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GEOLOGY AND ENGINEERING GEOLOGY

Reflections on the occasion of the 25th anniversary of the death of Hans Cloos

GÉOLOGIE ET GÉOLOGIE DE L'INGÉNIEUR

Reflexions lors du 25ème anniversaire de la mort de Hans Cloos

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The establishment of engineering geology as an independent scientific discipline and basis of all geotechnical practice, which was only a concept and distant goal at the time of Josef STINI, the grand old man of Engineering Geology, has become a reality. So great has been the success of this new branch of science that sound practice of construction in rock and soil has become unthinkable without it. However, as it appears to me the development of this science in the recent years does not seem to head in a direction that one could feel satisfied with. Again and again we seem to divert from the right path and one could say that many of us do not even seem to know the ultimate goal. This explains why one gets such different answers to the basic question of what Engineering Geology really is.

Many engineering geologists actually engage in activities which would rather fall within the scope of soil mechanics or rock mechanics. Instead they should rather deal with the influence of geological factors on the planning, design and execution of construction works by making use of their geological knowledge and construction experience. At the same time many engineers feel obliged to deal with engineering geological problems because of the gaps in knowledge left open by the geologist.

PECK's urgent appeal made at the International Conference on Soil Mechanics in Moscow, that soil mechanics cannot be practiced without a basic knowledge of engineering geology seems to have been noticed or understood by only very few people; incidentally, similar thoughts were expressed by TERZAGHI a few decades earlier.

At the International Conference of Rock Mechanics at Belgrade I felt obliged to warn not to practice rock mechanics without rocks, that is without engineering geology, and voiced the battle cry: "Geologists to the front"!

The numerous examples of unsuccessful cooperation between engineers and geologists would fill up books. This shows that it is not sufficient to bring two experts from different fields to work together. Since they even seem to speak two different languages, so that they can hardly understand each other, progress must be limited. A jurist and a medical doctor working together on a corpse: this is not necessarily forensic medicine! Similarly, engineering geology is not identical with applied geology.

Like physical chemistry, geophysics, biochemistry, biomedical engineering etc., engineering geology is one of those typical interdisciplinary sciences which are characteristic of our more recent scientific development and seem to be an absolute necessity. An additive accumulation of facts generally marks the initial stages of the development of such interdisciplinary fields, an agglomerate whose components will be cemented together in brief time to gain strength and characteristic features of its own. The scientists in such disciplines should not only be interested in, and capable of speaking the same language to exchange their ideas; the engineering geologist should feel bound to tackle the geological aspects of engineering problems, if necessary in cooperation with a fellow specialist from the field of geosciences, e.g. tectonics, and to transmit the result – in tangible, and quantitative form, – ,to the engineer.

The establishment of engineering geology as an independent science was from the beginning associated with impulses towards quantitative interpretation of geological facts, required for engineering calculations or at least for a rational assessment of engineering problems. These data could not be supplied by geologists used to express their findings only in descriptive terms – this is the place, where the engineering geologist comes in. The geologist should also aspire to express his findings in a quantitative manner, to make geology a natural science – as understood by Kant – without loosing sight of the essence of things. Some divisions of geology, particularly tectonics should work in close contact with physics and mechanics. The situation that an ordinary geologist in many countries still does not acquire a basic knowledge of mechanics and mathematics during his education is, in fact, a big hindrance for the necessary development of engineering geology.

The great impulses of the Twenties provided by such formidable personalities as STINI, SCHMIDT, SANDER and Hans CLOOS helped to direct the development of engineering geology. STINI's constant effort towards the quantification of geological facts is expressed in the quantitative measurement of rock joints and the development of systems to classify rocks and other geological features. To distinguish between genetic and morphological description and to express all spatial characteristics quantitatively was another big step, facilitated by the "Gefügekunde" of SCHMIDT and SANDER. It was left to Hans CLOOS, however, to take the major step towards the establishment of geomechanics. He was the first to relate the forces and stresses in the earth's crust with the resulting tectonic features. It was him who coined the term "geomechanics" and who enriched it substantially through his contributions which were milestones along the road of this promising development. Measurement of the orientation of joints and faults, determination of displacements that occurred along them, and the use of other fabric characteristics enabled him to carry out an absolutely correct kinematic analysis of folds, grabens

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and other tectonic features. By thus considering the kinematics, he was able to predict the deformation processes caused by a given configuration of forces and stresses. Verification of results from theoretical considerations through model experiments was a logical step and certainly another one of his great contributions to geomechanics.

This big step forward, the brilliant idea of viewing tectonics as a dynamic process in the exact physical sense, was so far ahead of its time that it provoked many skeptics, who doubted the correctness of his observations. As is usual with new ideas, the number of scientists who could realize the importance of his way of thinking was correspondingly small. If in later years many scientists have caught up on his ideas on tectonics research, and a distinct development towards quantitative description of geological phenomena has more or less been established it is essentially to be credited to this great geologist. He was not only a great scientist, but also a gifted teacher and a great man. As an excellent artist he expressed his findings in precise and artificially attractive sketches and in an exact language – a rarity in geological publications of those times. The initial objections to the model technique and its application to geology, which were never shared by engineers and engineering geologists disappeared as the problems related to modelling had been scientifically investigated.

CLOOS himself had anticipated the great importance of a systematic and physically exact tectonics for engineering geology and constructions in rock; the discovery of the Rhinegraben boundary fault in a railway tunnel near Freiburg as predicted on the basis of above considerations has confirmed the validity of this concept. Today we all know that no calculations or design of a tunnel or a large cavity in rock can successfully be made without knowing the primary state of stress in the rock mass. The distribution of these stresses and their variation, for example along a tunnel axis, can never be determined through measurements alone; much rather through a basic understanding of the mechanisms of stress redistribution processes which are responsible for the formation of this particular part of the earth's crust.

Even today it is comparatively unknown that the stability of rock slopes, natural or excavated, can only be calculated when the primary state of stress is known and that even rock slides may be substantially influenced by the same. To emphasize the importance of engineering geology and tectonics for rock mechanics practice, the Austrian Society for Geomechanics celebrated its 25-year-jubilee by organizing a colloquium dedicated to the memory of Hans CLOOS.

The work of this great man, who has disciples in many countries and who engaged himself fervently for individual freedom and the independence of research in hard times, has been recognized all over the world (Penrose-Medal, U.S.A.; Goethe-Prize, German Democratic Republic). The responsibility of the present day scientists is not only to cherish and use his ideas, but also to improve upon them. The persons most suited for this job in my opinion are the scientists in the field of engineering geology, who have accepted the difficult task of tilling the barren interdisciplinary land.