tivity of the Earth's lower mantle. Optical absorption spectra have been measured at pressures up to 133 GPa for major mantle minerals, including ferropericlase (Mg, Fe)O, silicate perovskite $(Mg_{0.9}Fe_{0.1})SiO_3$, and postperovskite $Mg_{(1-x)}Fe_xSiO_3$ (x=0,1÷0,3). We find that optical absorption spectra of lower mantle minerals depend on composition (including iron oxidation state), structure, and iron spin state. We find that the presence of ferric iron in perovskite and ferropericlase strongly affects the optical properties, while the effect of the spin pairing transition may be more secondary [Goncharov et al., 2006; 2008; 2009; 2010]. We also show that post-perovskite exhibits larger than perovskite optical absorption in the near infrared and visible spectral ranges which may have a profound effect on the dynamics the lowermost mantle. Absorption spectra of ferropericlase up to 800 K and 60 GPa show minimal temperature dependence.

The estimated pressure-dependent radiative conductivity, k_{rad}, from these data is 2—5 times lower than previously inferred from model extrapolations [Goncharov et al., 2009], with implications for the evolution of the mantle such as generation and stability of thermo-chemical plumes in the lower mantle. Further work is required for an accurate assessment of the radiative component of the thermal conductivity of lower mantle minerals, including the study of compositional and structural properties, as well as the iron spin state. These include (but are not limited to) study of mantle minerals with compositions more realistic for the Earth's interior (e.g., containing Al).

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Earthquake as kinetic process

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1. At present time the forecast of earthquake is one of the most actual problems of geophysics and to a considerable degree one of the primary tasks of Earth physics. The basic unresolved question of the earthquakes forecast is the prognosis of time of strong earthquakes occurrence. There are three models: dilatant-diffusion model, avalanche-unstable fracture model and stick-slip model. Unfortunately, while adequately describing the development of earthquakes, these models cannot predict earthquake. Actually they are only scenarios of earthquakes. At the same time it is essentially important that all these models consider ***earthquake as a process***. The models in question are based on solid mechanics and the physics of rock fracture. We propose the other approach based on thermodynamics, phase-transition theory and chemical kinetics. It allows to enter explicitly time into description of the process due to Arrhenius equation (as activation time). For elementary dislocation it is 10^{-13} s.

2. The kinetic approach allows to explain why aftershocks relaxation (Omori's law) has hyperbolic character and considerably differs from standard exponential relaxation of mechanical systems. The combination of the Boltzmann distribution law (statistical thermodynamics) and the Arrhenius equation (chemical physics) gives Omori's law ($N \sim t^{-1}$) directly.

From the same standpoint the role of fluctuations in the relaxation processes has been also analysed. Taking into account fluctuations it is necessary to replace the standard relaxation equation by

$$\frac{d}{dt}N = -\frac{N}{\tau_{\text{relax}}} + \phi(t)\sqrt{N} \ .$$

The solution is "stretched exponent", that is has long (hyperbolic) tail.

The kinetics of relaxation to equilibrium is limited by the speed of establishing the concentration fluctuations, which depends on the diffusion. In this case relaxation has character $N \sim t^{-3/2}$ instead exponential [Zel'dovich, Ovchinnikov, 1977]. Thus, in the real process $N \sim t^{-C}$ and $C \in [1;1.5]$.

3. The kinetic approach allows to look at diffusion in the crystals in the different way. The basic idea is that the diffusion process is not continuous — each act of displacement is accompanied by a relaxation. If Fick's law is explicitly added by the relaxation term, then instead of the diffusion equation the cable equation is obtained (it is similar for generalization of Fourier law realized by Cattaneo). Here it is essentially important that the problem of infinite rate of diffusion in this case disappears.

4. The solid rupture is traditionally considered as critical event, and strength is accepted to a constant of solid. Experience shows that it naturally depends on time and temperature. At present it is possible to state that such ***a limit of strength does not exist***. Tensile stress (load) p, fracture time τ and temperature T are uniquely related to each other [Zhurkov, 1968]:

$$kT \ln \frac{\tau}{\tau^*} = U - \text{const}\ p \ .$$

According to Russian Academician S. N. Zhurkov, the mechanism of rupture is connected with thermal fluctuation dissociation of bonds responsible for the strength. The sense of thermal fluctuation mechanism is that the potential barrier interfering rupture of bond is overcame due to of energy fluctuation. I. e. it is takes place over-barrier transition with characteristic exponential dependence of expectation time on temperature.

Our approach consists in the fact that transition occurs not due to the activation (energy excess), but due to the decrease of barrier height. The background is that the Zhurkov formula is equivalent in fact to ordinary thermodynamic relation

$$t = t_* \exp\left(\frac{\Delta G}{kT}\right).$$

The Gibbs "free energy" G has the physical dimension of energy but it is not energy per se. The Gibbs function is the pseudo-potential, which shows the natural direction of the dynamics of a thermodynamic system. The surface tension is defined is as $\gamma = \left(\frac{\partial G}{\partial s}\right)_{T,p,N_i}$. Reducing the height of the barrier means that the slope of the tangent to the barrier top decreases (in other words, the surface tension decreases). It is possible state the reverse — decreasing of surface tension reduces the height of the energy barrier. Since the surface tension is associated with the work expended to rupture of intermolecular bonds, then it is caused by these with bonds and inversely. Actually, γ is represented as ***work*** (per unit area) — cohesion work, i. e. it is a measure of intensity of work necessary for rupture. There are many reasons of decreasing the surface tension and thus reducing the strength, that is why it is difficult to define the strength limit uniquely.

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Separation of thin layered geological medium fields

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Within geological medium, as is known, various types of waves appear and multiply quickly and their propagation is accompanied by interferential phenomena. Complication of wave field is especially observable under condition of thin layered medium while conducting prospecting works by high frequency seismic methods. Application of more complex wave fields for studies of quantitative and qualitative features of geological medium is able to bring to incorrect conclusions. Therefore, for example, for solving the problems of seismic studies based on dynamic factors wave fields are to be of the same type and not damaged by accidental and regular waves-disturbances.

In our case difference method will be used which has physical basis under it [Gryn' M., Gryn' D., 2003]. The process of appearance, propagation and multiplying of various waves is accompanied by their interference. Therefore it seems natural to use procedures inverse to additive process: the search of algorithms for definition of form of separate waves or their groups and successive separation of the wave fields and their extraction. Difference method of target wave separation which is worked out is such one when according to direction of dominant wave on the temporal section or according to direction of assumed travel-time curve the differences between each pair of adjacent tracks are being determined successively. In this case, let us remind shared elements are extracted. However adjacent tracks of residual wave field superpose with inverse sign, in other words they are dubbed and on the edges of running processing windows the signals of target waves remain, therefore edge effects arrear, and for solving the problem we have conditions on the edges. Operators of bringing residual waves to initial form but with already extracted target waves have been worked out for elimination of dubbing and taking into account edge conditions.

Temporal section of target waves was determined as difference between input wave field and residual one. The procedure of target wave separation may be repeated in the direction of other dominant waves or according to other travel time curves.

Let us note that under land surface conditions of observation essential reason of instability of wave field effects of HFF may be considered with its variability of parameters, conditions of excitation and observing, and the major disturbances strong surface channel and main fields which superpose all the band of frequencies of reflected waves. Residues of these waves-noises have negative effect on the results of data processing by their dynamic properties.

Let us give an example of application of difference method on averaging of several tracks in the running window along the given direction according to the results of CMP obtained in the area near West Donbas mine, the Ternavska anticline (Fig. 1, *a*). The main disturbances for these data are residual modes of surface wave which frequency range coincides with frequency of useful reflected waves. The velocity of such waves is about 350 (±100) m/s. They have the same energy of amplitude as reflected waves and are present along all the profile.

The running window within which seismic tracks are averaging and separation of target waves and waves-noises takes place was realized on the base of 60 m, that is only 3 tracks are involved with a step of observation between them Δx=30 m. Sharpness of characteristics of the direction of a group of seismic receivers depends on the observation base. Under conditions of sub-horizontal occurrence of reflecting horizons the effect of the base upon tar-