

THE BASIC CONCEPTS OF ENVIRONMENTAL GEOLOGY AND ITS ROLE IN THE GEOENVIRONMENT MANAGEMENT

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Abstract: Environmental geology is a young interdisciplinary science which bring about, besides of new approaches to solving problems of connections between the geoenvironment and the man, new concepts and terms or enhancement of old concepts with new aspects. The most significant of them are: geoenvironment, geological factors of the environment and environmental geologic conditions. The principal role of environmental geology in the geoenvironment management is to ensure its rational use and protection.

Key words: geoenvironment, geological factors of the environment, environmental-geologic conditions, management of the geoenvironment

Introduction

The geoenvironment on the one hand affords the human community to take advantages of the mineral and groundwater resources and other favourable geologic phenomena, necessary for its existence and evolution, on the other hand it endangers the mankind by harmful geologic phenomena and brings about unfavourable conditions for the development of the society. Both types of these geofactors form together environmental geologic conditions of a territory, which bring the man benefits or problems in his evolution. Solving these matters, leading to the geoenvironment rational use and protection, is the main role of environmental geology in management of the geoenvironment.

Actual meaning of the concept the geologic environment

The term environment has been used about forty years. The first internationally accepted definition of this term, framed by Norwegian Prof. Wik, was: The environment is that part of universe, which is in interaction with the man, which the man exploits and affects and to which he adapts. Some different definitions appeared later taking into account, in contrast to this in substance natural scientific definition, as well as the socio-economic relations.

In connection with the original definition of the environment the geological environment (geoenvironment) can be defined as that part of lithosphere, which directly influences the conditions of the existence and development of the society, which the man exploits and converts (Hrašna, 2002). The basic components of the geoenvironment (geocomponents) are rocks, relief, and groundwater and geodynamic phenomena.

This meaning of the concept has been fixated only recently, in connection with the creating and using of the term and concept the environment. Until lately the term geoenvironment was used as the synonym of the lithosphere or the earth crust, i.e. in the meaning of the study object of geology, or in the meaning of a matter, i.e. as the space fill with rocks including pores and cracks fill with water. In the last meaning the term is used sometimes at present as well – to differentiate the concept of the rock environment, which does not include the free or non-adhesive water. The depth range of the geoenvironment depends on the scope of human interference with the earth crust, i.e. about 10 km at present.

Environmental-geologic conditions and the geofactors of the environment

Upon the geoenvironment can be introduced the system of various branches of geology: engineering geology, hydrogeology, economic geology, etc. Each branch defines therein geocomponents from the standpoint of its specialization. Geocomponents defined from standpoint of engineering geology, for instance, create the system of engineering-geological conditions. Relevant properties of the geocomponents in this system can be the factors of their other properties or the engineering-geological factors of some mans' activities (e.g. of construction, opening and exploitation of stone pits or sand pits, etc.). In the same way we can define hydrogeological, geophysical and others conditions and factors.

A lot of these way defined factors are of specific meaning and affect the objects and relations that merely the corresponding science is dealing with. However, some of them have effects on the quality of the environment and on land use, too. These are integrated into environmental-geologic conditions (geoenvironmental conditions), which are defined as the complex of geocomponets properties affecting the quality and/or the way of geoenvironment and landscape exploitation. These properties of the geoenvironment we call as the environmental-geologic factors or as geological factors (geofactors) of the environment.

Hence it follows, that we have specific properties of geocomponets, which can be the factors of their other properties, the geofactors of specific human activities (e.g. of construction) and the geofactors of the environment. The latter ones represent the usable properties of the geoenvironment such as available resources of mineral raw materials,

suitability for construction, etc. But, besides of geofactors that provide possibilities of the geoenvironment exploitation, which are called as geological potentials (geopotentials) of the environment, there are another geofactors, called as geological barriers (geobarriers) of the environment, which limit or in a negative way affect the land-use. To this group of geofactors belong geological hazards (geohazards), which endanger the environment or even health and life of people (ruinous earthquakes, catastrophic landslides, etc.) and geological constraints (geoconstraints), which limit the land use and/or raise the price of land-use (unsuitable foundation soils, susceptibility to landslides, etc.). The complex of all geofactors in a territory creates its environmental geologic conditions (Tab. 1).

Tab.1. Geological factors of the environment and environmental-geologic conditions of a territory

Geological potentials	Suitable condition for construction	Available resources of groundwaters	Available resources of mineral raw materials	Phenomena useful in health service, tourism and recreation	Environmental geologic condition of the territory
Geological barriers	Landslides Earth flows Avalanches	Pollution of groundwaters	Subsidence and sagging of the surface	Sheet erosion Wash out erosion	

The best way how to express environmental-geologic conditions of a territory is to compile a map. In Slovakia, there are geoenvironmental conditions usually depicted in maps of geofactors of the environment. The maps consist of several map sheets covering practically environmental aspects of all branches of geology mainly engineering geology, hydrogeology, geochemistry, economic geology, geophysics and pedology. Regarding the great amount of the maps, as well as the high degree of specialisation of some of them, a simplify comprehensive Map of significant geofactors is compiled for purposes of land-use planning and environmental protection. This map contains only some geofactors (taken over from the above maps) which in a high degree affect the land-use: significant mineral and water resources, unsuitable foundation soils, high quality fertile soils, seismic intensity, important landslides, high radon risk districts, and some others. An example of such map was published in Proceedings from 8th IAEG Congress in Vancouver (Hrašna, 1998). However this map does not contain all geofactors needful for representation of geoenvironmental conditions of a territory (contaminated soils and waters, sensitive or vulnerable rocks and soils, etc.). Thus

the question how a proper map of geoenvironmental conditions has to look like is still waiting for an answer.

The role of environmental geology in the geoenvironment management

The man in the course of his evolution employed all the time in a greater extent geopotentials, struggled against geohazards and surmounted geoconstraints taking always more ingenious measurements. But sometimes, in course of various activities, he brought about geohazards or deteriorated the geoenvironment by himself. Hence it follows that the main role of environmental geology in the geoenvironment management is the care of its rational use and protection.

The concept rational use of the geoenvironment covers generally these aspects:

1. Most useful from point of view of economic demands
2. Without harmful impacts on geoenvironment and landscape
3. Technical and economic unpretending
4. Architectonic and landscape suitable

The geoenvironmental conditions of a territory enable generally various possibilities of land use (mining of mineral raw materials, civil and industrial construction, transport construction, ground water exploitation, recreational, sanitary and sporting purposes, etc.). Decision making process in that case is aimed at the best way of land use from point of view of nation-wide or regional economic requirements. So, the first demand covers possible collisions of interests in a territory.

The second point tends care on trouble free exploitation of the geoenvironment and landscape, i.e. without unacceptable consequences such as invocation or activation of harmful geodynamic phenomena (landslides, suffosion, erosion a. o.), pollution of groundwater and rock environment, negative impact on superficial water and biota, etc.

Technical and economic unpretending exploitation of the geoenvironment requires the choice of reasonable methods of mining or constructions foundation and optimum sitting of activities in landscape. That calls for sites, which do not necessitate protection against stability failure or against pollution of the geoenvironment, alternatively only unassuming and inexpensive ones.

The last point calls for designs in harmony with nature. It means that interventions into the geoenvironment and landscape must be technically and ecologic sound and aesthetic suitable.

From listed above results that the concept rational use of the geoenvironment includes also its protection. Why than we speak separately of the geoenvironment protection? It is mainly in connection with old objects of techno-sphere, which were not built up in accordance with requirements of the geoenvironment rational use, in case of old ecologic loads, on the chance of accidents and in case of unstable territories (slope movements, erosion, subsidence, sagging a. o.). In general we distinguish the geoenvironment protection against pollution and against stability, integrity and structure failure, which bring about instability of a territory.

In the case of the protection against pollution we basically use four methods:

1. Removal of the techno-sphere objects
2. Removal of polluted rocks and/or soils
3. Technical improvement of techno-sphere objects
4. Technical measurements in the geoenvironment

Removal of techno-sphere objects is under consideration providing unassuming, not too expensive constructions or in the case of more challenging constructions with obsolete technology. Otherwise we go to technical improvement of techno-sphere objects, i.e. to improvement of technology and/or to increasing of objects sealing capacity. Another possibility is to seal up the rock environment under the construction or to apply a hydraulic shield. Removal of polluted rocks and/or soils is applied on the chance of accidents (e.g. crash of trailers or railway carriages conveying toxic materials) and after removing of techno-sphere objects, if necessary.

In case of unstable territories we use appropriate methods according to the way of the geoenvironment injury. Some of them are listed below:

1. Removal of the techno sphere objects (constructions, embankments,.....)
2. Removal of unstable parts of rocks mass (blocks of rocks, landslides,.....)
3. Measures against slopes stability failure (abutment walls, anchoring,.....)
4. Anti-erosion measurements (modification of slopes, method of farming,.....)
5. Countermeasure against sagging, suffosion, liquefaction,
6. Monitoring of unstable territories

Solution of these problems needs an extensive interdisciplinary approach. Consequently environmental geology is an interdisciplinary science, as within the system of geological sciences as in its position at the boundary of geology and other natural sciences, as well as technical and socio-economic sciences (Hrašna, 1999). It analyses all environmental aspects of the geoenvironment taking into account mainly its evaluations from point of view of

engineering geology, hydrogeology, economic geology, geochemistry and geophysics. At the same time it utilizes the knowledge of other geological sciences as physical geology, tectonics, mineralogy, petrology, etc. Knowledge of technical sciences, mainly of geotechnics it applies at proposals of rational means of the geoenvironment exploitation, at solving of problems of man's interference with geoenvironment and at proposals of the environment protection from harmful geological processes and from pollution.

Therefore an environmental geologist must work systemic, on the basis of all components of the environment and their mutual connection evaluation, and, at the same time prognostic on the basis of fore-casting of natural development as well as of possible changes of the geoenvironment due to man's intervention. Following such evaluation he can put forward proposals of the geoenvironment rational use or its protection against undesirable natural or by human activities induced geological processes. According to the nature and difficulty of the problems he solves them alone, in cooperation with other specialists (experts at the problems) or orders their solving at specialized establishment.

An environmental geologist has in geology similar position as a general practitioner in medicine. This has to know something of all problems of medicine (internal medicine, paediatrics', surgery, etc.) and must know when he is competent to deal with problem alone and when to send the patient to a specialist. There is necessary to subjoin that environmental geologists, when comparing them with physicians, should be included among the better ones, which take care of the health of the population mainly on the basis of prevention.

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