STUDY OF THE HYDROGEOLOGICAL RESPONSES TO MASS EXPLOSIONS DURING MINING OF THE IRON ORE DEPOSIT

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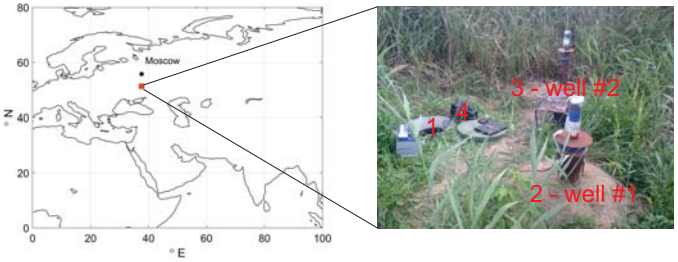
Abstract. The paper presents the results of measurements of water level changes in observation wells under dynamic impact. The measuring complex was installed within the iron ore deposit which is exploiting with underground and opening techniques (Belgorod region, Russia). The measuring point was equipped by 3-component short-period seismometer and 2 pressure sensors for monitoring water level variations in two wells with the depth of 54 m and 90 m. During the period of observation 32 mining mass explosions with epicentral distances from 850 m to 3.2 km have been recorded since June, 2019.

Here, for the first time, the amplitudes and frequency ranges of the hydrogeological responses of various aquifers in the near field are determined. There were no residual changes in the water level caused by the passage of the seismic pulse.

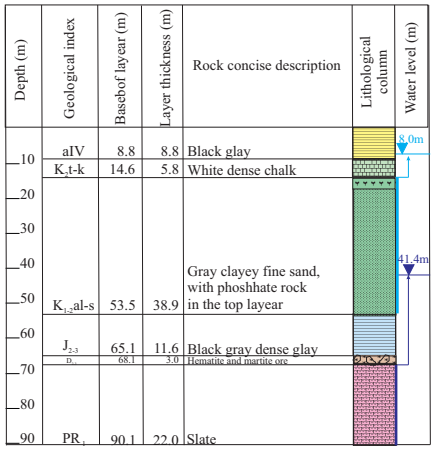
Regional location of measuring point



Explosion parameters:
Epicentral distance - R = 0.85-3.20 km
Amount of explosive
in one deceleration step - q = 368-2416 kg

1 - Seismometer SPV-3K (0.5-0.65 Hz)
2, 3 - Water pressure sensor Keller PR-36W
4 - Reftek-130 recorder
Sampling rate - 200 Hz (500Hz until 13th July, 2019)

Geological cross-section



Well resonance frequency [Cooper et al., 1965]:

$$f_0 \approx \frac{1}{2\pi}\sqrt{\frac{g}{H_e}}$$

$$H_e = H + 3d/8$$

where g - gravity acceleration, m/s^2;
H - height of the well water column, *m;*
d - interval of the well opening reservoir, m.

$f_{well\#1} \approx 0.06$ Hz

$f_{well\#2} \approx 0.08$ Hz

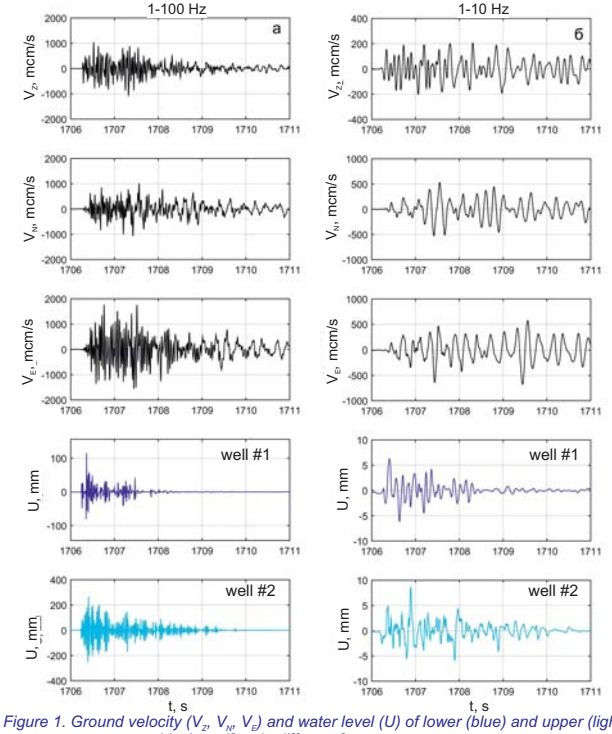


Figure 1. Ground velocity (V_Z, V_N, V_E) and water level (U) of lower (blue) and upper (light blue) aquifers in different frequency ranges.

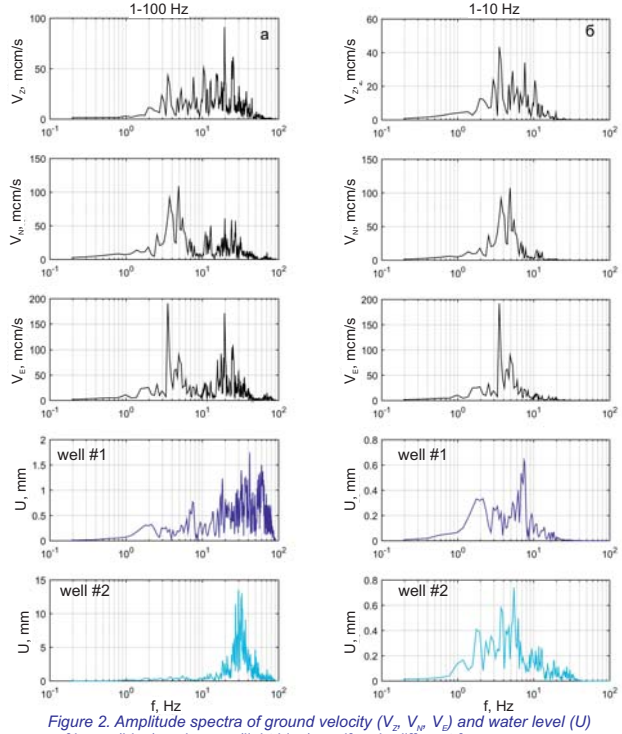


Figure 2. Amplitude spectra of ground velocity (V_Z, V_N, V_E) and water level (U) of lower (blue) and upper (light blue) aquifers in different frequency ranges.

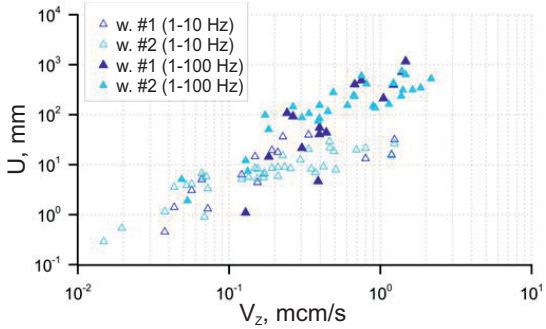


Figure. 3. The relationship between the amplitudes of ground velocity (V_Z) and water level (U) to the passage of seismic waves from explosions recorded in the well #1 (blue icons) and well #2 (light blue icons) in high frequency range of 1-100 Hz (filled triangles) and low frequency range of 1-10 Hz (empty triangles).

Conclusion

It is established that the reaction of aquifers to explosions is faster than ground velocity at the surface.

The hydrogeological responses in the water-saturated sands, slates and quartzites are registered at the different frequencies.

The heterogeneous block structure, different types of reservoirs (pore and pore-fracture types), and wave length less than the size of the reservoir explain the difference between seismic signals and variations in water level.

Probably these results can be used for the understanding of the hydrogeological and hydrogeomechanic processes in the near field of earthquakes.

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