METHOD OF STANDARD DEVIATION FOR ANALYSIS OF CAUCASUS BOREHOLE WATER LEVEL DATA

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Abstract

In this work it is explored by Method of Standard Deviation for Analysis of Hydrodynamic parameter. For that it was researched Hydrogeodynamic parameters of several earthquakes in Armenia and Georgia by following the earthquakes in South Caucasus and for comparative analysis it was used Hydrogeodynamic parameter of the Networks of Armenia and Georgia. The result of the monitoring of water level variation parameter indicated a direct connection between deformation processes to strong earthquakes.

Introduction

Seismological investigations in the Caucasus, and particularly in Armenia, have been conducted since late XIX century. They were related mainly to investigations of strong earthquakes. The regional seismic network of Armenia was a part of the USSR United System of Seismic Observation (USSO). The "Spitak" earthquake showed the necessity of developing the existing seismic network and its technical re-equipment with contemporary high technology equipment and software. After the establishment of National Survey for Seismic Protection (NSSP) of the Republic of Armenia (RA) in 1991, new tasks were posed for Armenian seismology, directed to the population protection against strong earthquakes. Since then, the seismic network was being developed through its upgrading and e increase of the number of seismic stations.

Experiment was done for earthquakes in time-series have been studied using the variation of water level in boreholes and earth tidal. Short introduction of method Standard deviation: the signal for imminent increasing regional seismic activity is the hydrogeodynamic parameter (water level) where is defined as a jump of daily averaged SDF (standard deviation function). Such approach permits to compare by numbers the daily behavior of the hydrogeodynamic field with those in other days. Among the earthquakes occurred on the territory under consideration in certain time period, the "predicted" one is the earthquake with magnitude M and epicenter distance which is identified by the maximum value of the function: The physical meaning of the function is the surface density of earthquakes energy in the point of measurement.

Investigated period of several earthquakes and hydrogeodynamic parameter in Armenia and Georgia. For comparative analysis using data of water level from the network:

Analysis Comparison of ground-water level in borehole "Noemberyan" (Observatory Network, NSSP of Armenia) and "Akhalkalaki" (Water Observatory, DSH Georgia) for "Van" (Turkey, 23.10.2011, M=7.2) [I], "Zaqatala" (Azerbaijan, 07.05.2012, M=5.4) [II], "Mingachevir" (Azerbaijan, 07.04.2013, M=3.8) [III] earthquakes.

Figure 1. Map of the epicenters with magnitude M>=3.5 for time period 01 Sep - 01 Nov 2011

I. Van (Turkey, 23.10.2011, M=7.2 (figure 1))

On the figures below at the first graph in the left corner is the picture of tidal behavior [m], the next shows the energy (J/km^2), the next – magnitude, and the last describes precursors (red columns) and water level signals (blue points). The blue points has been count using normal standard deviation and the red columns so called precursors were obtain by subtraction of the daily standard deviation of today and the previous day. The first graph in the right corner is water mean during 23 October the period of great Turkey (Van) earthquake and the next describes standard deviation of water level.

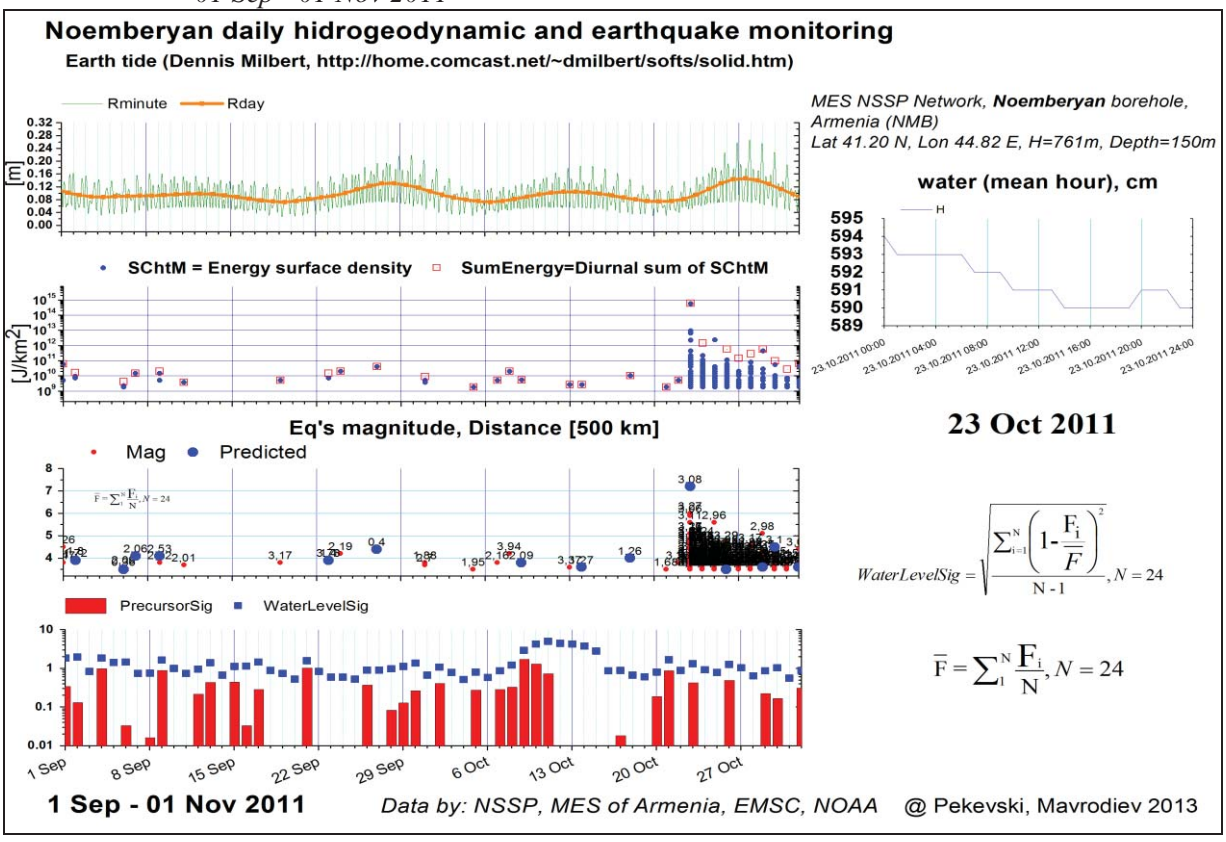

Figure 2. "Noyemberyan" borehole daily monitoring including period of earthquake in Van (2011)

On this figure on "Noemberyan" borehole during 23 October Turkey (Van) earthquake M=7.2 we can see anomaly, which is expressed by the falling of water level signal during one week before "Van" earthquake (figure 2). The anomaly has place to be during aftershocks too.

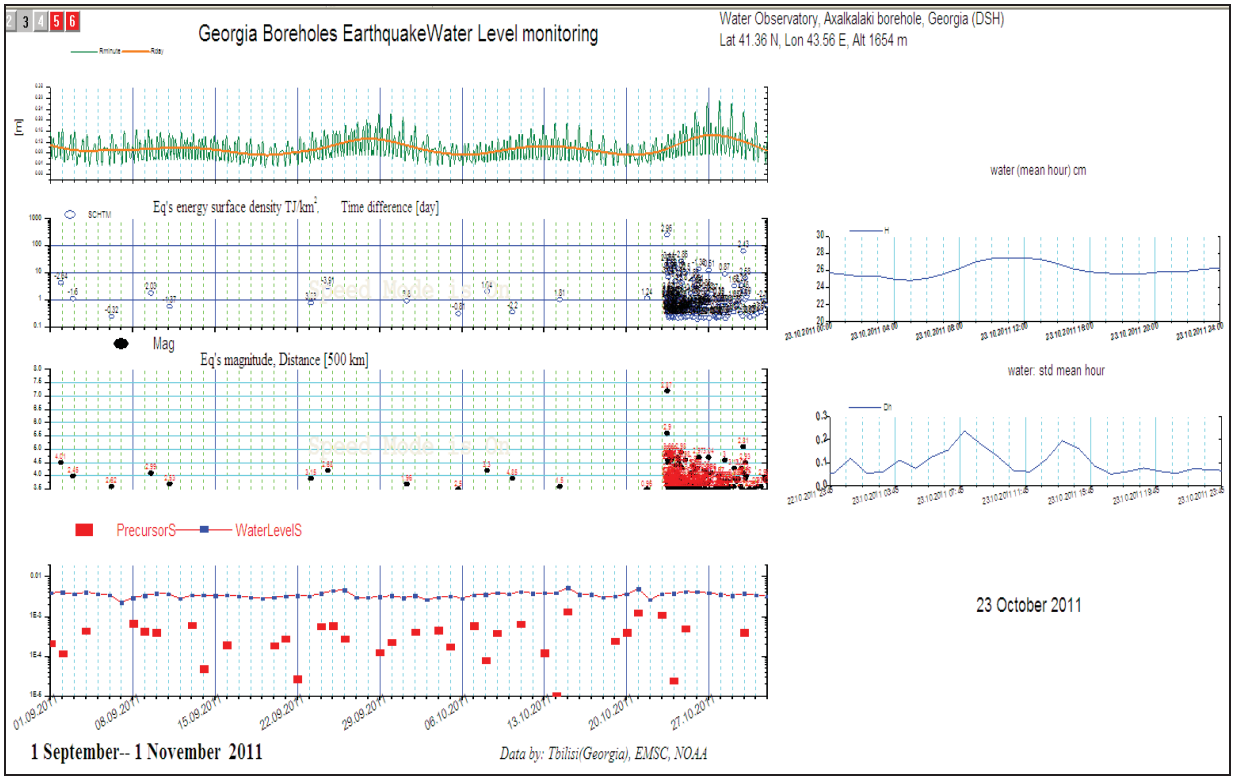

Figure 3. "Akhalkalaki" borehole daily monitoring including period of earthquake in Van (2011)

The same situation is on this figure. Here we have "Akhalkalaki" borehole data for 23 October (figure 3). As we have mentioned above, one week before the earthquake we have the same anomaly at "Akhalkalaki" borehole.

II. Zaqatala (Azerbaijan, 07.05.2012, M=5.4 (figure 4))

Figure 4. Map of the epicenters with magnitude M>=3.5 for time period 01 Apr - 01 Jun 2012

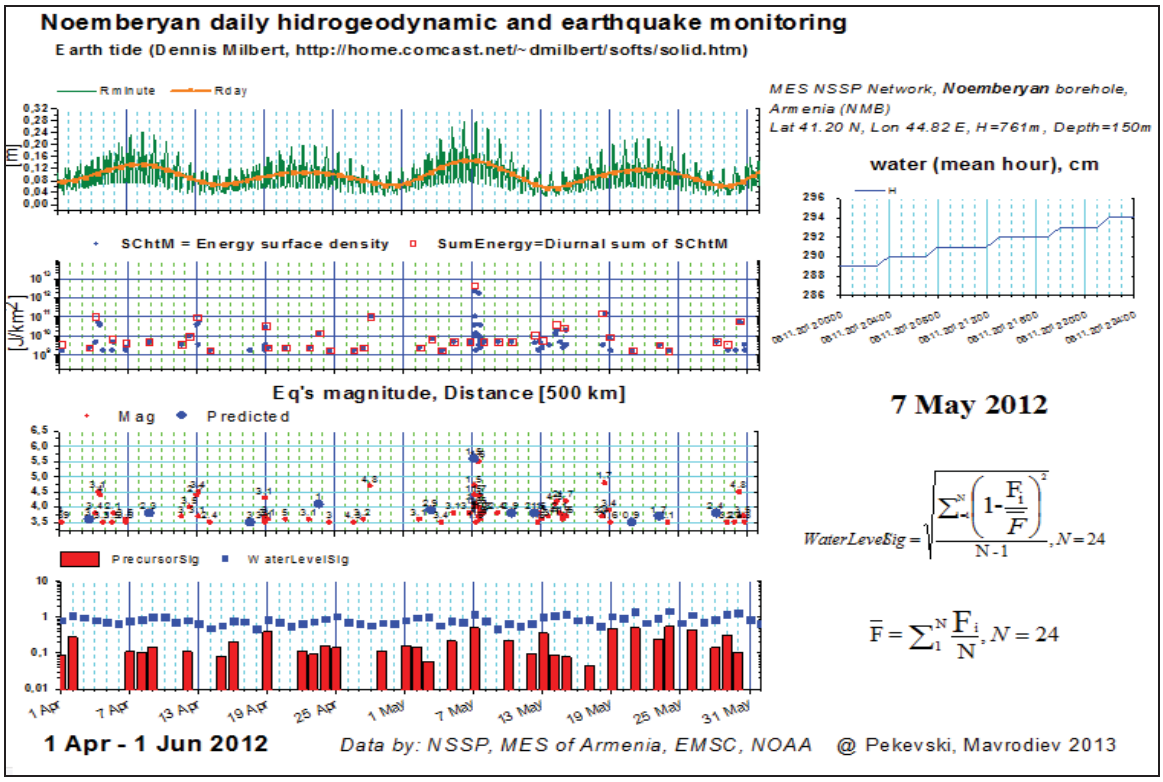

Figure 5. "Noyemberyan" borehole daily monitoring including period of earthquake in Zaqatala (2012)

On this figure, which describes "Noemberyan" borehole during "Zaqatala" earhquake (07.05.2013 M=5.4), we also have an anomaly, which appears in falling of water level signal during 3 days before an earthquake (figure 5). Also the anomaly continues during the earthquake.

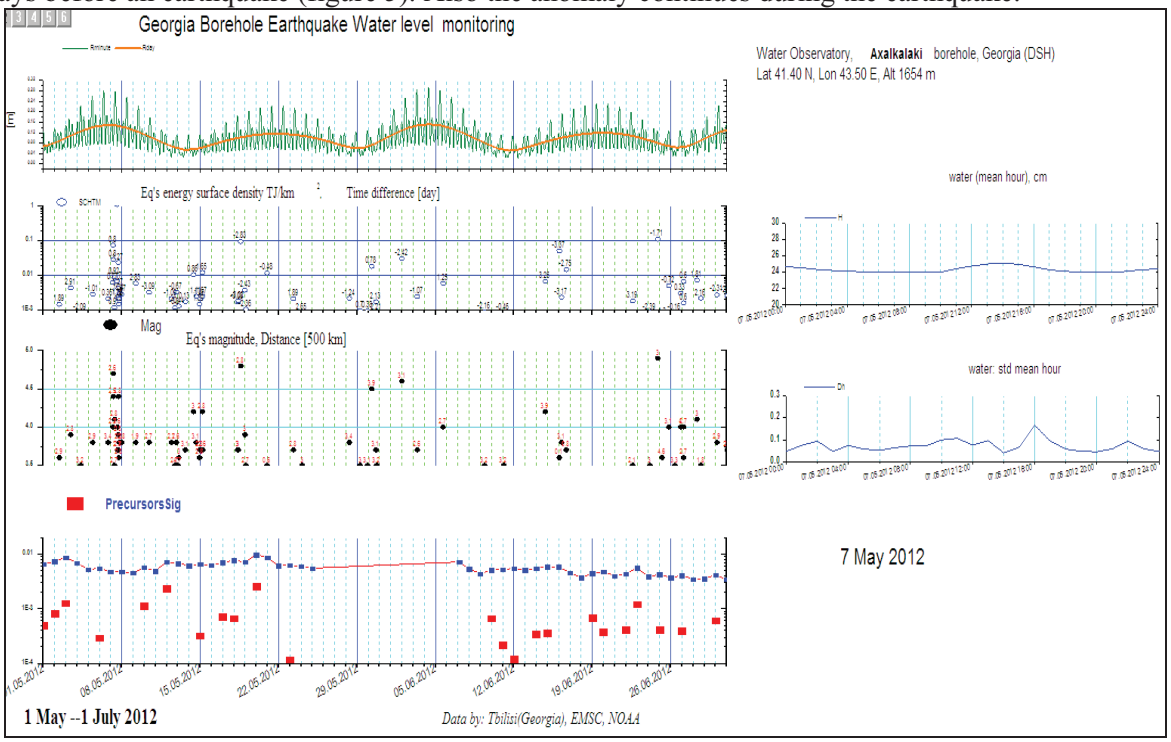

Figure 6. "Akhalkalaki" borehole daily monitoring including period of earthquake in Zaqatala (2012)

The same situation is on "Akhalkalaki" borehole (figure 6). As we see the anomaly starts during 3 days before an earthquake and ends after it.

Figure 7. Map of the epicenters with magnitude M>=3.5 for time period 01 Mar - 01 May 2013

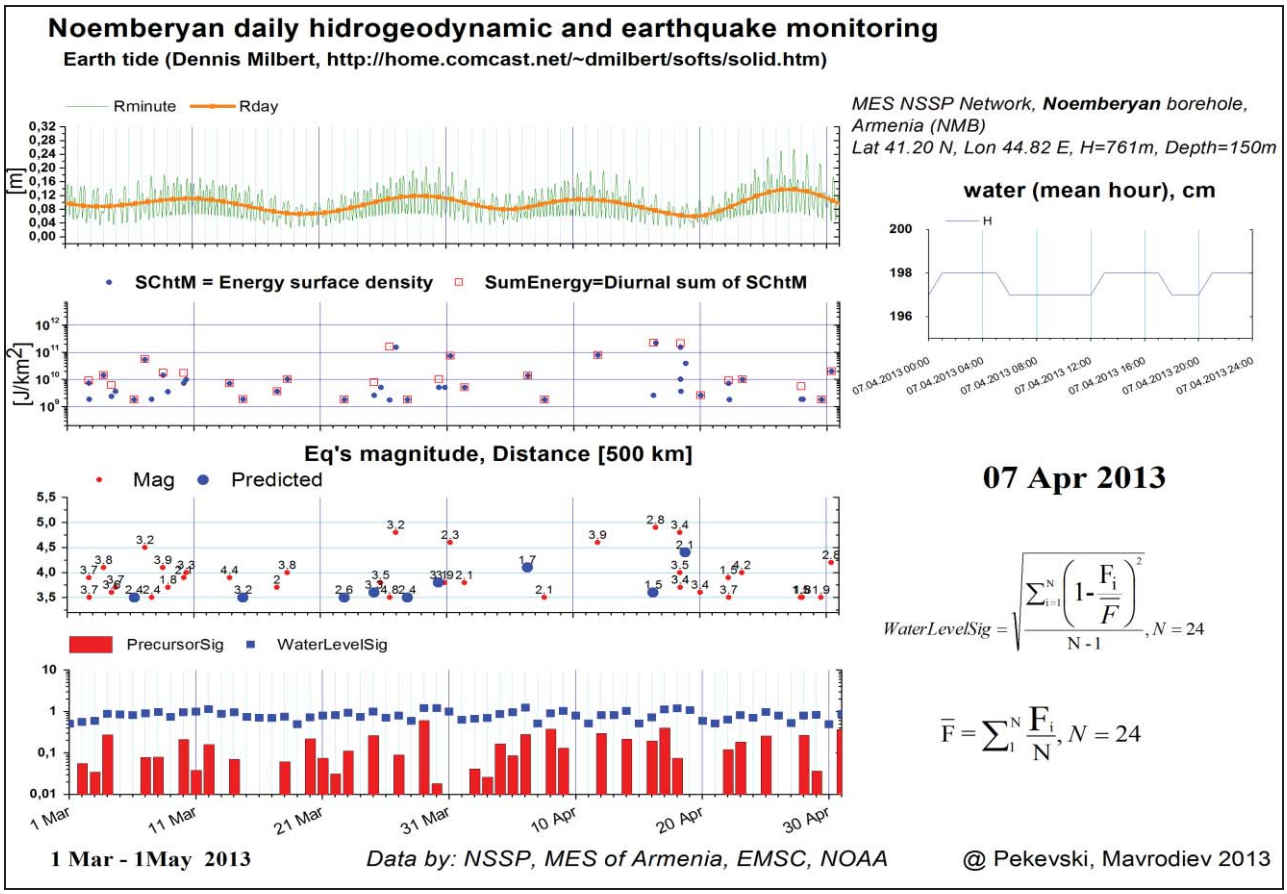

Figure 8. "Noyemberyan" borehole daily monitoring including period of earthquake in Mingachevir (2013)

III. Mingachevir (Azerbaijan, 07.04.2013, M=3.8 (figure 7))

One more figure of "Noemberyan" borehole for the period of "Mingachevir" earthquake (07.04.2013 M=3.8) has anomaly too (figure 8). We see the growing of water level signal during one week before this earthquake and falling after earthquake.

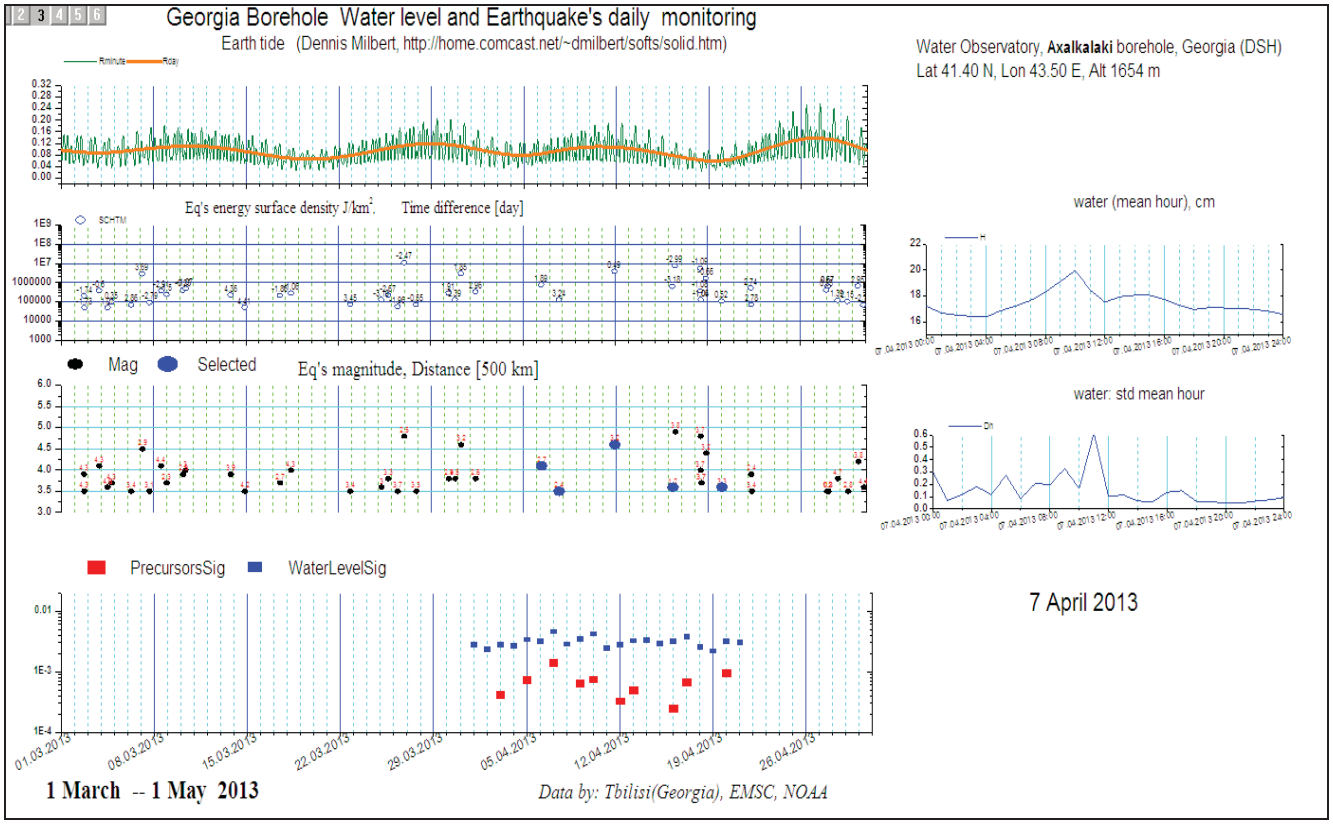

Figure 9. "Akhalkalaki" borehole daily monitoring including period of earthquake in Mingachevir (2013)

The same effect as on "Noemberyan" borehole we have on "Akhalkalaki" well too (figure 9). Growing of water level signal before an earthquake and then falling down after earthquake.

Conclusion

1. Before the earthquake "Van" (Turkey, 23.10.2011, M=7.2), the water level variation in the boreholes "Noemberyan" and "Ahalkalaki" is falling during one week before the earthquake, which means that the expansion process has occurred.

2. The water level variation in boreholes "Noemberyan" and "Ahalkalaki" before the earthquake "Zaqatala" (Azerbaijan, 07.05.2012, M=5.4) also is falling during three days before the earthquake, which means that the expansion process has occurred.

3. The water level variation in boreholes "Noemberyan" and "Ahalkalaki" before the earthquake "Mingachaur" (Azerbaijan, 07.04.2013, M=3.8) is growing during one week before an earthquake and then during it starts to fall down, which means that we have compression process before the earthquake and then expansion process.

The results of the monitoring of water level variation parameter indicated a direct connection between deformation processes imminent earthquakes and tides extreme.

Reference

1. S. Cht. Mavrodiev, L. Pekevski. On reliability of the geomagnetic quake as regional imminent-earthquake precursor, complex researchof earthquake's forecasting possibilities, seismicity and climate change correlations, BlackSeaHazNet Methodological-Coordination Workshop 2-5 May 2011, Ohrid,Republic of Macedonia. BlackSeaHazNet Series,Volume 1, pp 49-63.
2. S. Cht. Mavrodiev, L. Pekevski. On the FP7 BlackSeaHazNet Project and its Possible Application for Harmonic Existence of the Regions.Black Sea Energy Resource Devlopment and Hydrogen

Energy Problems.Springer, Published in Cooperation with Nato Emerging Security Challenges Division 7-10 October 2012.pp253-271.
3. T. Jimsheladze, G. Melikadze, G. Kikuashvili, S. Cht. Mavrodiev, L. Pekevski, M. Chkhitunidze. Study of Geomagnetic Variations in Geogia and establishment the Anomaly Nature of Earthquake Precursors, Complex researchof earthquake's forecasting possibilities, seismicity and climate change correlations, BlackSeaHazNet Training- SeminarWorkshop 13-16 September, 2011, Tbilisi, Georgia BlackSeaHazet Series Volume 2.pp205-214.
4. G.S. Vartanyan. Regional Geodynamic Monitoring System for Ensuring Safety in Geological and Exploratory Production of Oil and Gas // Izvestia. Atmospheric and Oceanic Physics. 2010. vol. 46 #8. pp. 952-964.
5. С.Ю. Баласанян. Сейсмическая Защита и ее организация. Гюмри Эльдорадо, 2004г, стр 164 - 169.
6. A. Sborshchikovi, G. Kobzev, S. Cht. Mavrodiev, G. Melikadze. Boreholes Water Level and Earthquake's Daily Monitoring Nano Studies 2013,8 pp. 203-212
7. http://theo.inrne.bas.bg/~mavrodi/everyday_monitoring.html
8. http://www.emsc-csem.org/#2
9. http://home.comcast.net/~dmilbert/softs/solid.htm

Преди Ренесанса - Боянската църква Бойко Вачев'2004
Before the Renaissance – Boyana church Boyko Vachev'2004