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APPLICATION AND METHODOLOGY OF KINEMATIC DISCONTINUITY ANALYSIS ON DRILL CORES

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Summary
For the site investigation of the Koralm tunnel drill core logging procedure was improved by analysing the brittle deformation structures in drill cores. Each discontinuity encountered in drilled cores and identified by acoustic borehole televiewer was examined with respect to their nature, surface markings, mode and sense of wall displacements, fillings and primary (in-depth) aperture. The computed data led to a consistent model of prevailing normal faulting and extensional jointing accompanied by slip along foliation planes. These results are partly compatible with the present local primary stress field as detected by hydro-frac methods. Thus, the kinematic discontinuity analysis (KDA) on drill cores is well suitable for the establishment of an appropriate stress concept and the modelling of the latest deformational kinematics of the rock mass. The analysis is currently continued on drill cores from the 2002 drilling campaign.

Introduction

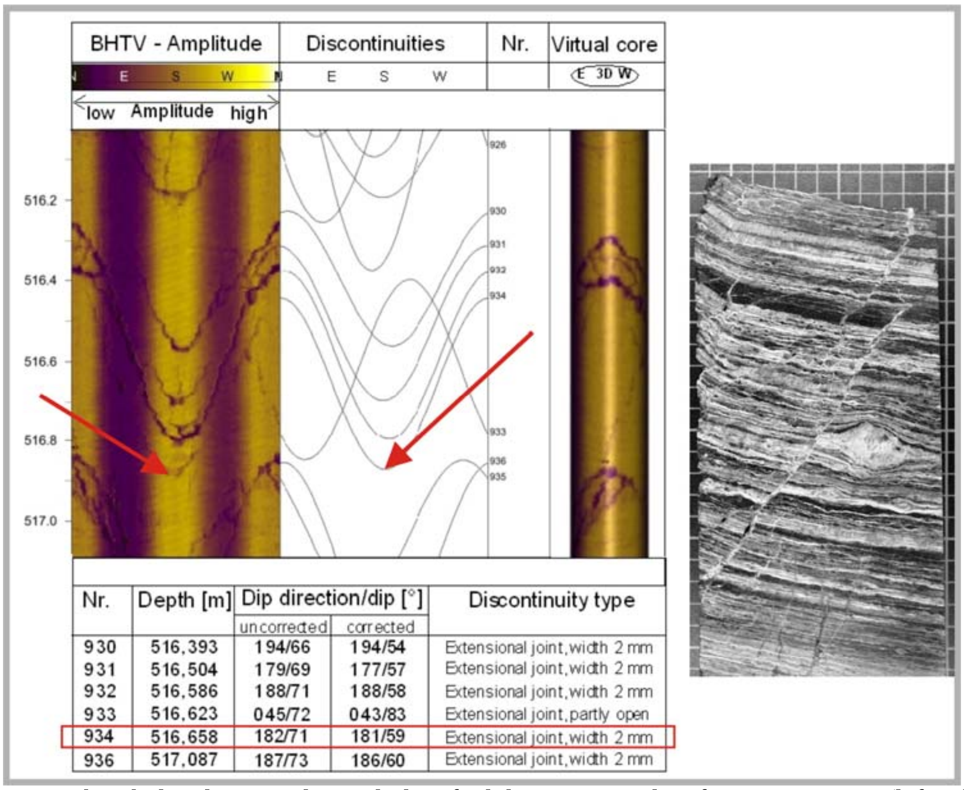
Engineering geological site investigation finds itself in between of the demands for optimisation of costs and output, respectively. With respect to geotechnical investigation drilling and core inspection in hard rocks, the international standard procedure consists mainly of the determination of lithological sequence, mineralogical peculiarities and the weathering state of the rock material, rock mass fracturing, the delimitation of faulted zones as well as several core recovery/quality index values. In many cases the pattern, geometry and surface properties of the discontinuities have been evaluated. Down-hole visualisation techniques have long been used for the on-site assessment of the rock mass quality, and even various statistical methods for the extrapolation/interpretation of the core data are available. There is, however, not much evidence that structural geology techniques have been applied systematically to geotechnical/engineering geological core description.
The objective of our work in the respective project was aimed to detect regional trends in brittle tectonics and to use the results for an interpretation of the (sub-) recently active stress regime at shallow depths (several 100´s of m). These data are considered decisive for the evaluation of directional dependence of the rock mass engineering deformational parameters, permeability, and the rock mass performance (e. g. failure mechanisms) during underground excavation altogether.
In this paper we point out the capability and potential advantages of structural investigations on discontinuities recorded by Acoustic Borehole Televiewer (BHTV), and identified consequently in the drill cores. Of particular interest was the comparison of structurally derived axes of compression/extension with the results of on-site primary stress estimations.

Methodology

- Identification of individual discontinuities with the help of optical or acoustic borehole televiewer records (Figure 1).
- Logging of identified discontinuities followed by the determination and interpretation of kinematical indicators like striations, R-, P- and T- fractures, partial healing of opened fractures and visible displacements along discontinuities (Figure 1).
- Processing of the field data including the determination of the theoretical compression and tension axes (P-T method) and probability distribution plots for the principal directions of the stress axes (Figures 2 and 3).

Discussion

The method of kinematic interpretation of natural fractures in drill cores renders comparatively high-quality tectonic data, especially in regions with a poor outcrop quality over large areas like in the project corridor of the Koralm tunnel, and this without much additional effort in the subsurface site investigation procedure. It has proved to be a promising approach for the spatial delimitation of structurally homogenous regions, the verification of geological models and the structural characterisation of the rock mass.



Nr.	Depth [m]	Dip direction/dip [°]		Discontinuity type
		uncorrected	corrected	
930	516,393	194/66	194/54	Extensional joint, width 2 mm
931	516,504	179/69	177/57	Extensional joint, width 2 mm
932	516,586	188/71	188/58	Extensional joint, width 2 mm
933	516,623	045/72	043/83	Extensional joint, partly open
934	516,658	182/71	181/59	Extensional joint, width 2 mm
936	517,087	187/73	186/60	Extensional joint, width 2 mm

Figure 1: Acoustic borehole televiewer log and identified discontinuity data from TB/D02-00 (left side) and drill core section showing multiple healed normal faults and extensional fractures (right side).

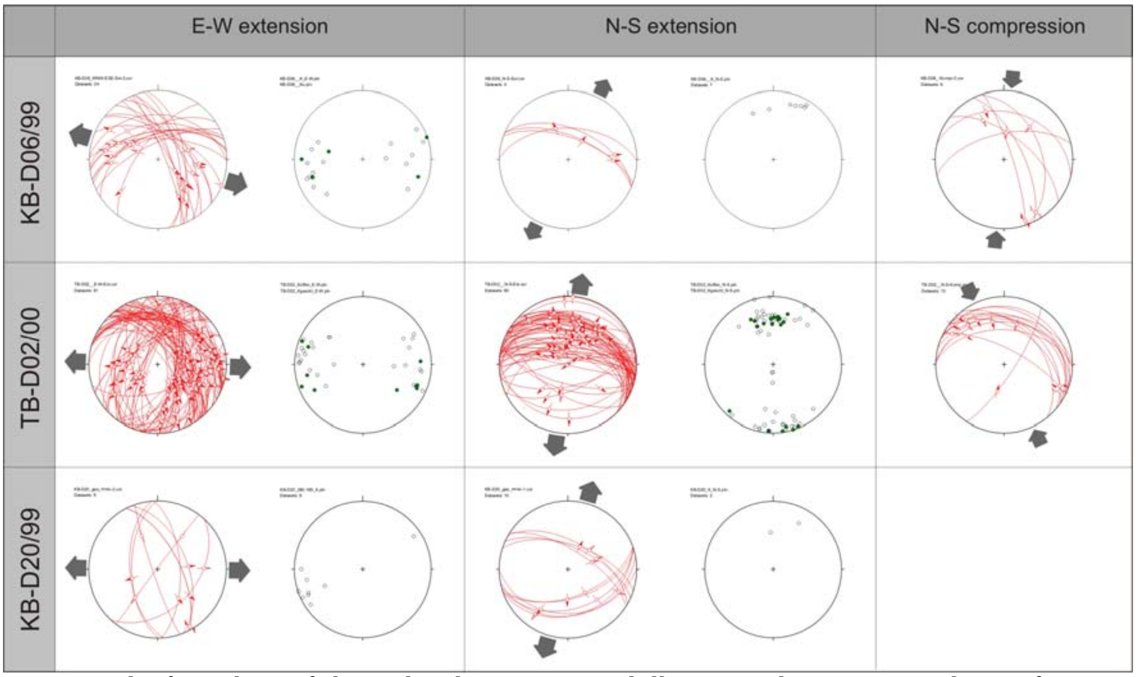


Figure 2: Results from three of the analysed investigation drill cores, indicating a prevalence of extensional tectonics. N-S directed compression is mainly observed on overprinted foliation planes.

Combined with in-hole stress measurements it can be of help for the interpretation of in-situ stress orientations. Compared to the initial assumptions based on regional tectonics the KDA results have led to a more detailed view of the actual fault kinematics. This has a direct impact on the prediction and interpretation of rock mass permeability and the discontinuity bound deformational properties of subsurface structures (hydrogeological modelling, fault properties, stress release and reorientation phenomena during excavation) and the interpretation of in-situ stress orientations. Compared to the initial assumptions based on regional tectonics the KDA results have led to a more detailed view of the actual fault kinematics. This has a direct impact on the prediction and interpretation of rock mass permeability and the discontinuity bound deformational properties of subsurface structures (hydrogeological modelling, fault properties, stress release and reorientation phenomena during excavation). The reliability of the method and potential limitations depend on the quality of core drilling and BHTV image processing, influences from the topography, and difficulties associated with an unambiguous determination and documentation of displacement directions from discontinuity surfaces
Additional structural geological investigations are currently performed on drill cores with a depth of more than 1000 m from the 2002 drilling campaign.

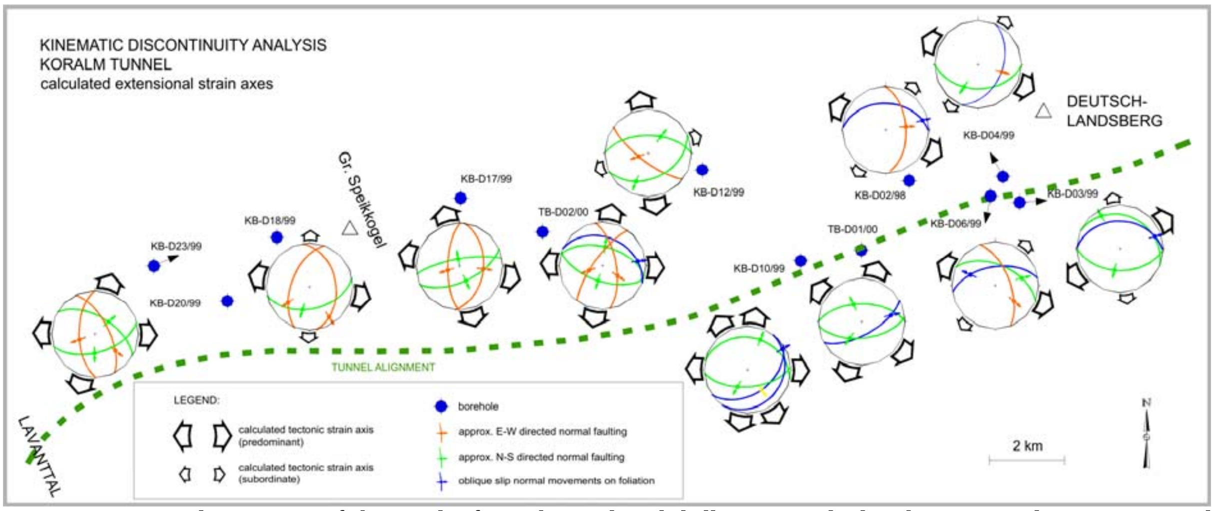


Figure 3: Regional overview of the results from the analysed drill cores: Calculated extensional strain axes and striae data representing the predominant fault plane populations.

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