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

Project report TSP 203*PLUS*

Tunnel Seismic Prediction in Crystalline Rock

Exploratory Tunnel Leibenfeld, Austria

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

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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

Being part of the Pan-European Corridor VI the Koralm railway project is the major rail construction project in Austria and will connect the provincial capitals Graz and Klagenfurt. Hereby the Koralmtunnel is of special interest due to its length of 32.8 km between the region of Deutschlandsberg and Lavanttal. The Koralmtunnel will be a base tunnel crossing the site of Koralpe. The project concept of preliminary investigation includes geophysical methods such as seismic measurements. Hence, the application of the TSP 203PLUS system was tested in the investigation tunnel near Leibenfeld.

Location of the Koralm Railway (solid line) with Koralmtunnel (dashed line).
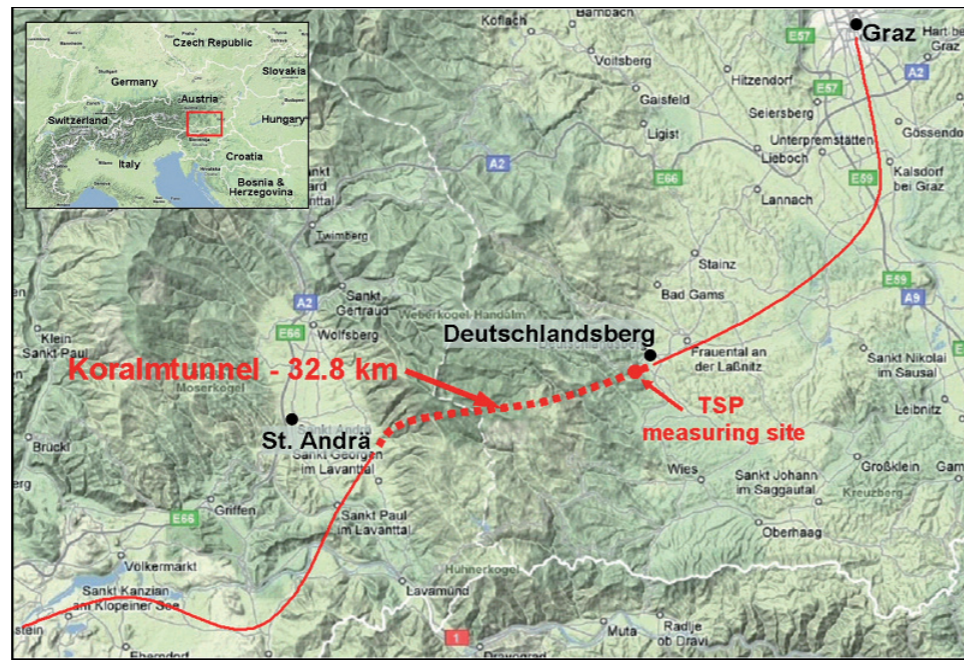
Objective

The goal of the measurement campaign using the TSP 203PLUS system was a comparison between data obtained by seismic investigation and real geological conditions which were encountered within the next 50 m to 170 m during tunnelling. This procedure allows the valuation of suitability referring to the Koralmtunnel project.

TSP results

The TSP prognosis revealed a prediction range of 170 m ahead of the tunnel face. The geology can be classified into a section of foliated gneiss including fracture zones with a remarkable amount of cataclasit and embedded silicate marble at 1'218 m to 1310 m and a section including just small fracture zones with a less amount of cataclasit and silicate marble at 1'310 m to 1'390 m. The statements of comparison between the TSP prognosis and the geological findings are being made for zones of minor rock mass quality. Furthermore, the figure on the right page shows the graphical comparison where the TSP result presents a longitudinal and plan view of detected seismic events. Between them, zones of colour shading according to the computed Young's Modulus illustrate clearly arranged characteristics of the geology.
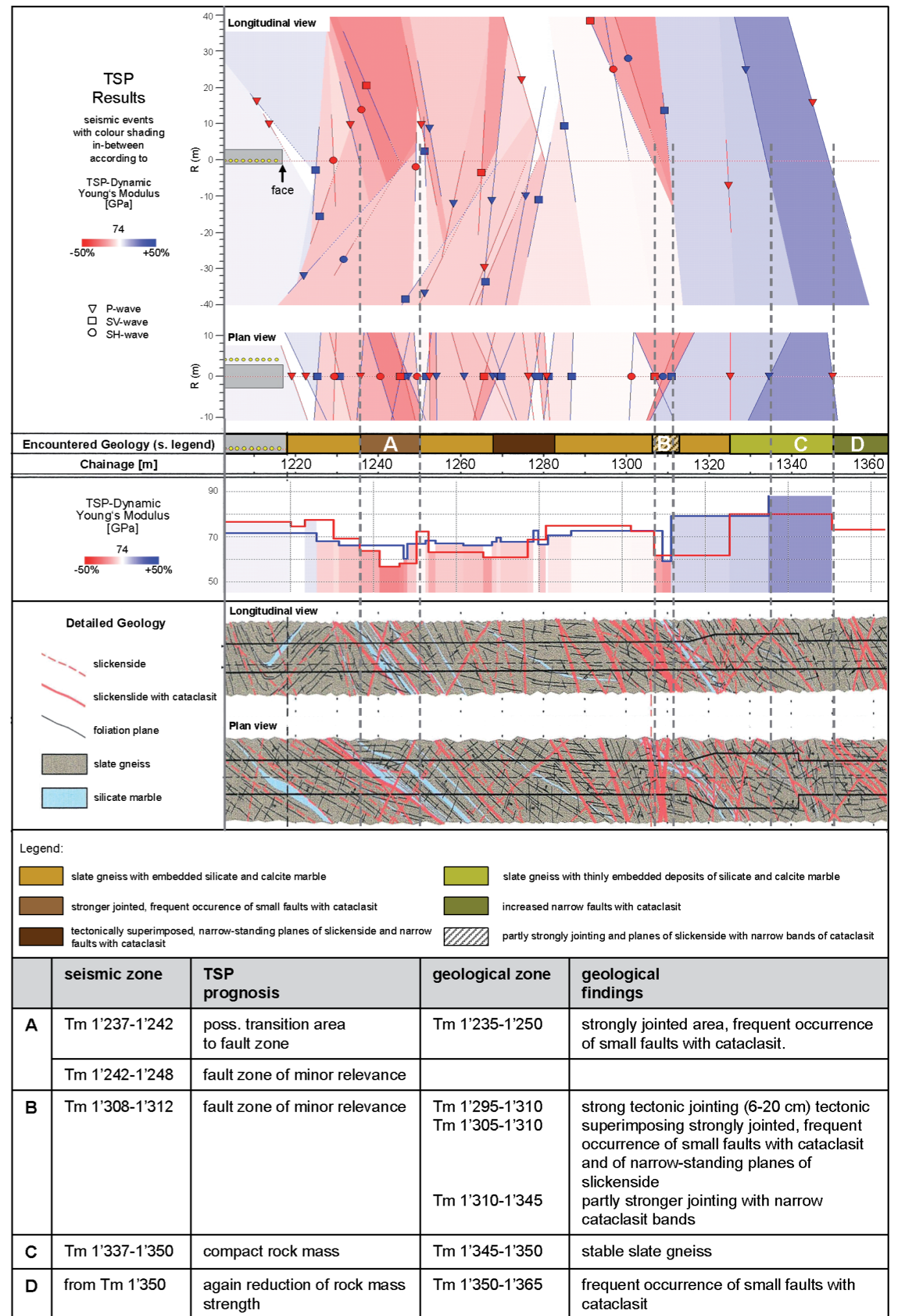
Geological findings

The encountered geological conditions between chainage 1'218 m and 1'400 m do not reveal critical sections referring to tunnelling activities. The predicted tunnel section is composed of schistose anisotropic rock mass where slate gneiss and carbonatic slate gneiss, respectively dominates. In them, there are thin embedded deposits or transitions to coarse grain gneiss (augengneiss, light resp. black mica gneiss), fine grain gneiss and mica schist. Secondary, there are marble facies as well as single thin deposits of amphibolites. The rock mass exhibits an intensive and narrow folding in ranges of metres to decametres.

Conclusion

It is found that the TSP prognosis is in good agreement with the geological findings. Both point out that there aren't any relevant faults, which are affecting the tunnelling strongly.
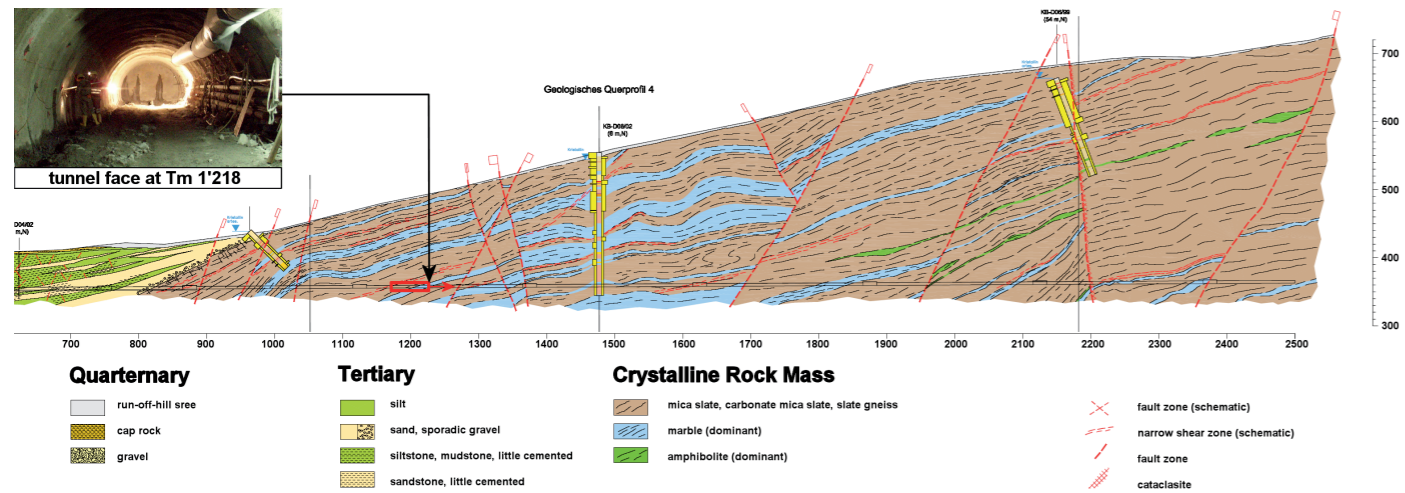
Geological prognosis of 1'700 m stretch of Koralm section. Tunnel face location at moment of TSP survey is indicated.

	seismic zone	TSP prognosis	geological zone	geological findings
A	Tm 1'237-1'242	poss. transition area to fault zone	Tm 1'235-1'250	strongly jointed area, frequent occurrence of small faults with cataclasit.
	Tm 1'242-1'248	fault zone of minor relevance		
B	Tm 1'308-1'312	fault zone of minor relevance	Tm 1'295-1'310 Tm 1'305-1'310	strong tectonic jointing (6-20 cm) tectonic superimposing strongly jointed, frequent occurrence of small faults with cataclasit and of narrow-standing planes of slickenside
			Tm 1'310-1'345	partly stronger jointing with narrow cataclasit bands
C	Tm 1'337-1'350	compact rock mass	Tm 1'345-1'350	stable slate gneiss
D	from Tm 1'350	again reduction of rock mass strength	Tm 1'350-1'365	frequent occurrence of small faults with cataclasit

TSP 203PLUS measurement results and encountered geology after excavation (top).
Comparison between TSP prognosis and geological findings (bottom)