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Staging of the Acoustic Response at Laboratory Modelling of Tidal Influence upon Seismicity

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INTRODUCTION

The seismic radiation is varied through the wide range of seismic energy from seismic emission (high-frequency seismic noise, HFSN) to earthquakes. Some features of external influence response on the different scales allow to consider the medium as a single whole seismoactive object. Earth tide is a bright example of external excited field. Tidal topic has long history in seismology. Results obtained by different scientists are contradictory and ambiguous often. We denoted instability of tidal effect manifestation as possible reason of this situation. In view of the aforesaid it is significant, that tidal effects in weak seismicity and HFSN prove more strongly in the stage of large earthquake preparation [Rykunov et al., 1998, Saltykov et al., 2004, 2007].

It is presumed that the metastable medium has more high tidal sensitivity. For example, sources of prepared earthquakes and extensive near-surface zones of micro-fissuring and dilatancy, which appear during source formation and stretch far enough. [Alekseev et all., 2001, Goldin, 2004, 2005]. Common features of observed effects allow to suggest existence of tidal modulation mechanism, which is similar (may be single) for different seismic scales. Modelling of these processes can improve our understanding of tidal effect nature.

LABORATORY EXPERIMENT

Results of rock sample destruction experiments under controlling are presented. Acoustic emission (AE) pulses act as analogue of seismic events. Tides are simulated by weak long-period variations added to quasi-stationary subcritical loading.

The results of tidal modeling confirmed AE intensity synchronization with external periodic influence with large (5-10%) variations of loading are known [Lockner, Beeler, 1999, Ponomarev et al., 2007]. But real (in nature) tidal strain&stress variations are much less and equal to splits of percent. Therefore, investigation of weak modulation influence upon deformed rock is one of main proposed purposes.

Used software-programmable electro-hydraulic system INOVA [Patonin, 2006], can provide various procedures of experiment, among them programmable modulatory action. Axial deformation with stable strain rate and additional action of meander with specified period and amplitude was chosen as mode of operation. The relation between background and periodic strains reaches three orders, which corresponds to real relation between maximal tectonic and tidal strains.

RESULTS

For detection of periodic loading modulation of AE we used procedure based on Rayleigh criteria of uniformity and considered uniformity of AE impulses distribution on time interval, multiple to period of loading. Moreover, the predominant phase of periodical loading, corresponding to maximal AE activity, was calculated in sliding time window.

In all experiments we observed instability of modulation effects. So the following stages were distinguished:

- synchronization of AE and periodic loading at the initial part of test;
- absence of synchronization at the elastic stage;
- resumption of synchronization during plastic deformation.

Stability of phase corresponding to maximal AE activity was discovered within the initial part and plastic deformation stage. Absolute values of phase for initial loading and during plastic deformation are different.

CONCLUSION

Now we regard revealed staging of AE response to weak periodical loading as our main result of these experiments. Different stages of AE response are connected with different state of rock samples during loading and destruction. Observed effects of synchronization can be considered as analogue of tidal modulation of HFSN and appearance of “tidal” seismicity in source zone of prepared large earthquake.

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