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THE RESPONSE OF GEORGIAN WELLS TO KAMCHATKA EARTHQUAKES

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Abstract. *A consistent water level response to earthquakes occurring 7,800 km from Georgia was observed. Typically, the Oni well responds 2-2.5 times more than other wells. However, to the M8.8 earthquake, the Oni well's response was six times greater than that of other wells.*

Key Words: *Earthquake, water response in wells of Georgia.*

Introduction

Water level monitoring is made at the following deep boreholes of Georgia: Kobuleti, Nakalakevi, Gori and Oni.

The article contains information about several hydrodynamic anomalies that were observed during the earthquake (2025, Mag ≥7.4) in Georgia on the multiparametric monitoring network of M. Nodia Institute of Geophysics. Study area, material and methods

A water level recording system is in operation in Georgia. It records water level, atmospheric pressure, and air temperature. The XR5-SE-M data logger records this data every minute. Data transmission is accomplished via an MC-35i modem. Data processing and figures creation is realized by program StationsMany. These programs are written in MatLab-language.

Information on magnitude, depth and distance about earthquakes was extracted from www.msc-csem.org. Additional information for these earthquakes: the value of the vertical component of the surface wave velocity, received from www.iris.edu/app/station_monitor (GNI station, Armenia).

Results

In July and September 2025, earthquakes with magnitudes of M=7.4, 8.8, 7.4 and 7.8 occurred in Kamchatka. They were detected by a water level recording system in Georgia, located 7800 km away from the event site.

Table 1. Earthquakes and water reaction in Georgian wells

Time	Magnitude	Depth, km	Distance, km	Water reaction, cm
20 July 2025, 06:49	7.4	25	7810	Oni: 6.3 cm
29 July 2025, 23:24	8.8	20	7817	Oni: 61 cm; Gori: 9.3 cm; Nakalakevi: 9.2 cm; Kobuleti: 2.1 cm
13 September 2025, 02:37	7.4	46	7778	Oni: 6.8 cm
18 September 2025, 18:58	7.8	30	7819	Oni: 16.2 cm; Gori: 2 cm; Nakalakevi: 4.3 cm;

For these earthquakes, the value of the vertical component of the surface wave velocity reached, respectively: 168 μms/sec; 1195 μms/sec; 141 μms/sec, 381 μms/sec.

For earthquakes with M=7.4, the P-wave arrived at a speed of 12.1-12.3 km/sec. The surface wave arrived at a speed of 3.8-3.9 km/sec. For earthquakes with M8.8 speeds are 12.87 km/sec and 4.03 km/sec. For M7.8 speeds are 12.54 km/sec and 3.89 km/sec.

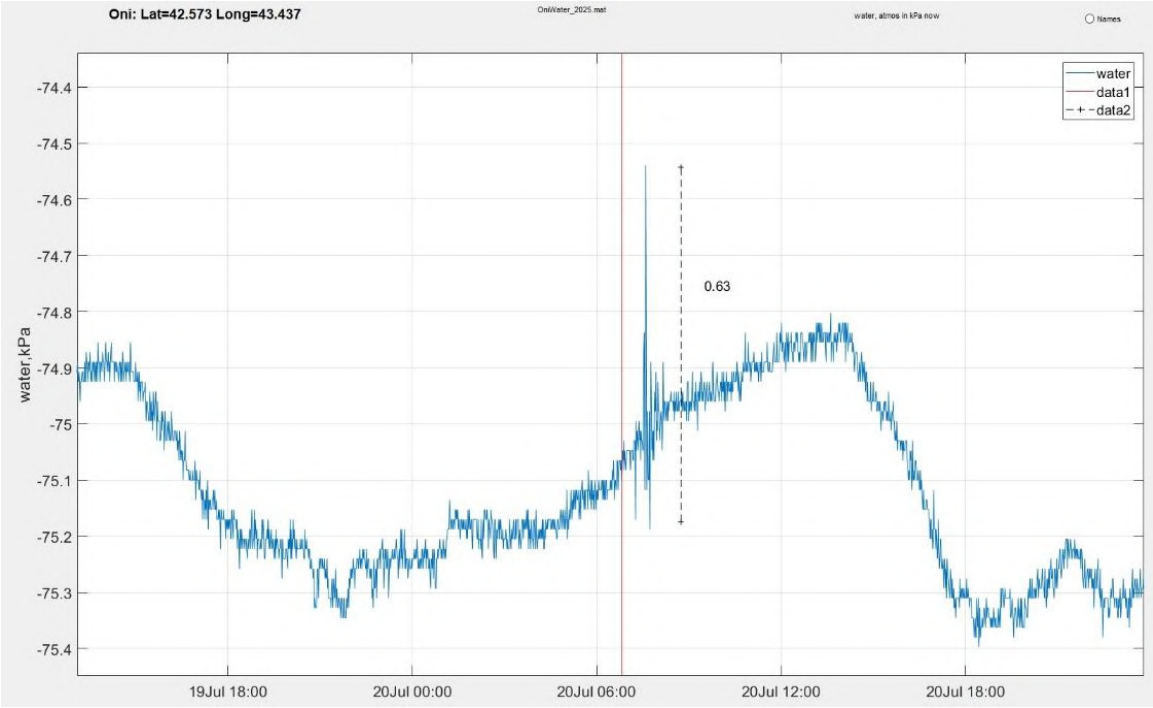

Fig. 1. Water level response to the M=7.4 earthquake in Oni Station

In all cases, the Oni station produced the most consistent results. For the M8.8 earthquake, four stations responded. Fig. 2 shows the response to a wave arriving along the shortest path of 7800 km. A slight response is also noticeable to a wave traveling from the opposite direction, a distance of 32200 km.

Long-term observations have shown that the Oni borehole is more sensitive to earthquakes than other stations. Typically, its response amplitude is 2-2.5 times greater than that of any other well [1,2]. However, to an M8.8 earthquake, its response was 6.6 times greater, significantly exceeding normal.

Possible reasons for this behaviour: a) The value of the vertical component of the surface wave velocity M8.8 is 7.1 bigger. b) Depth of Oni well is small, resonance period 32 sec. c) Phase shift is positive and equal +15°+24° [3].

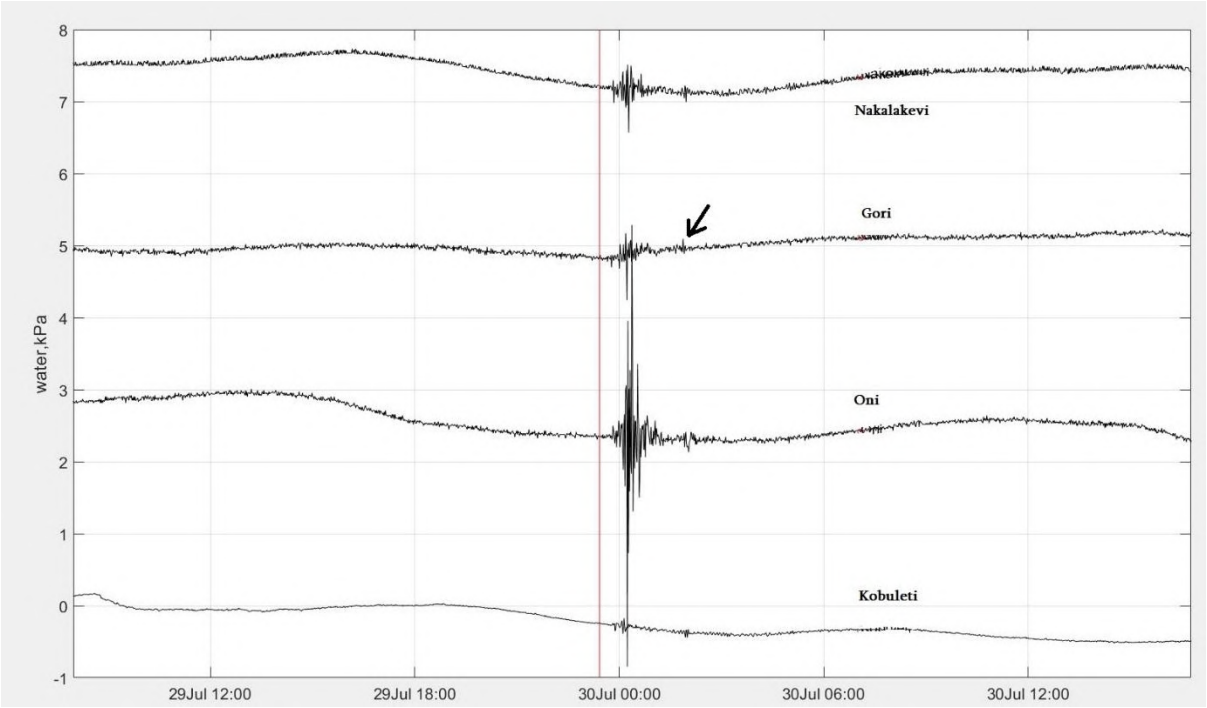

Fig. 2. Water level response to the M=8.8 earthquake in Nakalakevi, Gori, Oni and Kobuleti

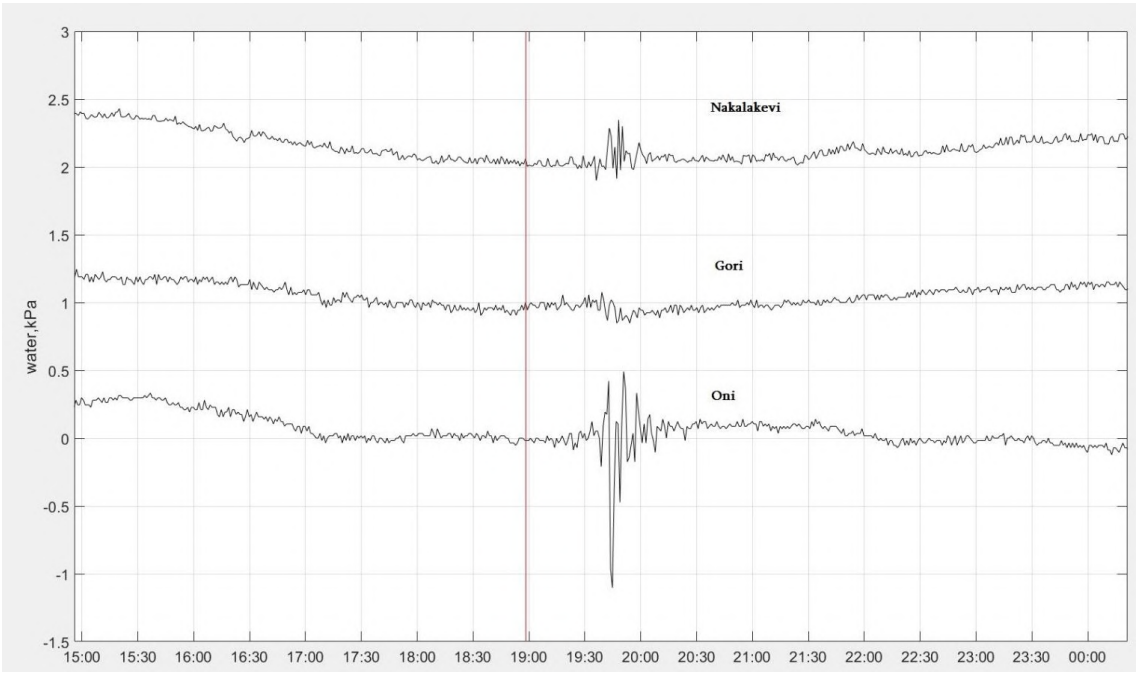

Fig.3. Water level response to the M=7.8 earthquake in Nakalakevi, Gori, Oni.

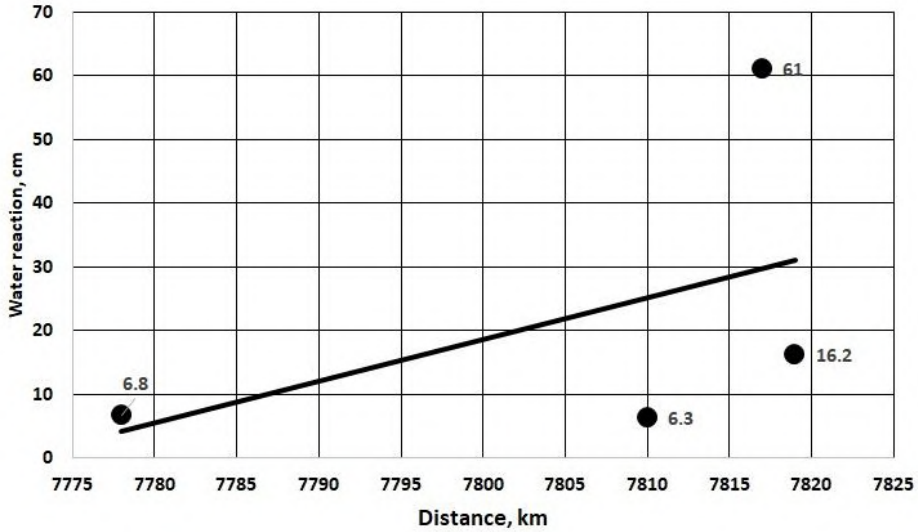

Fig. 4. Water reaction vs Distance in Oni Station

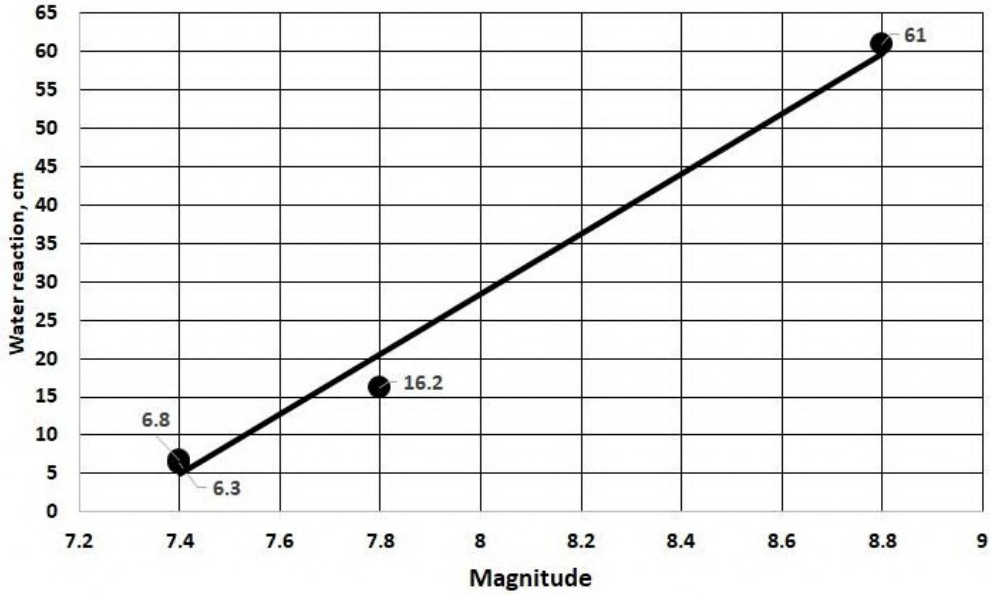

Fig.5. Water reaction vs Magnitude in Oni Station

It is important to answer the question: What properties should a sensitive well have? Let us recall the properties of our wells. Possible cause is the following properties or a combination of them.

Depth: Oni=255 m; Nakalakevi=600 m; Gori=1500 m; Kobuleti=2000 m.

Resonance period: Oni=32 sec; Nakalakevi=49 sec; Gori=77 sec; Kobuleti=89 sec.

Phase shift (M2): Oni:+15° ÷ +24°; Nakalakevi:+0.1° ÷ +1°; Gori:+9° ÷ +10°; Kobuleti: -26° ÷ -28°.

Conclusion

In some cases, the well in Oni begins to react radically more strongly to earthquakes than other wells.

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