ON CLASSIFICATION SYSTEMS

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Presented at the workshop on
"Reliablity of classification systems" a part of the international conference GeoEng2000, Melbourne, November 2000

What are classification systems?

According to Webster's dictionary

classify is to arrange in classes, and

classification is the act or process of classifying; it is systematic arrangement in groups or categories according to established criteria

In rock mechanics and rock engineering classification is used as a matter of describing or characterizing the ground quality with respect to certain purposes. Most classification systems are for rock support estimates, the reason being that this is the field of main importance as is mentioned by Hoek and Brown, 1980: "After all, design of underground excavations is basically the design of underground rock support systems."

Figure 1 shows the unified classification system presented by Deere Deere et al., which shows where rock mechanics and rock engineering are located in the field of geo mechanics

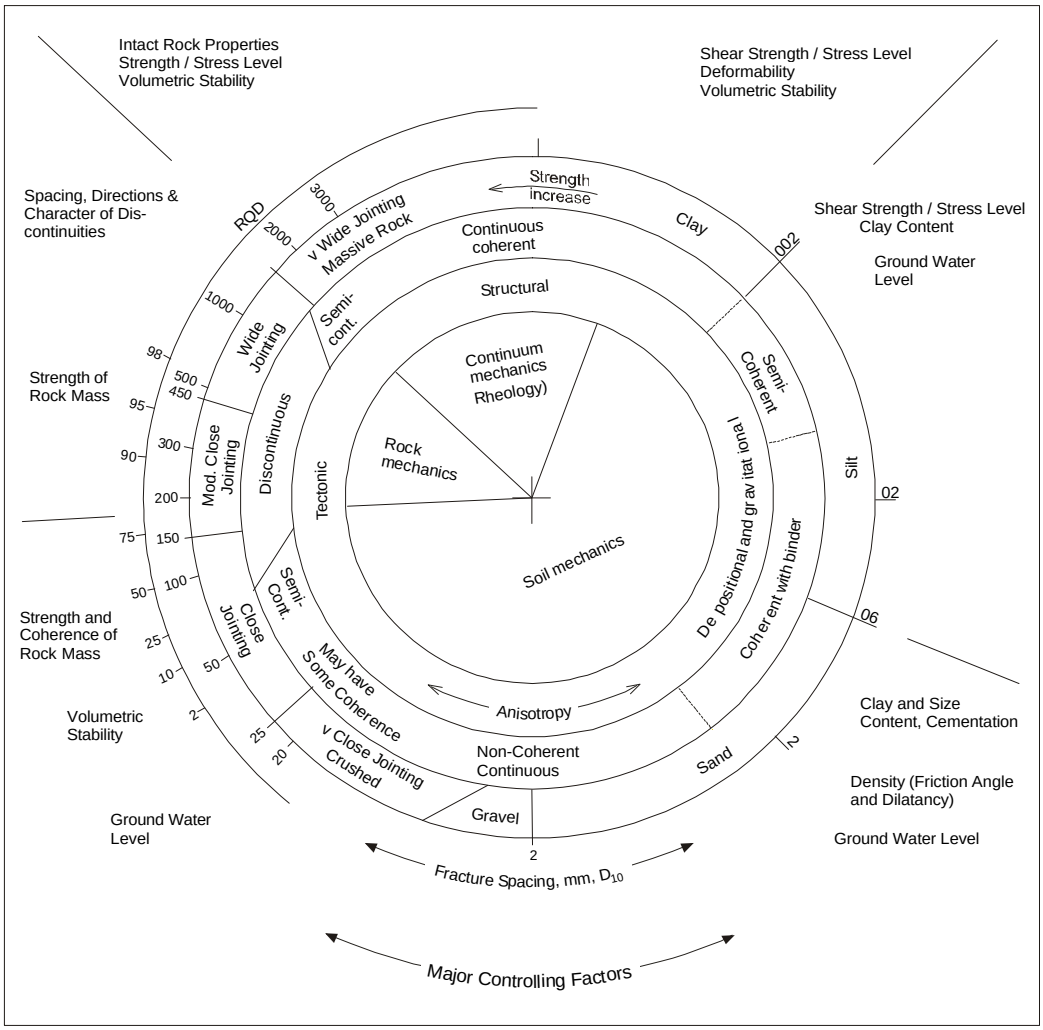

Figure 1 The unified classification chart (from Deere et al., 1969)

The main types of classification and characterization systems can be grouped into the following types:

Descriptive:	the input to the system is mainly based on descriptions
Numerical:	the input parameters are given numerical ratings according to their character
Behaviouristic:	the input and classes are based on the behaviour of the rock mass in a tunnel
General:	the system is worked out to serve as a general characterisation
Functional:	the system is structured for a special application (for example for rock support)

Table 1 shows some of the main systems for characterizing and classification of rock masses connected to constructions in rock:

What has been presented in the literature on experience with classification systems?

Brekke and Howard declared already in 1972:

"Rock masses are so variable in nature that the chance for ever finding a common set of parameters and a common set of constitutive equations valid for all rock masses is quite remote.
Simplified engineering-geological classifications, as well as sophisticated mathematical formulations have in many instances proven to be valuable tools in assessing rock mass behaviour. However, they are often both in literature as well as in engineering practice given a general validity although they may be highly inadequate both from the point of view of restrictive assumptions, and from the point of view of the variability of rock masses. Misused in this way, they may be more misleading than helpful, giving a false feeling of adequate design procedures."
"Most of them have proven to be of great value in geological engineering when carefully used, considering the conditions that they are specific to each individual site. On the other hand, most of them are continuously misused because the premises for and assumptions made in developing the classification systems have not been carefully studied by users, and because they have been given a validity for "quantification" of rock mass behaviour that is far more general than was intended by their authors."

(Excerpts from Brekke T.L. and Howard T.R.: Stability problems caused by seams and faults.
Rapid Tunneling & Excavation Conference, 1972. pp. 25-41.)

Other authors have expressed similar opinions, given in the following quotations, which are arranged chronologically:

"If the art of soil classification is far from satisfactory, the confusion is often made worse in that users are unaware of its limitations and apply it for purposes other than that originally intended".
Arthur M. Casagrande, 1948

"The success of the field investigation will depend on the geologist's ability to recognise and describe in a quantitative manner those factors, which the engineer can include in his analysis."
Douglas R. Piteau, 1970

"In view of the scarcity of reliable information on the strength of rock masses and of the very high cost of obtaining such information, it is unlikely that a comprehensive quantitative analysis of rock mass strength will ever be possible."
Evert Hoek and Edwin T. Brown, 1980

Table 1 Some of the main classification and characterization systems

Name of classification	Form and Type*)	Main applications	Reference
The Terzaghi rock load classification system	Descriptive and behaviouristic form Functional type	For design of steel support in tunnels	Terzaghi, 1946
Lauffer's stand-up time classification	Descriptive form General type	For input in tunnelling design	Lauffer, 1958
The new Austrian tunnelling method (NATM)	Descriptive and behaviouristic form Tunnelling concept	For excavation and design in incompetent (overstressed) ground	Rabcewicz, Müller and Pacher, 1958 - 64
Rock classification for rock mechanical purposes	Descriptive form General type	For input in rock mechanics	Patching and Coates, 1968
The unified classification of soils and rocks	Descriptive form General type	Based on particles and blocks for communication	Deere et al., 1969
The rock quality designation (RQD)	Numerical form General type	Based on core logging; used in other classification systems	Deere et al., 1967
The size-strength classification	Numerical form Functional type	Based on rock strength and block diameter; used mainly in mining	Franklin, 1975
The rock structure rating (RSR) classification	Numerical form Functional type	For design of (steel) support in tunnels	Wickham et al., 1972
The rock mass rating (RMR) classification	Numerical form Functional type	For use in tunnel, mine and foundation design	Bieniawski, 1973
The Q classification system	Numerical form Functional type	For design of support in underground excavations	Barton et al., 1974
The typological classification	Descriptive form General type	For use in communication	Matula and Holzer, 1978
The unified rock classification system	Descriptive form General type	For use in communication	Williamson, 1980
Basic geotechnical classification (BGD)	Descriptive form General type	For general use	ISRM, 1981
The Geological Strength Index (GSI)	Numerical form Functional type	For design of support in underground excavations	Hoek, 1994
The Rock Mass index (RMi) system	Numerical form Functional type	For general characterisation, design of support, TBM progress	Palmström, 1995

*) Definition of the following expressions:

Descriptive form: the input to the system is mainly based on descriptions

Numerical form: the input parameters are given numerical ratings according to their character

Behaviouristic form: the input is based on the behaviour of the rock mass in a tunnel

General type: the system is worked out to serve as a general characterisation

Functional type: the system is structured for a special application (for example for rock support)

"Provision of reliable input data for engineering design of structures in rock is one of the most difficult tasks facing engineering geologists and design engineers."
Z.T. Bieniawski, 1984

"We must realise that no classification system can be devised that deals with all the characteristics of all possible rock materials or rock masses."
Williamson D.A. and Kuhn C.R., 1988

"Judgement is thus the intelligent use of experience or, more cautiously expressed, it is the recognition of one's limitations of the methods one uses, and of the limitations and uncertainties of the materials one works with; and this brings us back to geology."
Herbert H. Einstein, 1991

So, back to this workshop. We are gathered here today to inform each other and discuss what our opinion is and what can be done to improve reliability of classification systems. From the experience of Doug and myself the following items have been selected:

- The inevitable uncertainties and errors in geology
- How the input parameters are collected
- How the calculations are performed to find the classification value or number
- The implementation of the classification system in our assessments
- When and how the classification is used (and misused) during planning and construction

The agenda has been chosen according to this. What we hopefully should end up with is some statements or recommendation on:

- limitations of classification systems,
- What can be done to improve their reliability?
  - how to improve collection and quality of input parameters?
  - clarify confusions of the ratings of input parameters
  - the correlations used between the classification systems?
- Recommendations when and where classification systems can be best used
- Possible further developments into improved classification system(s)