TSP 203*PLUS* System
The solution for Tunnel Seismic Prediction

The TSP 203PLUS is the latest high-end technology based on many years of experience. This system solution is specifically developed for underground construction.

It evaluates seismic echo signals reflected from changes in the elastic rock characteristics normally associated with discontinuities in rock masses.

TSP 203PLUS provides accurate spatial information concerning the geology and rock mechanical properties in front of and in the vicinity of the face.

Success is in the details
- Practical system components
- Comprehensive measurement
- Expert software

Practical features of TSP 203PLUS
- Ready to measure within 30 minutes
- Prediction range from up to several hundred metres
- Can be used in both TBM and conventional headings
- Easy non-obstructing integration in the construction operation thanks to flexible application (face access not necessary)
- Spatial positioning of fault zones and potentially water-bearing features thanks to 3-component seismic sensors (P- and S-waves)
- Fully independent battery operation
- Built for the roughest site conditions

Further information about TSP 203PLUS from Amberg Technologies are available from your local distributor or by e-mail: geophysics@amberg.ch

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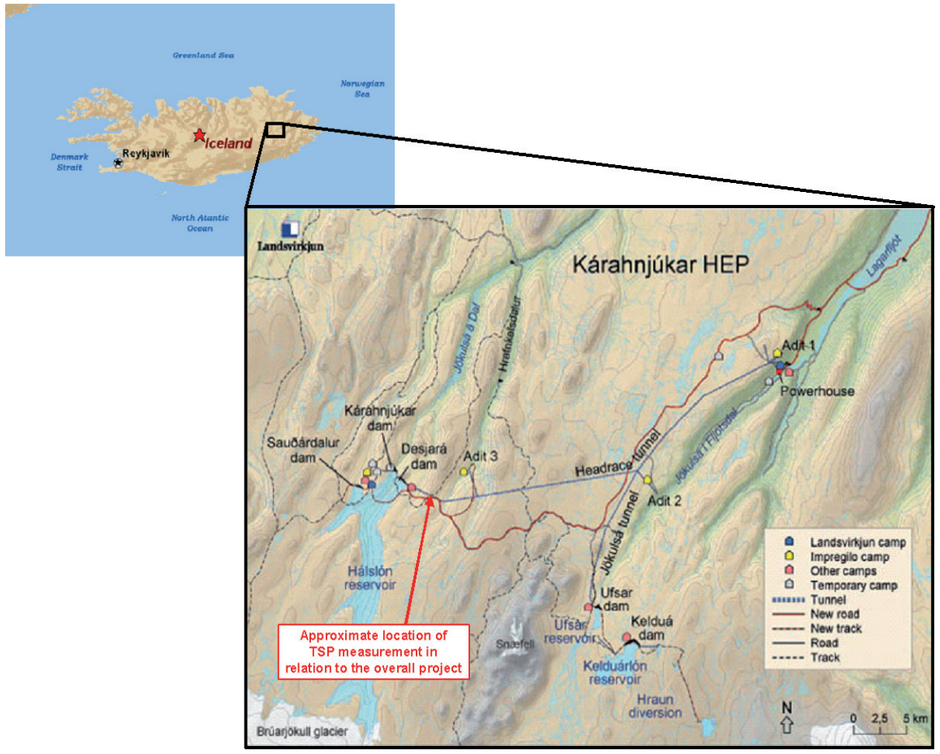
Project report TSP 203*PLUS*

Tunnel Seismic Prediction for volcanic rock

Kárahnjúkar Hydropower Project, Iceland



Location of the Kárahnjúkar project. Arrow indicates the approximate location of TSP measurement in relation to the overall project.

Project

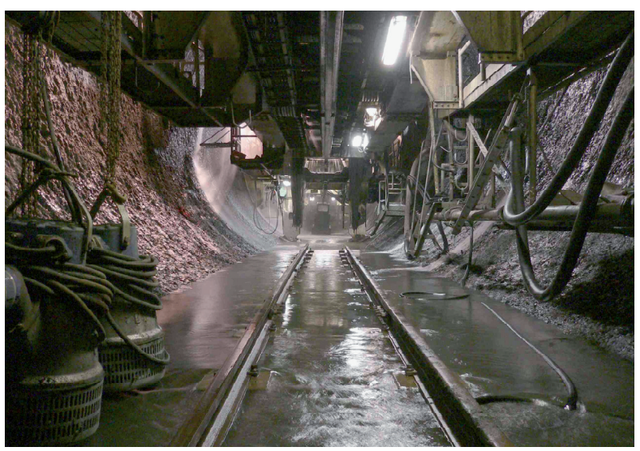
The Kárahnjúkar hydro electric power project is designed to harness the Jökulsá í Fljótsdal and Jökulsá á Dal glacial rivers, both of which originate in the north-east segment of the Vatnajökull ice cap and run through the Jökuldalur and Fljótsdalur valleys to a common estuary at the coast. Early plans would have required two separate storage reservoirs; however the project currently under construction includes both rivers linked together. This means that the proposed reservoir at Eyjabakkar could be omitted, and that a single large reservoir, Hálslón, handles the seasonal storage for both rivers.

Geology

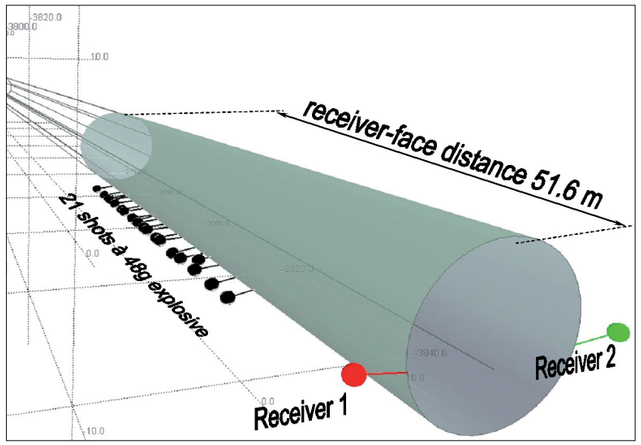
The geology over the length of the project varies considerably. The rock types and strengths range from sedimentary (UCS 10MPa), scoria and sandstones through to conglomerates and right up to basalt and andesite (UCS up to 400MPa). The geology in the location where the measurement was taken was changing from the Olivine Basalt expected up to about 3,700m to partly stratified sandstone, pumiceous with conglomerate lenses. However the distance between the surface boreholes is some 1900m allowing for the potential of considerable variation from the borehole predictions. The level of water inflow was expected to be dripping with local inflows with a moderate chance of high water inflow. This appears to be the case with considerable inflows visible in the face area.
The receiver tubes were placed in a rock mass that was a cemented conglomerate requiring only shotcrete for initial support. However it was described as an area with very porous rock and therefore high energies were not expected from the shots.

Target

The goal of the measurement was to test the application of the TSP 203PLUS system in the specific environment of the tunnels on the Kárahnjúkur project. A measurement would be taken and then the results of the predicted conditions would be compared against those actually encountered over the next 50-100m. This was especially relevant to Adit 3 because considerable water inflows were currently being experiencing from heavily fractured ground ahead of the face entailing a major pregrouting program. It is of interest to identify the extent of this zone to help plan the requirements of the grouting program.



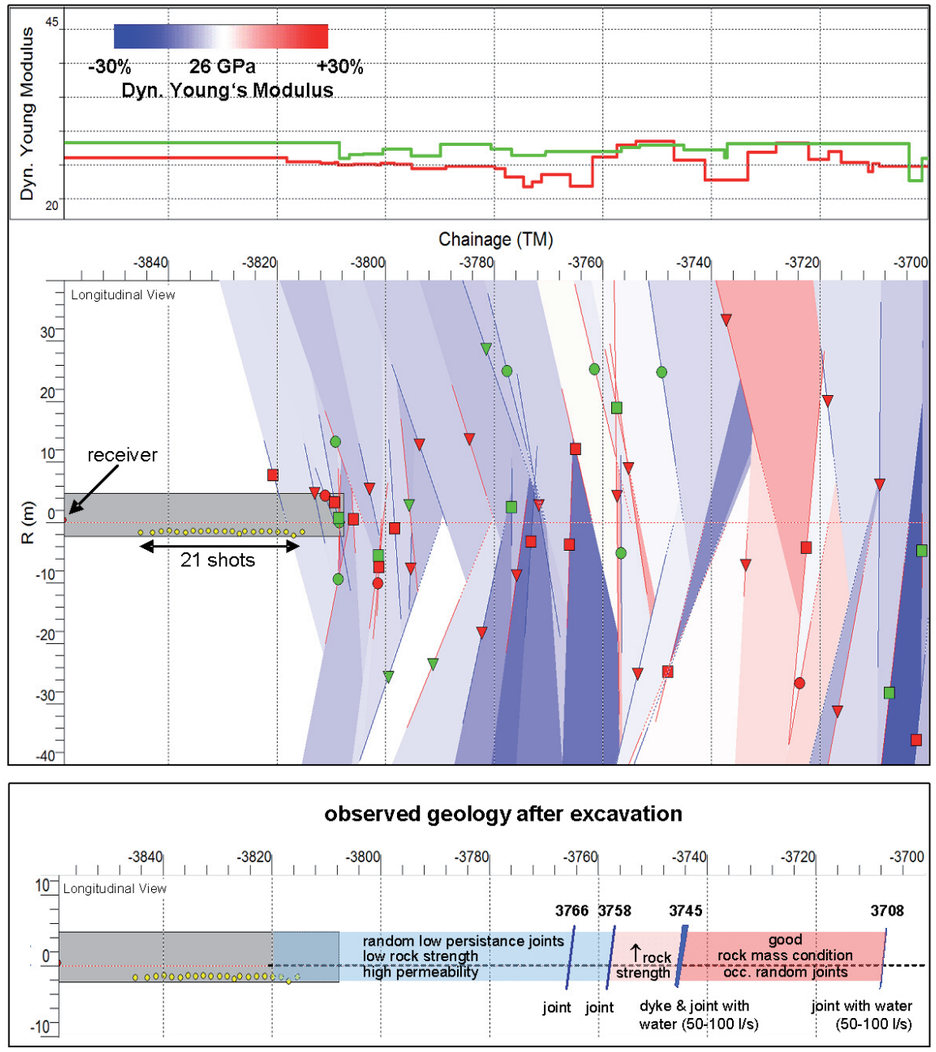
Tunnel section with location of the shot holes on the left hand side of the tunnel and the localised inflow of water.



Receiver-shot layout of the TSP survey consisting of 21 shot holes each charged with 48g explosive along the left tunnel side wall.

Results

After the stretch of prognosis had been excavated a comparison has been carried out between the TSP prediction and the observed geology. It is obvious from the geology that TSP had successfully detected the relevant features of the geology. The rock zone behind the tunnel face revealing lower rock strength with random low persistence joints and high permeability had been well seen in the TSP prognosis showing a higher number of reflection events with reduced rock strength values of the dyn. Young's Modulus. The subsequent significant joints at chainage 3766 and 3758 and the dyke with water inrush at chainage 3745 could be confirmed within an accuracy of 4-6 meters in location. The good rock mass condition with occasionally random joints had been indicated by the reddish areas of increased Young's Modulus values as well. Finally, another joint related water inrush could have been predicted at chainage 3708, about 100m ahead of the tunnel face



TSP result in longitudinal view (top) and observed geology after excavation of the predicted area.