

**KARSTOLOGY, AN INTEGRATED SYSTEM
OF SCIENCES ON KARST**

**KRASOSLOVJE, INTEGRALNI SISTEM
ZNANOSTI O KRASU**

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Izvleček

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Vladimir Panoš: Krasoslovje, integralni sistem znanosti o krasu

Prispevek podaja pregled osnovnih potez in sestave današnjega krasoslovja kot modernega integralnega sistema znanosti o krasu. Ta sistem se je razvil v 70-tih in 80-tih letih 20. stoletja iz multidisciplinarnega sklopa posameznih vej različnih znanosti, ki so preučevale specifična kraška vprašanja razmeroma neodvisno. Zahvaljujoč naraščajočim potrebam izvirajočim tako iz teorije kot iz vsakdanjega življenja, je sklop postal integralni sistem znanosti, ki je sposobna kompleksno preučevati ne le ozemlja na različnih vodotopnih kamninah ampak tudi ustrezne procese in medsebojne vplive naravnega in družbenega okolja.

Ključne besede: krasoslovje, integralni multidisciplinarni sklop, členitev krasoslovja

Abstract

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Vladimir Panoš: Karstology, an integrated system of sciences on karst

The paper reviews basic traits and structure of the present-day karstology as of a modern integrated system of sciences dealing with karst. This system developed in the seventies and eighties of 20th century from a multidisciplinary set of partial branches of various sciences that studied specific karst problems rather independently. Due to growing theoretical and practical demands this set became an integrated scientific system that is able to study completely not only the regions built of variably soluble rocks but also pertaining processes and interactions between the natural and social sphere.

Key words: karstology, integrated multidisciplinary system, classification of karstology

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INTRODUCTION

The second half of 20th century is noted, especially on the field of science, by unprecedented advance of international collaboration and broad exchange of experiences, by foundation of non-governmental world organizations or commissions, by birth of new specialized branches of existing sciences and, at the same time, by formation of modern integrated interdisciplinary systems of science.

The advent of this development stage was promoted, all the world over, by enthusiastic and experienced investigators who opened fully their admirable scientific ability and initiative retarded by the gruesome 2nd World War. It was the generation of present-day seventiers that succeeded to position of pre-war generations and those of ancestor classic periods.

The same traits can be traced also on the field of Earth's sciences, where the need of solution of complex questions in individual types of landscape sphere stimulated formation of several integrated interdisciplinary scientific systems (e. g. ecology, glaciology, karstology, oceanology, vulcanology a. o.).

One of developers of modern karstology is Ivan Gams, a son of classical karstland of Slovenia, a respectable continuator of long national tradition initiated by Ivan Vajkard Valvasor, a reputable but very demure geographer and karstologist, and a co-founder of the International Speleological Union a. s. o.

The pioneer research activities of Ivan Gams contributed considerably, for example, to the origin and development of new important branches of karst studies, and to the constitution of karstology as an integrated interdisciplinary system of science. In order to commemorate the value of this unusually fruitful scientific effort as well as the seventieth birthday of that excellent man the following sections of submitted paper review basic traits and existing structure of modern karstology.

BASIC TRAITS

The present-day karstology is an independent integrated scientific system of individual branches that take up complex studies of regions underlain with rocks being variably soluble by water.

The system assumed its present-day form in the seventies and eighties of this century due to differentiation and abreast with integration of a former, rather loose multidisciplinary set of several scientific systems that were primarily rooted firmly in geology, geography, speleology and archeology at the close of 19th century. Karstology of that time objectivized venerable knowledge of human society on karst phenomena as well as prehistoric man's experiences from their practical use.

However, the bearing of modern karstology is much wider. The object of this scientific system is a karst landscape, all its abiotic, biotic and socioeconomic elements and components, but also their internal mutual interactions as well as external relations of the karst itself with adjoining landscapes of other type and with outer factors.

The tasks of this system of science involve:

- ◆ collection of data on territorial distribution of the karst landscapes, on their geological structure, on factors and processes controlling their development in a whole as well as of their individual elements and components;
- ◆ analysis and a complete synthetic evaluation of acquired partial informations;
- ◆ formulation of conclusions, integration of these in the theoretical base of the system, their utilization for elaboration of prognosis of future development as well as for rational application in the socioeconomical praxis.

Regarding specific features of the karst landscape, especially the existence of complicated subterranean zone of endokarst, the modern karstology had to create and use numerous specialized methods of investigation, adequate to particular features of the entire karst environment and of the individual objects of study. Nevertheless, the present-day karstology cannot dispense with methods of geology, geography, biology, ecology, mathematics, cybernetics, physics, chemistry, technical and other sciences, nor even with experimentation, modelling and formation of an uniform international information system.

One of important peculiarities of karstology is the fact that especially some of its branches use not only the scientifically or technically educated specialists but also numerous informed laymen joint mostly in well organized, trained, equipped and experienced teams and important national or international societies. Any research and investigation in karst cannot be realized without close collaboration of scientists with those teams. Therefore also pedagogical, educational and sport branches become integral parts of the modern karstology system.

Nowadays especially the social branches of karstology develop very quickly due to pressing demands for rational and effective application of theoretical conclusions in the socioeconomical, medical or cultural praxis, utilization of natural karst resources and effective conservation of karst nature and environment.

STRUCTURE

The structure of the system of karstological sciences reflects the basic structure of the karst landscape. That is to say, the karst landscape is also a system that consists of natural components and elements created by natural processes and thus directed by natural laws, of social components created by the activity of man and accordingly directed by social laws and, finally, of natural-technical components subjected to laws of both types mentioned. Among components and elements of all three types there exist numerous and complicated relations and interactions. Investigation, revelation and explanation of these interactions evoke development of new specialized branches of karstology. That is why the internal differentiation of the system of sciences on karst has not been yet finished up.

The peculiarity of karst landscape, i. e. the existence of two individual vertical zones (exokarst and endokarst), united in development and function, is also reflected in the structure of karstology and, moreover, in denominations of its partial branches. The disciplines that exclusively deal with the endokarst zone retain denominations derived from a traditional term "žspeleology" which was introduced by E. Martel at the end of 19th century. Though this denomination refers mainly to amateur and sport activities in karst caves some investigators tend to use it until recently in a wider sense instead of "karstology".

Neither full accord of views on the comprehension of the content of the system of karstological sciences nor the definitive limits of all its partial branches exists until now. Nevertheless its actual structure, regarding the best developed branches may be implied as follows:

1. **Group of sciences on natural complexes of karst landscape**

1. 1. **general physical karstology**

deals with general regularities of natural complex of karst landscape at the present;

1. 2. **paleokarstology**

studies general regularities of natural complex of karst landscape in the past.

2. **Group of sciences on natural components of karst landscape**

2. 1. **karst geology** deals with regularities of geological structure, its development, territorial location, geological properties of soluble rocks as well as with processes of rock formation and alteration;

2. 2. **karst sedimentology**

studies regularities of development, territorial distribution and properties of sedimentary and weathering covers on the karst surface as well as of allogeneous and autochthonous fillings of endokarst cavities; special lines are **speleomineralogy** dealing with

regularities of formation and constitution of speleothems and **speleochronology** studying relative and absolute age of cave fillings;

2. 3. **karst geophysics**

studies regularities of geophysical factors and processes in karst cavities (radioactivity, ionisation, geomagnetism, geotidal movements, seismicity, geothermal power etc.); besides of it it deals with location of endokarst systems;

2. 4. **karst geomorphology**

a science on development regularities of exokarst forms and on pertaining morphogenetic processes and interrelations; its special line -**speleogenetics** - deals with development regularities of the endokarst cavities, whereas **speleomorphology** studies the shapes;

2. 5. **karst climatology**

deals with regularities and spacial differentiation of climatological factors in karst landscape as well as *their part in modification of karst processes*; a special line is **speleoclimatology** that deals with microclimatic conditions of cave environment; it studies also dynamics of cave atmosphere and its part in modification of physical and chemical processes;

2. 6. **karst hydrology**

studies regularities controlling function of karst hydrosphere, especially of superficial water regime; problems of endokarst hydrosphere are studied by **karst hydrogeology**; a special line of both branches is **karst hydrochemistry** that deals with chemism of water, with causes of its quantitative and qualitative changes in space and time as well as with consequences of those changes concerning intensity of karst processes;

2. 7. **pedokarstology**

studies genetic processes and regularities of spatial differentiation of soil covers upon karst surface;

2. 8. **biokarstology**

a very differentiated branch studying actual development of biosphere in karst conditions; the branch has been traditionally divided into **phytokarstology** (studying floral elements of exokarst zone), **zookarstology** (studying faunal elements of exokarst zone) and **biospeleology** (dealing with higher and lower floral and faunal elements of endokarst zone); a special, well developed line of biospeleology is **hydrobiospeleology** that studies biotic elements in subterranean karst water;

2. 9. **karst paleontology**

studies development regularities of biosphere in karst landscape in the past; it deals especially with fossil biological remnants in

- weathering and sedimentary covers of karst surface and in fillings of cavities;
2. 10. **cryokarstology**
studies regularities of karst development in permafrost conditions;
 2. 11. **glaciokarstology**
studies regularities of karst development in glaciers and development of ice forms in glaciated cavities;
 2. 12. **vulcanospeleology**
studies cavities in volcanic rocks by means of speleological methods;
 2. 13. **resource karstology**
studies regularities of formation, spacial location, quantity and quality of natural resources in karst landscape as well as develops methods of their rational and ecologically acceptable exploitation.
3. **Group of sciences on socioeconomic complexes of karst landscape**
 3. 1. **general socioeconomic karstology**
studies general regularities of actual socioeconomic complexes of karst landscape;
 3. 2. **historic karstology**
deals with general regularities of socioeconomic complexes of karst landscape in the past;
 3. 3. **history of karstology**
a science on development of karstological sciences in course of development of human society and its intellectual level.
 4. **Group of sciences on socioeconomic components of karst landscape**
 4. 1. **karst archaeology**
studies general regularities of prehistoric man's development in karst landscape: an important line of this branch of science is **speleopaleontology** that studies products and conditions of production process of prehistoric man in karst, especially in caves;
 4. 2. **cultural karstology**
deals with types of cult (religious) and other cultural utilization of caverns and other karst landscape features by prehistoric, historic and recent man, his artistic, creative and literary activities motivated by anorganic, organic and human elements of karst landscape;
 4. 3. **anthropogenic speleology**
studies artificial (man-made) subterranean cavities; it falls into: **suburban speleology** (concerning in prehistoric or historic suburban, subseat objects and military saps), **mine speleology** (dealing with cavities of abandoned mines) and **housing speleology**, (concerning in cavities used by recent man for dwelling);
 4. 4. **military karstology**

- studies influences of karst landscape outlines upon strategy and tactics of war activity and upon kinds of use of exokarst and endokarst objects for military purposes;
4. 5. **operational speleology**
deals with operational, organizational, economical and conservational needs of touristic caves and of natural cavities adapted for production, warehousing, transport purposes etc.;
 4. 6. **speleophysiology**
studies behaviour of human, faunal and floral organisms in the cave environment as well as causes of ascertained states and determined changes;
 4. 7. **speleotherapy**
studies environmental elements, components and processes of natural or man-made cavities and their part in medical treatment of various diseases as well as their positive impact upon immunological system of human body; along with it this branch deals with formation and application of adequate medical methods.
5. **Group of sciences on complexes dealing with general regularities of karst landscape**
5. 1. **mathematics karstology**
deals with formation and application of methods of exact sciences (mathematics) in karstological studies;
 5. 2. **constructive karstology**
deals with planned transformation of karst landscape for purposes of rational permanent use by human society;
 5. 3. **karst landscape theory**
studies general regularities of karst landscape, its structure, dynamics, functions, outstanding properties and their spatial and temporal differentiation;
 5. 4. **environmental karstology**
falls into **karst ecology** (or eco-karstology) that studies relations and interactions among the abiotic and biotic spheres of karst landscape as well as types, intensity and consequences of human impact, and **karst landscape conservation** that deals with solution of theoretical and practical problems of effective conservation of a very delicate balance of karst system as well as with formulation, enforcement and observance of pertaining rules;
 5. 5. **thematic karst cartography**
deals with compilation of thematic maps and plans of exokarst and endokarst subjects in form of specific image models and implies progressive analytic methods of observation and surveying (incl. far distance research methods, automatic map construction etc.);
 5. 6. **karstological documentation and informatics**

- deals with development and application of modern methods of documentation, preservation and conveyance of karstological informations (karstologic data-banks) at international level;
5. 7. **pedagogic karstology**
develops and applies effective didactic methods in outside-the-school education of adult laymen who take interest in research, sport and other voluntary activities in karst landscape.
 6. **Group of sciences on regional complexes dealing with specific regularities of karst landscape**
 6. 1. **regional karstology**
studies the complex of natural and socioeconomic components and interactions of given karst landscapes in frame of individual states or administrative regions (older concept);
 6. 2. **zonal karstology**
studies the complex of natural and socioeconomic components and interactions of karst landscapes of individual natural provinces and climatic zones of the Earth (modern concept).
 7. **Group of technical sciences on karst landscape**
 7. 1. **technical speleology**
deals with technical and organizational aspects of adjustment of caves for touristic or other utilization;
 7. 2. **karst hydroeconomy**
deals with technical and organizational aspects of utilization of water resources in exokarst and endokarst zones regarding the supply of drinking or industrial water, with conservation of its quantity and quality as well as with management of pertaining natural-technical water systems;
 7. 3. **karst hydroenergetics**
deals with technical and organizational aspects of utilization of exokarst and endokarst water resources for the production of energy as well as with management of pertaining natural-technical hydroenergetic systems.

CONCLUSION

The reviewed system of sciences on karst develops rapidly. The most outstanding aspect of this process is represented by inception of new partial branches with specific methodology and with continuing integration of the entire system. Another important aspect is determined by the fact that the practical realization of karst research and investigation in the frame of all partial branches requires - due to difficult conditions in both the exokarst and endokarst zones - development and application of several subsidiary disci-

plines, techniques and crafts which do not exist in other systems of sciences. There are especially technical activities connected with the invention, construction and utilization of special research and documentative instruments and equipment, methodology of training in spelealpinism, speleodiving, speleorescue service etc. Along with it also the mining technique for the speleological research or for adaptation of caves for tourism and other kind of utilization have to be developed and applied.

Growing demands of socioeconomic utilization and along with it of effective conservation of karst landscape and its environment as well as of solid prognosis of its development necessarily contribute to profundization of karst recognition. Due to it, no wonder, karstology discovers new problems that have to be urgently studied and explained. Consequently, the evolution of the system of science on karst is not completed by far. It will be a matter of future generations.

KRASOSLOVJE, INTEGRALNI SISTEM ZNANOSTI O KRASU

Povzetek

Za drugo polovico 20. stoletja je značilen napredek v mednarodnem sodelovanju in izmenjavi izkušenj, značilno je ustanavljanje nevladnih svetovnih organizacij ali komisij, nastanek novih vej že obstojelih znanosti in nastajanje modernih integralnih interdisciplinarnih sistemov znanosti. K temu je največ pripomogla prav generacija današnjih sedemdesetletnikov. Tak razvoj je mogoče slediti tudi na področju znanosti o Zemlji, kjer je potreba po reševanju kompleksnih vprašanj v okviru posebnih tipih zemeljskega površja vzpodbujala nastanek številnih integralnih interdisciplinarnih sistemov znanosti (npr. ekologija, glaciologija, krasoslovje). K takemu razvoju krasoslovja je pripomogel tudi Ivan Gams, znan a skromen geograf in krasoslovec, soustanovitelj Mednarodne speleološke zveze in pionir krasoslovnih raziskav, ki je veliko pripomogel k uveljavljanju nove znanstvene veje - krasoslovja.

Današnje krasoslovje je samostojni integralni sistem znanosti poameznih vej, ki kompleksno preučujejo ozemlja na različno topnih kamninah. Objekt tega sistema znanosti je kraško ozemlje, vse njegove abiotske, biotske in družbenoekonomske elemente in komponente, a tudi tako njihovo medsebojno vplivanje kot tudi zunanje odnose samega krasa s sosednjimi ozemlji.

Sedanja struktura krasoslovja bi lahko bila taka:

1. **Skupina znanosti o naravnih sklopih kraškega sveta**
 - 1.1. splošno fizično krasoslovje
 - 1.2. paleokarstologija
2. **Skupina znanosti o naravnih sestavinah kraškega sveta**

- 2.1. geologija krasa
- 2.2. sedimentologija na krasu
- 2.3. geofizika krasa
- 2.4. geomorfologija krasa
- 2.5. klimatologija krasa
- 2.6. hidrologija krasa
- 2.7. pedokarstologija
- 2.8. biokarstologija
- 2.9. paleontologija krasa
- 2.10. kriokarstologija
- 2.11. glaciokarstologija
- 2.12. vulkanospeleologija
- 2.13. surovine na krasu
- 3. Skupina znanosti o družbenoekonomskih spletih kraškega sveta**
 - 3.1. splošno socioekonmsko krasoslovje
 - 3.2. zgodovinsko krasoslovje
 - 3.3. zgodovina krasoslovja
- 4. Skupina znanosti o družbenoekonemskih komponentah kraškega sveta**
 - 4.1. arheologija na krasu
 - 4.2. kulturno krasoslovje
 - 4.3. antropogena speleologija
 - 4.4. vojaško krasoslovje
 - 4.5. uporabna speleologija
 - 4.6. speleofiziologija
 - 4.7. speleoterapija
- 5. Skupina znanosti o kompleksnem preučevanju splošnih zakonitosti kraškega sveta**
 - 5.1. matematično krasoslovje
 - 5.2. konstruktivno krasoslovje
 - 5.3. teorija krasa
 - 5.4. kraško okolje
 - 5.5. tematska kartografija na krasu
 - 5.6. krasoslovna dokumentacija in informatika
 - 5.7. pedagogika na krasu
- 6. Skupina znanosti o regionalnih kompleksih kraškega sveta s specifičnimi zakonitostmi**
 - 6.1. regionalno krasoslovje
 - 6.2. zonalno krasoslovje
- 7. Skupina tehniških znanosti v krasoslovju**
 - 7.1. tehnična speleologija
 - 7.2. hidroekonomija na krasu
 - 7.3. hidroenergetika na krasu.