

GPR in shallow subsurface studies: case Umbozero mine

Juho Kupila¹, Peter Johansson¹, Janne Kivilompolo¹, Jouni Pihlaja¹, Ulpu Väisänen¹, Vladimir Konukhin², Anatoly Kozyrev² and Lena Alakangas³

Geophysical methods, including ground penetrating radar (GPR), can play an important role in dynamic field studies. GPR has many applications in a number of fields. In the Earth sciences it is used to study bedrock, soils, groundwater and ice.

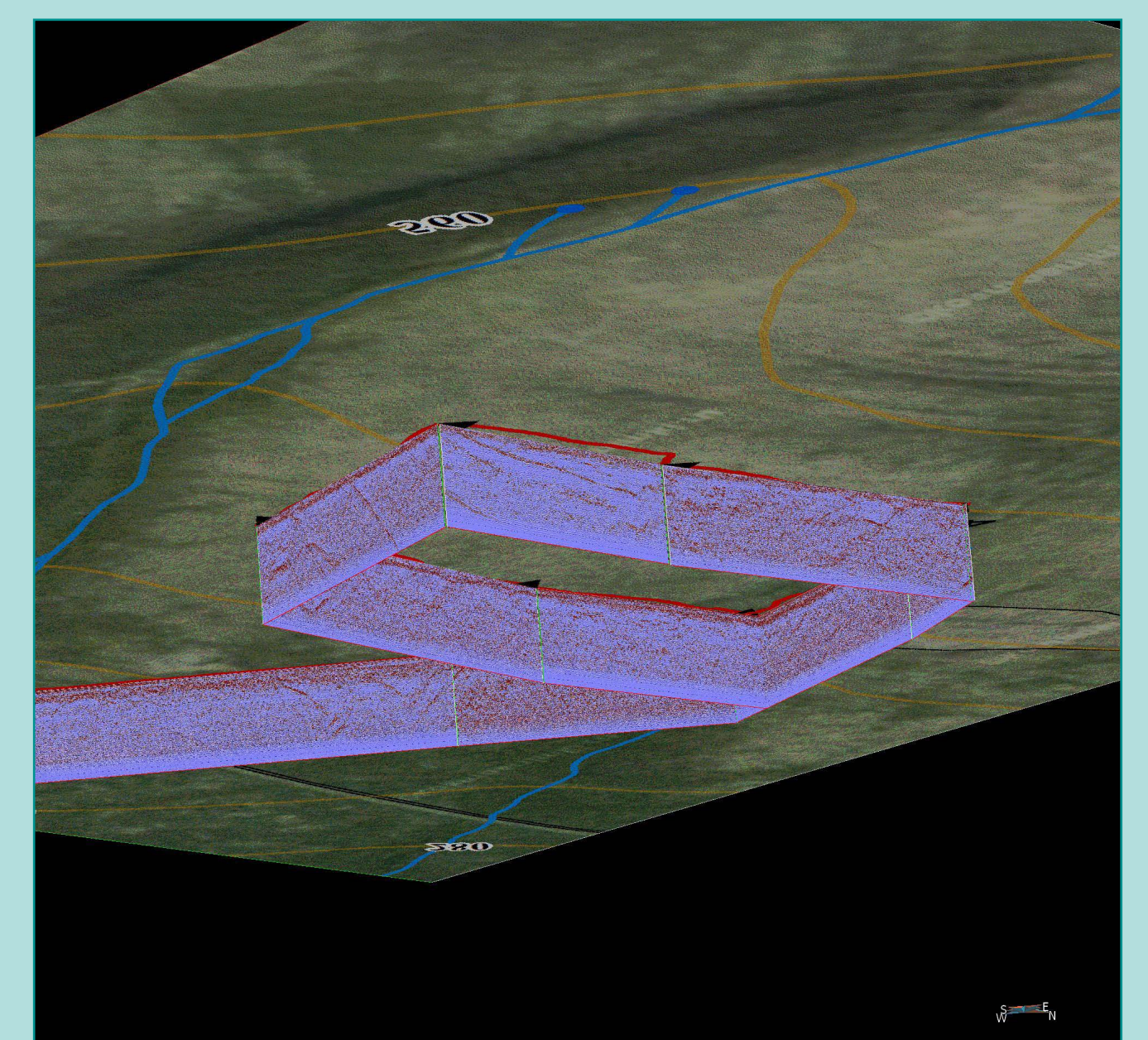
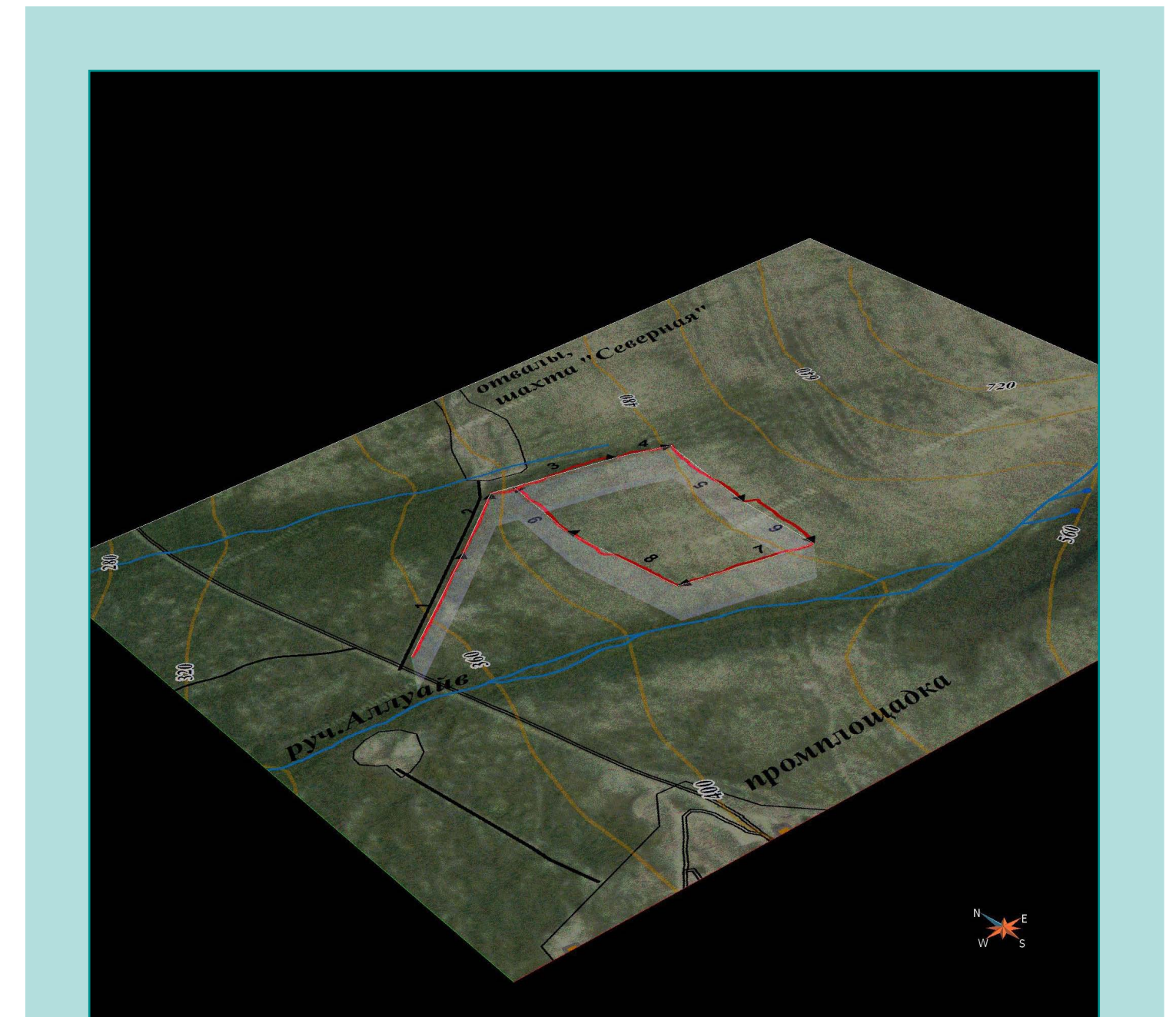


Location of the study area, Western part of Lovozero massive in North-West Russia.

In this case study, GPR was used to determine characteristics and thickness of the soil and conditions of groundwater and also to find out the possible locations of the faults and other major structures in bedrock under the thin (1-5 meters) layers of soil. Studies were carried out in the area of Umbozero mine site, which is located in the north-western part of Russia, in the western slopes of Lovozero alkaline massive. The underground mine was closed in 2004. Field studies were executed in several periods in 2012 and 2013 with Finnish, Russian and Swedish experts. Studies also included soil and water sampling for collecting new data from the closed mine site to improve the methods of the mine closure process.

GPR survey was focused on two different types of areas: the tailings pond and the wide slope area above the underground mine. At the tailings, the survey was also made along the dam to find out the original structure of the dam. The instrument used was Swedish Malå ProEx with 100MHz antenna, which proved to be accurate enough with sufficient range of depth. XY-location of the profiles was sharp, but without more specific elevation data, the vertical level was more or less relative. Results of the survey varied, depending on the measured area. On the tailings pond, layers of imported material were thick and mostly saturated with groundwater, and the texture of the material was partly very fine-grained. Thus the penetration of the GPR pulse was poor and it was not possible to reach the original level of the ground surface with this method. However, some structures and general outlook of the material can be seen from the profiles. Above the underground mine, where soil layer cover was only 1-5 meters and material mostly coarse, dry moraine, thickness and structure of soil and some structures of the bedrock surface were clearly interpretable. Interpretations from the bedrock supported the studies related to the seismic activity and faulting in the area, which earlier had caused collapses in the underground mine.

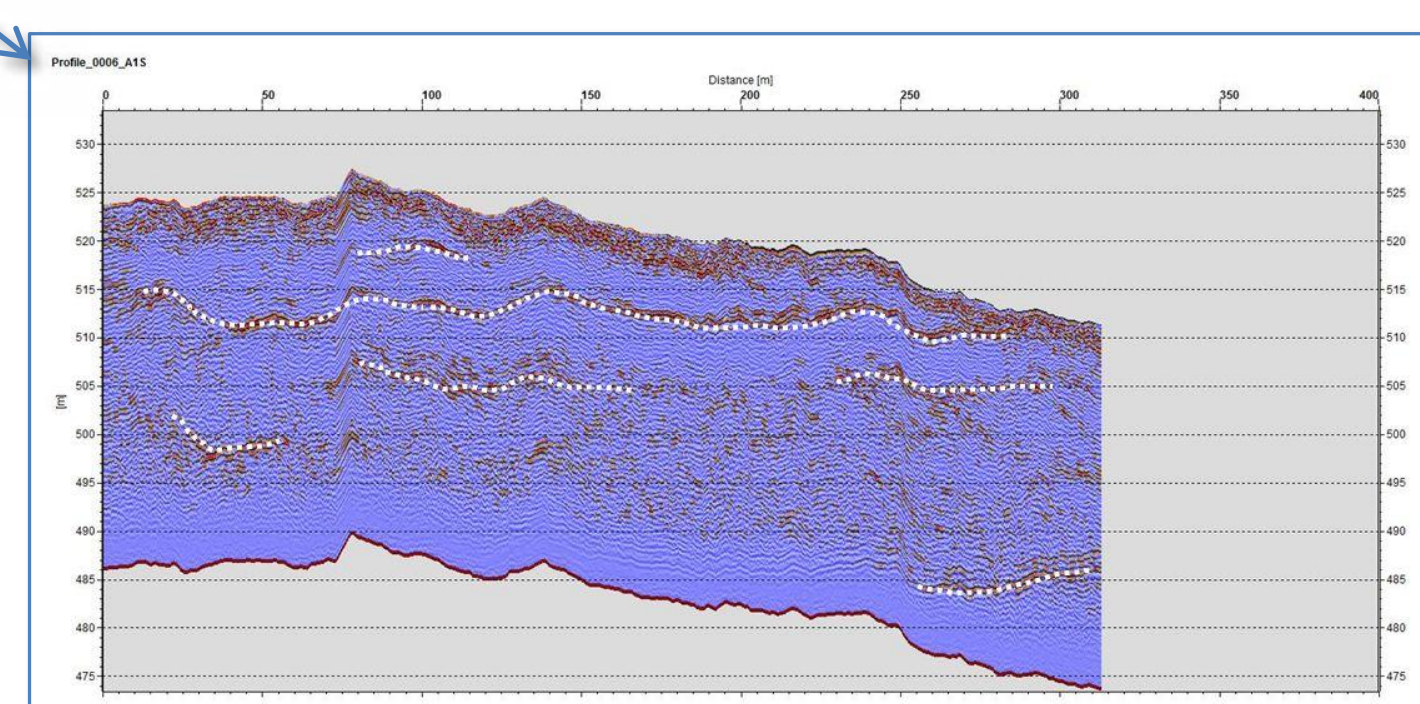
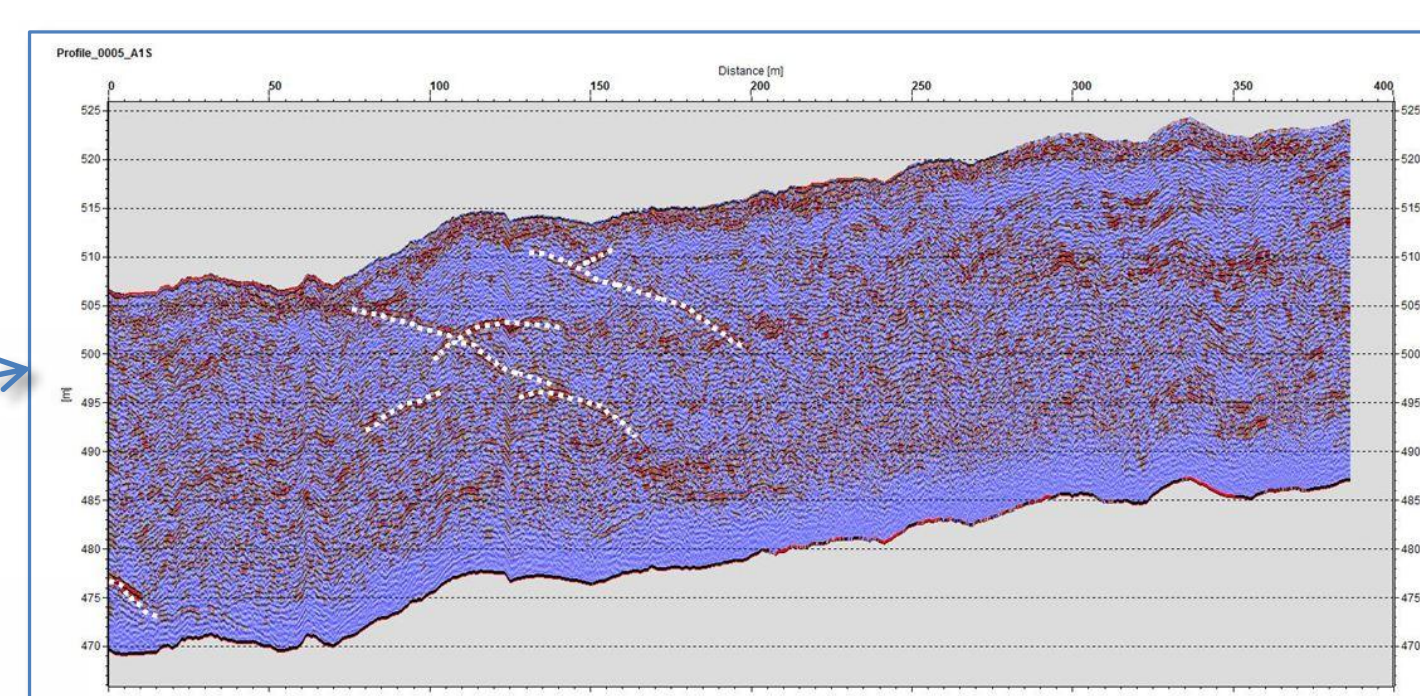
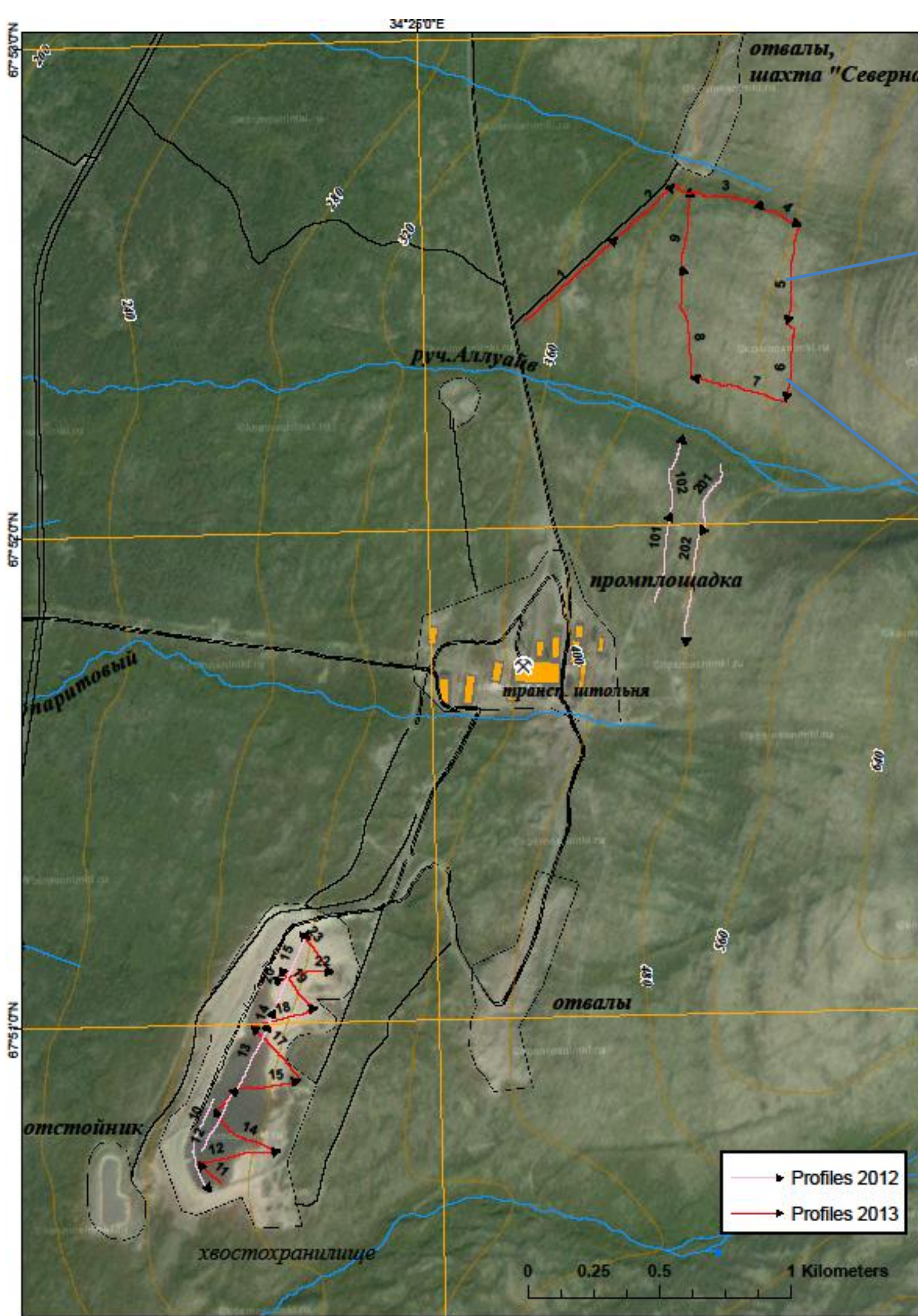
“ENVIMINE” -project was partly funded by European Union via Kolarctic ENPI CBC program and included studies in Finland, Sweden and Russia.



3D-views to the study area at the mine site.



GPR measurements at the tailings and at the mine site.



Sample GPR-profiles with some interpretations of bedrock structures.

¹ Geological Survey of Finland, Rovaniemi, Finland
e-mail: juho.kupila@gtk.fi

² Mining Institute RAS KSC, Apatity, Russia

³ Luleå University of Technology, Luleå, Sweden