2018 Near Surface Research Award
Abstract
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Current climate changes and increasing human impact on the environment influence soils' conditions and stability. It leads to thawing permafrost, erosion and ground distortions. One of the dangerous objects formed as a result of these processes is landslides. Landslides are a natural hazard in many countries for people and their homes, and for strategically important engineering structures. In order to prevent these events from happening it is necessary to diagnose physical and mechanical properties of geological environment precisely and predict the potential appearance of ground failures. Landslide is a complex geological formation consisting of a combination of layers having opposite gradation and physical properties. In assessing the danger of landslides, it is of prime importance to investigate the structure of the landslide slope and its water saturation as well as the properties and status of the soils comprising the slope. Engineering seismic prospecting is the most suitable method to monitor changes of physical and mechanical properties. It is a part of geological prospecting works performed during the building and service observation of engineering constructions, e.g. roads, buildings, dams, etc. and infrastructure of mining facilities (mining, coal producer, open cuts, etc.). Conventional near surface geophysical techniques including the seismic, electrical methods, magnetometry, are applied with varying success to study the structure of the landslide. Existing software and method analogues do not meet requirements for accuracy of processed engineering seismic data. In particular, this is due to the fact that geophysical methods allow images in terms of physical parameters only, which are not straightforward related to the geological and mechanical properties required by geologists.
It is especially important to carry out these studies in areas of permafrost in Russia, which covers more than 60% of the entire territory. This is a wide variety of specific problems. These are areas of permafrost in Yakutia, where diamonds are actively mined and it is necessary to control the stability of foundations and slopes of open-cast working. This is also the problems of exploring and developing the Arctic region (our institute has the Arctic Center - "Samoilovsky Island" - a new research station in the Lena River delta.). The problems of monitoring the infrastructure in the fields of Western Siberia, since mechanical loads on the permafrost are produced by all hydrocarbon production facilities. It is also the problems of researching unique geological objects of permafrost in the Altai Republic, which are of great scientific interest.

The key idea is to use the combination of refraction and surface waves methods: combination P-wave and S-wave velocities will be used for soils physical and mechanical properties reconstruction based on correlation dependencies. Thus, the purpose of the research is to improve diagnostic methods of soils physical and mechanical properties using seismic prospecting data. The following objectives will be performed:
1. Numerical experiments for testing and determining the range of applicability of the developed methods and algorithms.
2. Acquisition of field seismic data in the Novosibirsk region and the Republic of Altai.
3. The field data processing for determining velocity structure and physical and mechanical properties.
4. Interpretation of results and determination of the degree of landslide hazard in the region.

During of the project a field data will be acquired for active landslide at the Chagan-Uzun settlement in the Agach district, Republic of Altai. Data will involve seismic reflection, seismic refraction, seismic tomography, surface waves data and electrical tomography. The data will be processed using our developments, in particular, modified method of spectral analysis of surface waves and layer-by-layer

velocity section reconstruction method. The resulting seismic Vp and Vs velocity models will be compared with and each other and with electrical resistivity data processing results. Further, we plan to interpret the geophysical results within engineering geomechanical approaches. We have previously carried out similar studies in the study of the road, when it was necessary to study the hydrogeological parameters of the subsurface by seismic methods. [Kurlenya M.V., Serdyukov A.S., Chernyshov G.S., Yablokov A.V., Dergach P.A., Duchkov A.A., Procedure and Evidence of Seismic Research into Physico-Mechanical Properties of Cohesive Soils, doi: 10.1134/S1062739116030598]. We expect that the interpretation and conclusions will allow us to study the genesis and evolution of the landslide. We will be able to assess the danger of the descent of a landslide.