of all Caucasus. During observations a lot of anomalies were fixed, but because of the diversity of chemical water content it was impossible to conduct observations of the unified parameters for creating the complete picture of strains on the whole territory. This is the reason why we decided to conduct observations for those parameters which could fix tidal variations with deformation of 10^{-8} degree, what is compared with strains differences during earthquakes preparation period. Besides, it was possible to conduct unified observations. Water level in the deep boreholes was one of them. That way since 1985, the network of 10 boreholes of different depth (from 250 up to 3500 m) covers the whole territory of Georgia. Boreholes characterize all basic geo-plates and open waters of deep aquifer, actually they represent sensitive volumetric strainmeters, and react on the deformations about 10^{-7} -10^{-8}, caused both by endogenous, and exogenous factors. A borehole was considered informative if it was fixing tidal variations and was included in the network. Special monitoring equipment is installed at boreholes which record several parameters, i.e. water level and micro-temperature, atmosphere pressure and surface temperature, tilt, magnetic field and others. Data is collected by datalogger XR5-SE-M. The data can be gathered in real time using the GSM net. Frequency of data collection is 1 minute. For the visualization and manipulation of data using special program which are developed at M. Nodia Institute of Geophysics.

1. Introduction

Georgia is a part of a big geodynamical active region. As a result of plate migration, strong compressive strains are being built in the crust. The energy released during sudden stress drop events may trigger earthquakes.

All over the world and in Georgia also, various anomalies (Hydro-dynamical, hydro-chemical, micro-temperature etc) are observed before earthquakes, besides in most cases, on enough distant places from epicentres. Therefore studying the geodynamical processes may help to forecast the natural catastrophes with reasonable probability.

1.1. HYDROCEMICAL MONITORING

Since 1979, the researches for the forecast of earthquakes promoted development of a hydro-chemical network of special regime regional observation. On the territory of Georgia hydro-chemical observations are carried out on the 23 boreholes (Fig. 1).

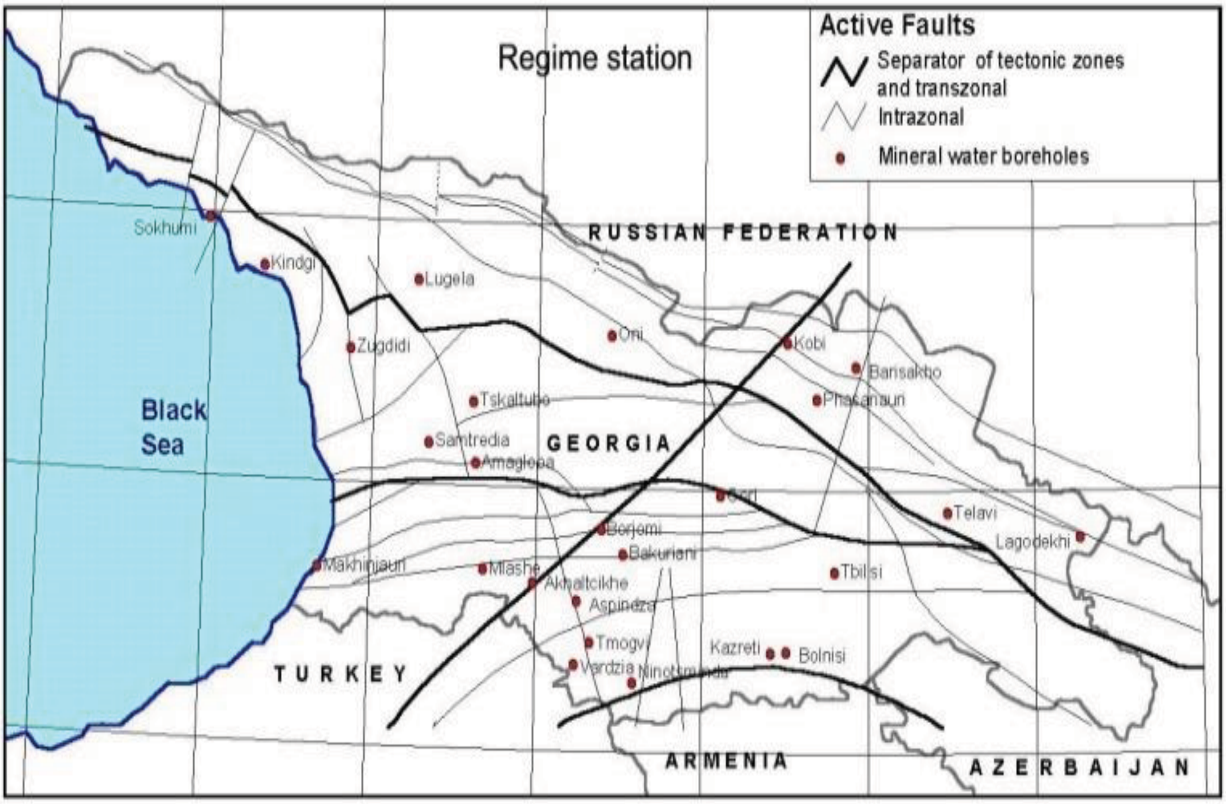

Fig.1. Scheme of hydro-chemical monitoring stations on the territory of Georgia

Measurements of water debit- by volumetric method, temperature of water and air - by mercury thermometer were daily carried out on the water points. Helium concentration was directly defined on the water points with the same frequency. Chemical composition of water was assessed on 20 components (HCO3, Cl, SO4, Na, K, Ca, Mg, J, Br-, Zn, Cu, Fe, Mn, He etc). Water chemical analysis was done by standard methodology.

1.2. WATER LEVEL VARIATION MONITORING IN THE BOREHOLES

The modern methods of earthquakes forecast allow watching temporal and spatial changes of strain in the terrestrial crust. One of them is the monitoring method of hydrogeodeformation ground field (HGF). A regime network, according to the development of VSEGINGEO, in Caucasus has been established since 1985. Till now the network of 10 boreholes of different depth (from 250 up to 3500 m) covers the whole territory of Georgia. Boreholes characterize all basic geo-plates and open waters of deep aquifer, actually they represent sensitive volumetric strainmeters, and react on the deformations about 10^{-7} -10^{-8}, caused both by endogenous, and exogenous factors. A borehole was considered informative if it was fixing tidal variations and was included in the network (Melikadze G. et al., 1989).

They are situated in different tectonic areas. The deep boreholes with undisturbed regime were chosen for the observations which were not influenced by other boreholes.

Boreholes are equally spread all over the territory, basically on main geo-plates. These wells record all kinds of deformation caused by exogenous (atmospheric pressure, tidal variations and precipitation), as well as endogenous\ tectonic processes (Rojstaczer S. et al., 1998, Melikadze et al., 2002). On some boreholes, reaction of tidal-variation or atmosphere pressure dominated. For example, the atmospheric pressure is dominant at Adjameti and Oni boreholes and then tidal variations. But the tides are dominant on the Marneuli and Lagodekhi boreholes (Melikadze et al, 2004).

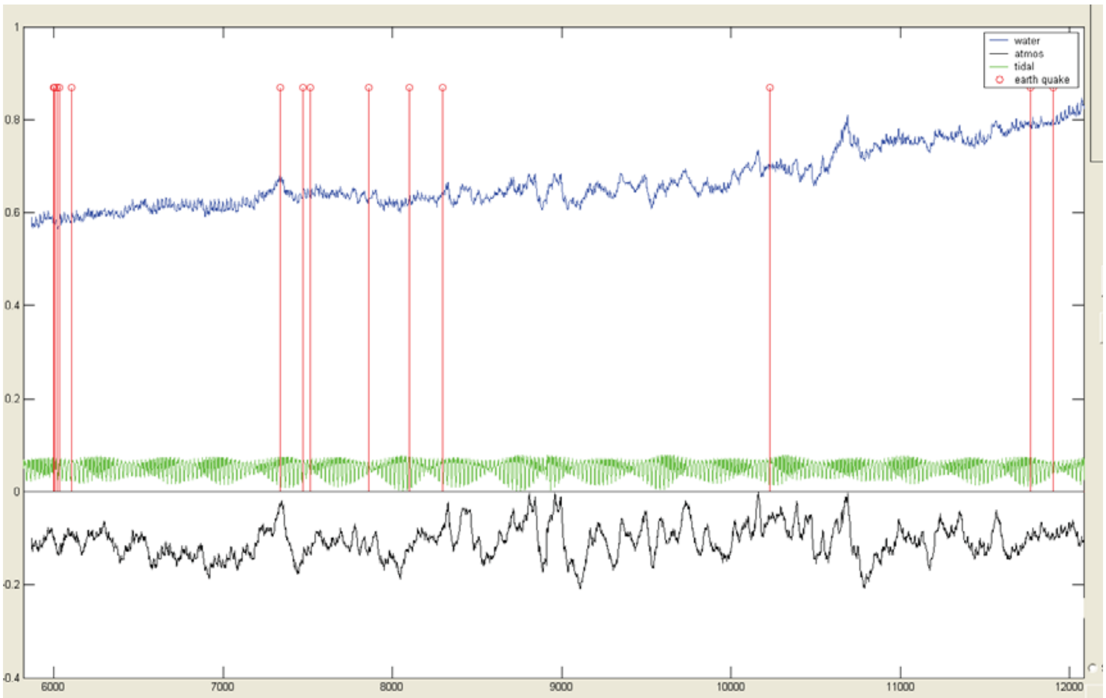

Fig. 2 Variations in time of water level (the bottom line), atmospheric pressure (the top line) and the tides (an average line) in the Adjameti borehole. Vertical lines correspond to the occurrence of earthquakes.

2.1 Data collection

Primary data is collected by datalogger **XR5-SE-M** and modem Siemens**Mc35i**.Frequency of data collection is usually 1 minute.

Fig.3 Data Logger XR5-SE-M

Let discuss some properties of datalogger XR5-SE-M. It has 8 analog inputs, can log at any interval from 1 sec. to 24 hours; internal batteries life is about 2 year under typical usage.

Retrieved from XR5 data is a text-file. The data is entered first into Excel, then into the database, created on Delphy-language and MatLab programs.Delphy-base contains data for each well separately. Each well is characterized by: water level, atmosphere pressure and theoretical values of tidal. There is also a database for all earthquakes.

Delphy-base of the merged data for individual wells, combined with earthquakes can be used in the MatLab-programs. If we want to study one individual well, we use the programs **RestDance** ,**WaterAndQuakes** (made in MatLab).If we want to look behavior of all wells together, than we use the programs **GeorgiaMap , StationsMany.**

Data can be transferred with help of GSM modem. We use two models:

a) Wavecom model 1206B (recommended by manufactures);

b) Siemens MS35i

Modems must be configured.

The program LogXR can automatically receive the data, from start time to last data. There is no possibility to receive only a portions of data. Here works the principle: all or nothing.

Sometimes it happens, there is no connections, so we manually connect, transfer (save) data and then clear memory for next portion of data(typically data should be collected everyday, otherwise the memory maximum is one month) . Setting of time is extracting from the computer during Setup, so the time on computer must be according Greenwich

2.2 Internal batteries and GSM connection.

The XR5 uses two AA size, 3.6v lithium batteries. If the XR5's battery voltage reads below 6.0v, the batteries should be replaced (**Tadiran TL-5903/S**).Battery life is greater than 2 years under typical usage. An external power input is provided. If external power is used, the batteries will power the unit during power outages; battery shelf life is up to 10 years.

The stability of GSM connection depends on the region , where the borehole is situated. We use Magti GSM connection , digital mode. The connection with east Georgia is more stable than in west Georgia.

Conclusion.

According to the new methodology, we have selected informatively deep boreholes for the special network, which covers the whole territory of Georgia and characterizes all basic geo-plates. They represent sensitive strainmeters and fix the deformations processes about 10^{-7} -10^{-8}, caused both by endogenous and exogenous factors.

All over the world including Georgia, various anomalies (Hydro-dynamical, hydro-chemical, micro-temperature etc) are observed before earthquakes, besides in most cases, on enough distant places from epicentres. Therefore, studying the geodynamical processes may help to forecast the natural catastrophes with reasonable probability.

Analyzing data of different parameters show us the importance of improving the existing multiparametric observation network by adding new parameters as well as to expansion of contacts and collaboration with colleagues from our neighbouring countries in order to exchange data and to create the observation network on the territory of whole Caucasus and Black Sea region.

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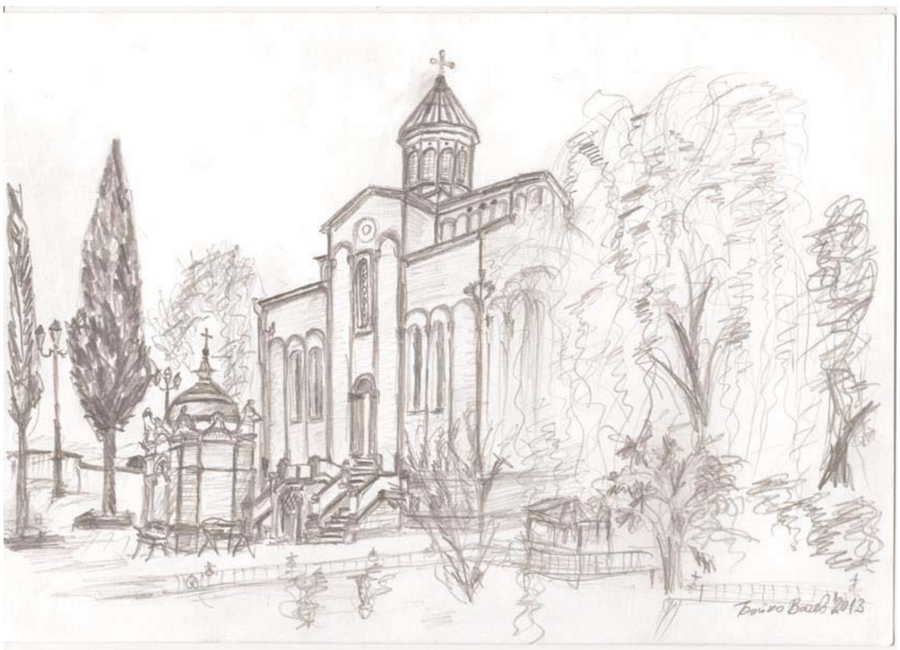

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