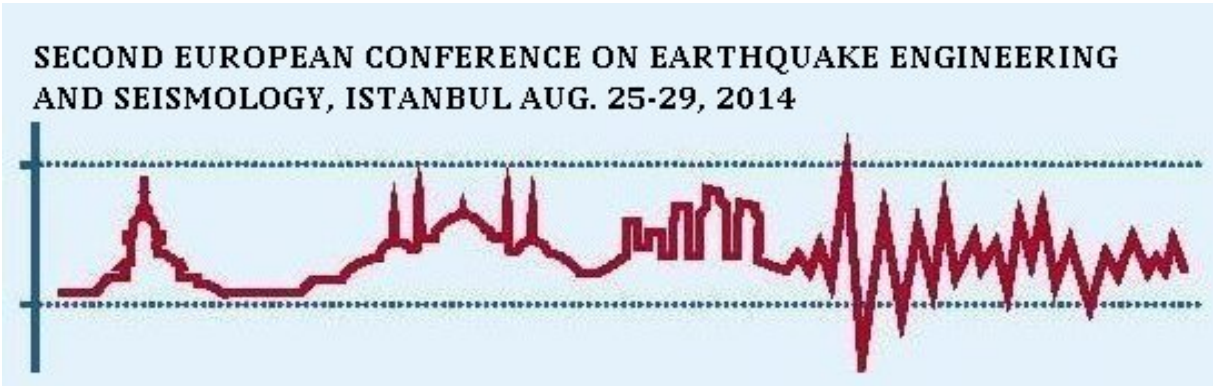

STRONG EARTHQUAKES' INVESTIGATION WITH PRECISION MONITORING OF UNDERGROUND WATER

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Precision monitoring of underground water level has being carried out in Geophysical Observatory (GPO) "Mikhnevo" area since 02/2008 synchronously with seismic events registration by small aperture seismic group "Mikhnevo" and STS-2 station (Vinogradov et. al., 2012). Hydrological and seismic data complex processing lets to find out hydrological response to tele-seismic events with M=7.5+ in area, that is located within aseismic region - Russian Plate. Post-seismic variations are tracked in strong earthquakes underground water records that is believed to be connected with filtration relationships structure change on microlevel. Groundwater level and ground displacement velocity precision monitoring results are used to identify background parameters and find out abnormal periods, that are connected to hydrological environment response to earthquakes.

Tidal components of seismic and hydrological data are considered as main indicators those characterize geological environment mode of deformation. Step-by-step data processing methodology is developed in IDG RAS. 300 seconds rows decimation, barometric pressure removal and filtration in the range of 11-13 hours and 22-26 hours are applied. Tidal values of ground displacement vertical component were found out in STS-2 station data (real data) and with ETERNA 3.0 program package (theoretical data) (Besedina et al., 2012).

Real diurnal and semidiurnal tidal component amplitudes in GPO "Mikhnevo" area are 1.7 times more then theoretical values. Envelope of semi-diurnal tides in real ground displacement has asymmetric form in comparison with diurnal envelope. Tides in underground water level correspond to ground displacement ones and are characterized by signal intensity decrease (Besedina et al., 2013).

Preliminary tides envelopes visualization allows to identify periods of ground displacement and underground water level tidal components complication in comparison with theoretical rows. Such abnormal periods can be connected with additional factors impact to massive condition including seismic waves propagation. That was how geological environment response to strong earthquake with magnitude M=8.8 that took place near Honshu Island, Japan on 03/11/11was found out in seismic and hydrological data (Fig.1).

Water level variation maximal amplitude during surface waves propagation was ±24 mm with peak ground velocity about 1.7 mm/s. Water level increase about 12-13 mm had being registered for 6 hours and after that smooth level decrease 6-8 mm below initial level had been found out. Underground water level in porous fractured reservoir was rather stable before earthquake so it is believed that dynamic impact by seismic waves propagation did initiate water level increase.

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Comparative analysis of diurnal and semidiurnal tidal components of ground displacement and water level variations within period of observation is evidence of significant signal intensity variations in comparison with background values.

Gradual increase of ground displacement diurnal tides amplitude had been found out since 07 to 13 of March 2011 with values stabilization by 15 of March 2011. Besides real ground displacement diurnal tides amplitude during first quarter of lunar cycle is 1.2 times more then during last one. Otherwise theoretical diurnal tides amplitudes during first and last quarters are comparable (Fig.2a).

Real ground displacement diurnal tides amplitude decrease below theoretical values is registered while 11-12 of March 2011 with following increase during the period of 13-15 of March 2011 shaped like signal form distortion in comparison with theoretical envelope (Fig.2b).

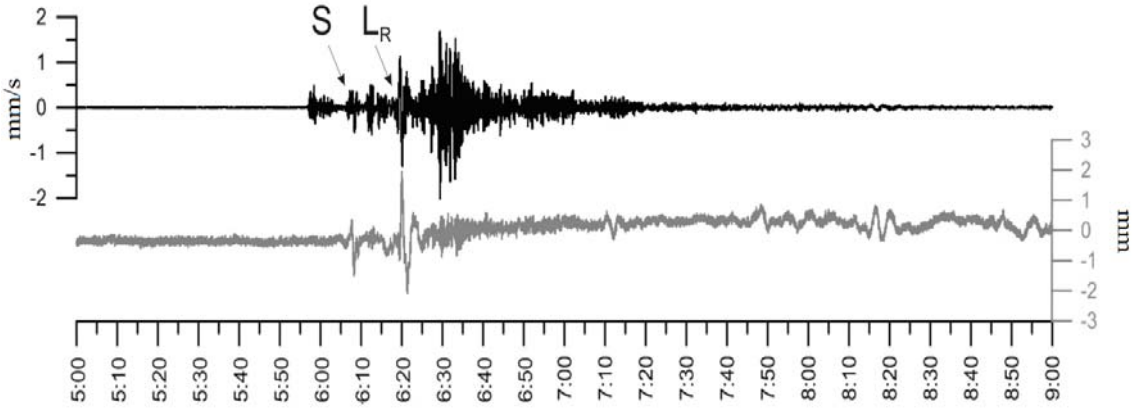

Figure 1. Post-seismic water level change (light line) and ground movement velocity (dark line) while M_w=8.8 Honshu event seismic wave propagation 03/11/11.
Water level data is cleared of barometric pressure and tidal component

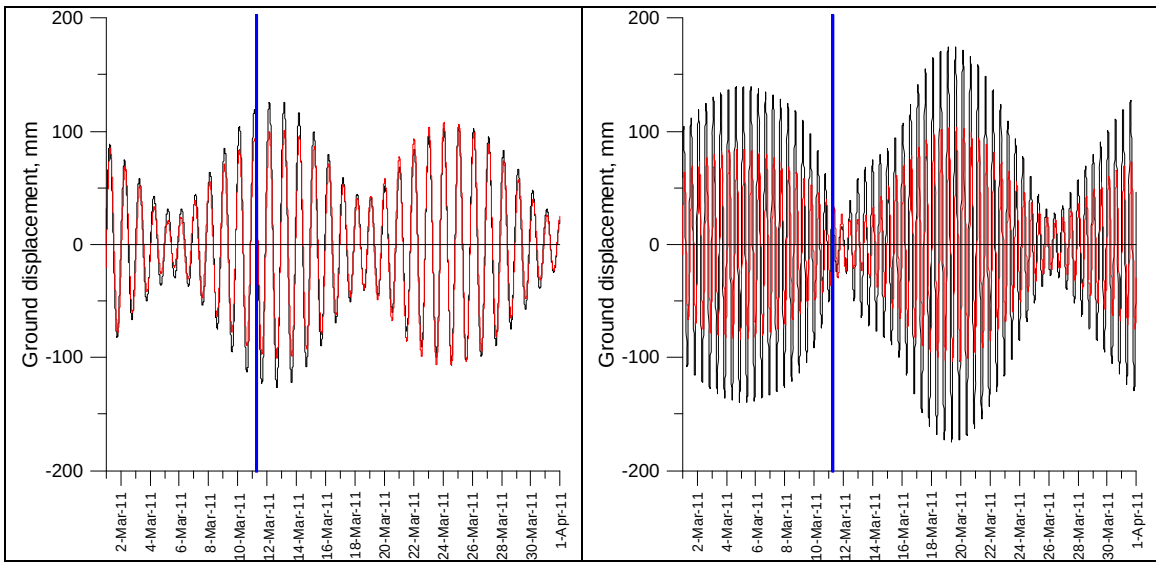

Figure 2 Diurnal (a) and semidiurnal (b) ground displacement tidal components
(black line - real data, red line - theoretical data)
Blue line - Honshu M=8.8 event moment

The same situation is observed either for water level variations tides amplitudes ratio. Water level variations extremums are tracked with a delay in comparison with ground displacement maximum values. Semidiurnal delay is equal to one day and diurnal delay is equal to three days (Fig.3b). Signal mistiming was observed during a period of 11-13 of March 2011 for semidiurnal component of ground displacement and water level variations and during a period of 05-09 of March 2011 for diurnal component of water level variations (Fig.3a).

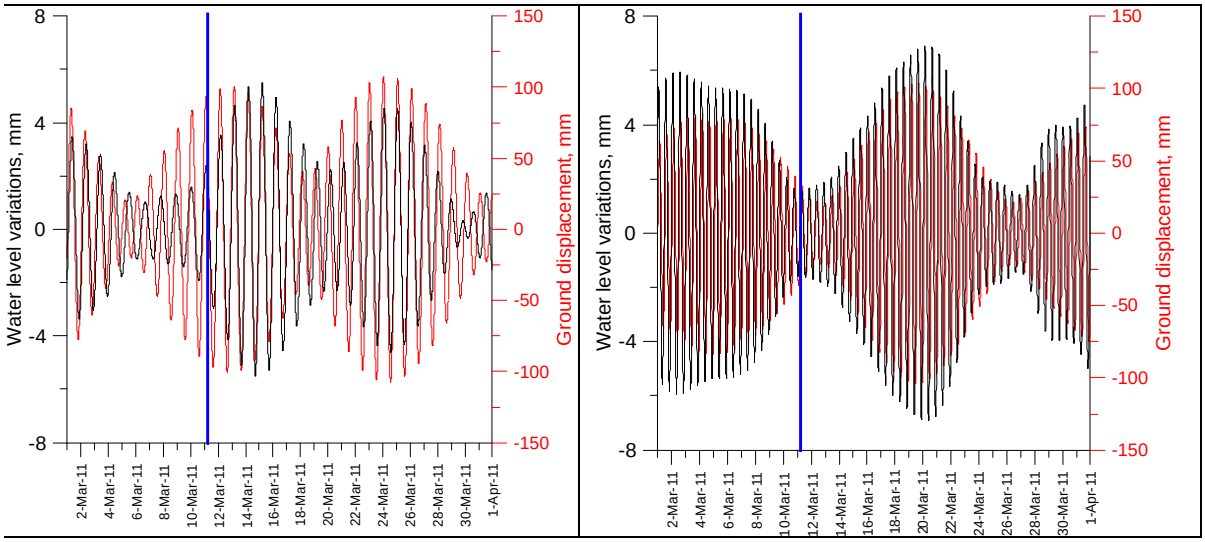

Figure 3 Diurnal (a) and semidiurnal (b) tidal components
(black line – water level data, cleared of barometric pressure, red line - theoretical ground displacement data).
Blue line - Honshu M=8.8 event moment.

Preliminary phase shift estimation for semidiurnal component with M_2-type wave predominance was done with consideration of lunar cycle. Period on observation 01-23 of March 2011 is characterized with 6.7 mm/day water level increase and was divided to three periods. First and third periods, 01-08 of March and 17-23 of March, are accordingly timed to new moon and full moon periods. This time phase shift between tidal component of real and theoretical ground displacement and water level variations doesn't exceed 10 degrees. During second period timed to first quarter of lunar cycle phase shift reaches 15 degrees. This period main series of for-shock and after-shock activity related to Honshu strong event were registered. Phase shift value increase confirms that ground displacement and water level tidal component variations are related to fluid collector response to tele-seismic event on substantially aseismic area, within GPO "Mikhnevo" located besides Russian Plate.

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