CHAPTER 1

General Part

INTRODUCTORY REMARKS

Public health depends in great measure on environmental conditions. The father of modern medicine, Hippocrates (460 - 377 B.C.), wrote among other things: "*Disease does not come to us from out of the clear blue sky, but rather develops from everyday small sins against nature.*" In his two - volume work "**Pathologie regionale de la France**", the well - known French pathologist R. Marot (1958) in connection with the given relationship even concluded in a pessimistic tone: "*Man will always remain liable to the action of laws of the environment surrounding him. He will never be able to free himself completely from that environment, no matter how much he would like to; and his fight against aggressive diseases, in spite of indisputable successes (improvement of living conditions, prolongation of life expectancy), will not finally dismantle the yoke in which he is held*" (p. 413). It is certain that man faces great difficulties in studying nature and seeking to establish the true causes of disease or the positive influence of natural factors on health. Medicine in its research seems to have lost sight of this fundamental task; hence, rapid development of various alternative treatment methods is somewhat understandable.

But the current level of development of biology, medicine, physics, chemistry, geography, geology, and many other sciences makes it possible to uncover not only basic regularities governing the distribution of disease on concrete territories, but also the factors that determine the level of public health. All that is needed is greater cooperation and coordination of multi - disciplinary research efforts, together with utilization of the possibilities afforded by more or less neglected sciences, above all geology, as one of the basic natural sciences. We note that Aristotle (Fourth century B.C.) and Pliny the Elder (First Century A.D.) already called attention to the geological (lithological or material) composition of a region as one of the primary factors in human life. As Aristotle taught, "*Water is of the same quality as the rocks across which it flows.*"

The efforts of doctors and geographers to study the distribution of human diseases throughout the world without deeper examination of the causes and regularities of their incidence led to the very early appearance of a special discipline of geography or medicine - **medical geography**. The very long period from Hippocrates to the end of the 19th Century can be characterized as the period of formation and development of descriptive medical geography. This discipline enjoyed especially rapid development during the 60's and 70's of the 20th Century in the United States, the former Soviet Union, France, Germany, Great Britain, and China. Elaborated at that time were many new conceptual and procedural problems based on a synthesis of the ideas and observations of an increasingly wider range of sciences. Today we have an exceptionally rich world literature in this area of science.

Based on a number of natural and social sciences, medical geography understandably has been able to synthesize primarily general information about the natural conditions of some territory or another. In order to fill the gap in the borderline area between geography and geology in treating the relationship between *living and non - living nature*, Soviet pedologist in the middle of the 20th Century formulated the principles of a new scientific discipline - **landscape geochemistry** (environmental geochemistry), which regards the Earth's surface in terms of a dynamic system with interdependence and intermingling of elements of the lithosphere, hydrosphere, and atmosphere. In the given system, closely interconnected and interdependent living organisms and inorganic materials interact with each other (Fig. 1.1). The position of the soil in the system is central, since it is predominantly in the soil that the interaction is realized. Rapid development of landscape geochemistry and its practical implementation have occurred since the outset of the 1960's. At the same time, **geochemistry** as a whole - like all the atomic sciences - has undergone intensive development, and its ideas and methods have been increasingly incorporated into other geological disciplines, as well as into medicine, biology, and astronomy. This has enriched those old and thoroughly elaborated areas of knowledge with new concepts and opened up to them new prospects for practical application that promote resolution of the increasingly complex problem of health protection. An immeasurable contribution here was made by Vernadskii, who already at the end of the 19th Century laid the foundations of the study of trace elements, constructed the basis of geochemistry and biochemistry, and created the general science of the biosphere. In this he emphasized the interconnection of all processes in the lithosphere, hydrosphere, and atmosphere with processes occurring in the living matter of human beings, animals, and plants. "*The Earth's crust,*" wrote Vernadskii among other things, "*includes several geological shells - the biosphere, the stratosphere, and the metamorphic and granitic shells. All of them were biospheres when found on the Earth's surface in the course of geological time. They are all genetically interconnected and taken as a whole represent a single phenomenon.*" Proceeding from one of his capital laws - which holds that the elementary composition of organisms is inseparably linked with chemical composition of the Earth's crust - and regarding living material as a regular function of the biosphere, Vernadskii more than once stressed that organisms must be studied in close connection with chemical properties of the Earth's crust. "*Like geochemistry, biogeochemistry can be studied in three directions:* ***first****, from the biological aspect, in connection with its significance for understanding the phenomenon of life;* ***secondly****, from the* ***geological aspect*** *(boldface mine - M.K.), in connection with its significance for understanding the environment, i.e., primarily the biosphere; and* ***thirdly****, from the applied aspect, in connection with its practical significance, which can be scientifically reduced to the biogeochemical role of mankind*" (V. I. Vernadskii, 1934). Working on these principles, Vernadskii's distinguished student A. P. Vinogradov (1938) created the study of **biogeochemical provinces**, special natural zones characterized by elevated or reduced content of certain chemical elements in soil and water. Less than a full two decades later, V. V. Koval'skii intensively developed the study of trace elements and their biological significance. "*The diversity of geological and geochemical processes leads to geographic changes in the chemical composition of soils, natural waters, and plant and animal organisms, as well as to variability in exchange of substances, the emergence of morphological variability, periodic incidence of endemic diseases, sharpening of natural selection, and formation of new taxonomic units. In this way, the geochemical environment can gain significance as an important factor in organic evolution*" (Koval'skii, 1963).

In the past four decades, more than 50 substances of organic composition but inorganic (abiotic) origin have been discovered. These substances have been found in calcareous meteorites, warm volcanic ash, and storm clouds highly charged with electricity at the moment of discharge. A new term - *abiogenic organic compounds* is now used in chemistry. In contrast to *biogenic organic compounds*, their molecules are symmetrically constructed and therefore do not react to polarized light rays.

According to A. L. Yanshin (1988), this discovery makes it possible to reduce the problem of the origin of life on Earth to the time when molecules of abiogenic organic matter (which always existed) arose. In keeping with the Curie principle, their appearance must have had an asymmetrical cause.

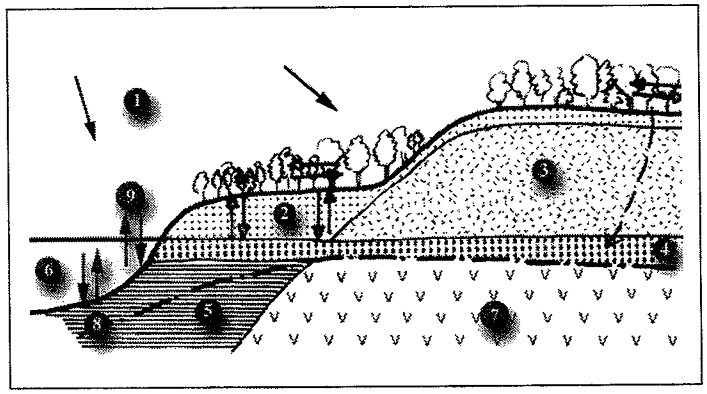

Fig. 1.1. Simplified plan of geochemical landscape. 1. lower atmosphere; 2. pedological soil; 3. weathering zone; 4. aquifer; 5. continental deposits; 6. water surface; 7. principal rocks; 8. landscape lower boundary; 9. connections within the system.

"*Comparative planetary study of the solar system supports the conclusion that asymmetry was caused by the Earth's strong magnetic field. It has been established that such a magnetic field is a specific characteristic of our planet. It is absent on the Moon, is 2,000 times weaker on Mars, and 20,000 times weaker on Venus than on Earth. But such a strong magnetic field has not always existed on Earth. It appeared in the course of a specific stage in the development of our planet, when differentiation of its original material resulted in the formation of a heavy core, and the upper shell of the Earth started to rotate around this core. According to existing data, the Earth's magnetic field was considerably stronger in archaic times than it is today. The reconstruction of molecules of abiogenic organic substances and their acquisition of asymmetric structure should probably be linked with the period when the Earth's heavy core was formed and a strong asymmetric magnetic field arose.*

Whatever the case, if we accept the influence of a strong magnetic field on reconstruction of the inorganic molecule, then the possibility exists that such phenomena can occur at the submolecular level and new ways or forms of life can arise at the present time also.

Could this be the cause of the appearance of new types of previously unknown viruses such as the AIDS virus?" (Yanshin, 1988).

In his inaugural address to the first students of the Faculty of Agriculture in Belgrade at the beginning of 1921, J. Zujovic (the father of

Serbian geology) had this to say: "*Allow me to cite in conclusion one more interesting example of dependence, an example from terrain composed of the oldest crystalline schists, of gneiss. Upon decomposing, this rock yields an inconsiderable quantity of infertile soil containing unusually small amounts of the phosphate and lime so useful for the development of organisms. Not only is farming poorly developed on such terrain, but animals are also sickly. It has been observed that snails are scarce there and their shells very thin; that hens lay very thin - shelled eggs; that the skeletons of livestock are quite weak; and finally that even the recruits are very small.*"

Given below are a few more examples illustrating the significance of certain geochemical factors for man and human health. This question will be discussed in greater detail in the corresponding chapter.

a) Already in the middle of the 19th Century, the incidence of goiter - a disease very widespread in various forms throughout the world - was linked with a deficit of iodine in the drinking water. It has also been known since ancient times that a deficiency of fluorine creates a predisposition for the development of caries. On the other hand, a fluorine surplus - especially pronounced in volcanic regions and in zones with water - bearing horizons rich in phosphorus deposits - causes endemic fluorosis of the teeth and skeleton. Natural zones of endemic fluorosis with severely diseased people and animals have been described in North and South America, India, Sri Lanka, Vietnam, and China.
b) It has been established that low rates of stomach cancer incidence and mortality are registered on the magnesium - rich chernozem of Armenia and sandy soil of Egypt (K. L. Bazikyan, 1957; V. A. Chervyakov, 1964; E. S. Feldman, 1977; N. V. Lazarev, 1966). On the other hand, Japanese authors link increased mortality from this disease with muddy peat - rich marsh soils characterized by a high level of groundwater, as well as with soil formed on alluvial material derived from broken - up volcanic rocks.
c) Acute anemia in domestic animals has been shown to be caused by deficiency of cobalt in the grass in some biogeochemical provinces and by copper deficiency in others. It is known that strontium rickets in animals and chronic molybdenum toxication are pronounced in cattle feeding on plants from molybdenum - rich soil. Endemic blindness of animals is caused by excessive soil nickel content on the arid steppes in some regions of the former Soviet Union.
d) The correlation between high nitrate content in drinking water and increased frequency of stomach cancer is especially clear in Columbia.

It is not difficult to ascertain that in practically all of the listed examples, the main cause of disease is some geological factor (rocks, soil, groundwater, mineral raw material) with its geochemical, geophysical, hydrogeological, and other characteristics (Table 1.1).

TABLE 1.1.

Influence of geological factors and socio - ecologic data on human mortality (after Mazac, ed., 1986). Mean correlation coefficients R* between geological (symbol TZ), geophysical (RN, RA), socio - ecologic (SE) factors and mortality (A to K) on various diseases or mortality index (L) calculated as the average of three independently found R - values. Coefficients R* > R* (0.05) = 0.264 (critical valid for n = 56 samples and significance level p = 0.05) proved statistically significant correlations between the analyzed parameters (where percentual impact is shown).

Symbols	Mortality on	Mean correlation coefficients R*			
		Radon RN	Tectonics TZ	Radioactivity RA	Index SE
A	Cancer generally	0.047	0.484 23.4%	0.143	0.375 14.1%
	Cancer of:				
B	bronchus and lungs	0.194	0.282 8%	0.186	0.488 23.8%
C	stomach	0.177	0.098	0.236	0.058
D	female breast	-0.170	0.057	0.054	0.090
E	rectum	0.182	0.136	0.227	0.208
F	large intestine	0.048	0.125	0.062	0.257
G	Blood circulation generally	0.010	0.159	-0.096	0.447 20.0%
H	Vessel, brain attack	-0.102	0.127	-0.065	0.078
I	Ischemic diseases	-0.008	-0.056	-0.146	0.386 14.9%
J	Heart attack	0.060	-0.017	0.072	0.235
K	Suicides	-0.140	0.158	0.046	0.063
L	Mortality index (MI)	0.064	0.297 8.8%	-0.028	0.469 22.0%

This confirms the earlier stated thesis as to the unambiguous close connection between living and nonliving nature. It can therefore be asked with justice: *Why has geology not been far better represented in study of environmental influence on man? More precisely, why has better use not been made of experienced geologists with an abundance of information and voluminous geological cartography at their disposal?* There can be no dispute as to the intensive development that geological science has undergone during the past century in the fields of regional geology, tectonics,

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geophysics, petrography, geochemistry, hydrogeology, geological engineering, research on nuclear and other mineral raw materials, etc. The very rich geological literature has been insignificantly utilized for the needs of medical geology and medicine. Despite the plethora of medical and medical - geographic atlases that have been compiled, there has been practically no comparison with diverse geological maps and atlases. We are inclined to the opinion that the advances in medical science, above all pathology, would have been even greater had there been more reliance on knowledge about numerous elements in the geological environment and direct interpretations given by geologists. In other words, *advances in the discovery and elimination of disease would have been far greater had medical geology developed parallel with medical geography.*

The first and one of the rare steps in involving geological science more significantly in multidisciplinary efforts of public health protection was taken by H. Zeiss, who introduced the term **geomedicine** in Germany already in 1931. Zeiss and his followers used this term to designate *a branch of science apart from medical geography that in studying the development of disease in space and time (geoecology, environmental ecology) focuses attention on geospheric factors causing one form or another of the studied phenomenon.* Both factors encompassed by the general geoecology of man (inhabitants of the Earth) and ones treated in the geoecology of human diseases are considered here. In terms of regional occurrence, geofactors affecting human health and disease are examined on the *micro-*, *meso-*, and *macroplans* (N. J. Jusatz, 1983). According to German authors, a leading role in realization of geomedical research must be played by multidisciplinary collaboration with specialists in the field, a view that is completely in order.

HISTORY OF MEDICAL GEOGRAPHY AND MEDICAL GEOLOGY

History of Medical Geography

The roots of medical geography reach back into the distant past. Already in Hippocrates, we find the idea that corporal and spiritual attributes of man and disease are linked with environmental factors. It is interesting that Hippocrates in considering their influence on man distinguished not only factors of physical geography (weather, climate, wind, water, soil, and relief), but also social and ecological factors, i.e., basic elements of the way of life, especially customs of the people, terrestrial laws, etc. In this sense, Hippocrates appears not only as the universally acknowledged father of the whole of modern medicine, but also as the first physician to foretell the future development of medical geography, geographical pathology, medical ecology, and even social hygiene.

Something more than 2000 years ago, the connection of certain endemic diseases with the natural environment was precisely indicated in the book "**The Spring and Autumn of Lu**". Later on, observations and discussions of this subject appeared in many ancient Chinese books on medicine and geography.

In comparison with this, the first stages in development of the medical geography derived from classical medicine (which lasted until the beginning of the 18th Century) were more comprehensive and based on increasingly modern research methods. In presenting a historical survey of the development of medical geography in individual countries, we have relied mainly on the "**Handbook of Medical Geography**" (edited by A. A. Keller, O. P. Shchepin, and A. V. Chaklin, 1993). Our aim is above all to get a picture that stresses the role of natural factors and enables us to discern the place of medical geology and possibilities for its development.

Russia. Medico - geographical studies in Russia were already being conducted in the 18th Century. We note several works from the first quarter of that century dealing with the properties of mineral waters, medicinal herbs, useful minerals, and poisonous animals. Also of interest is the program of education for army doctors, which included chemistry and balneology, anatomy and physiology, **mineralogy** (boldface mine - M.K.), and botany. During the relatively long period of its adoption (up until the 30's of the next century), army doctors made a significant contribution in the field of nosogeography, resolving questions of the distribution of diseases, primarily infective ones.

Medical geography in Russia achieved its greatest flowering in the 19th Century. A large number of studies in the domain of this discipline were published in the pages of the first Russian medical journals, and the Russian Geographic Society was formed in 1845. It can be stated that by the end of the first half of the century, medical geography had become an independent branch of medicine, elaborated both in the form of medico - geographical description of territories and in the guise of theoretical investigations. In his valuable work "**Attempt at Medical Geography of the Caucasus with Reference to Intermittent Fevers**," N.I. Toropov in 1864 wrote as follows: "*In order to be able to prevent any disease, it is necessary first of all to know from what and where it arises, i.e., to know the causes of its development in the organism and the area of its distribution on the Earth's surface. Study of the nature of the disease usually provides the answer to the first question, while the young science of medical geography gives the answer to the second.*"

The medico - geographical work of Russian physicians in the second half of the 19th Century was characterized by increased interest in study of the socio - economic conditions at concrete localities and their influence on health, sanitary conditions, and diseases. However, also of importance here were the fundamental works of Vernadskii, Dokuchaev, Sukachev, Vinogradov, and Pavlovskii, studies of decisive significance for the development of medico - geographical ideas, as has already been discussed in our introductory remarks. A great contribution to the development of this new discipline was made by A. A. Shoshin, at whose initiative was formed the Commission on Medical Geography (transformed into the Department of Medical Geography in 1963), which he headed over the course of the next two decades. Shoshin's scientific work represented a fundamental contribution to medical geography. He developed the theoretical principles of medical geography, explicated methods for medico - geographical investigation of territories and research on the geography of human disease (nosogeography), formulated the tasks and content of medical cartography, etc. The following approaches to the statement of theoretical questions and definition of the subject, tasks, and content of medical geography were fundamentally new:

a) Consideration of medical geography as an independent science on the interface between medical and geographical science;
b) Definition of the subject of medical geography as the regularities governing both negative and positive influence of natural and socio - economic factors at a given locality on human (public) health, incidence of human diseases, and their geographical distribution;
c) Postulation of a leading role for socio - economic factors in the complex of multiple influence erted by local conditions on public health; and
d) Development of several basic directions of medical geography:
   - medico - geographical estimation of natural and socio - economic factors;
   - medical management of the environment;
   - state protection of public health;
   - nosogeography; and
   - medical cartography.

Medico - geographical investigation of different regions of the Soviet Union and other countries, together with determination of the geographic distribution of diseases, represented an important aspect of work of the Commission.

The fact that the Commission dealt with an exceptionally vast territory made it necessary to organize conferences on different questions of medical geography, and the *first scientific meeting* was held in Leningrad already in November of 1962. This meeting treated pressing questions of medical geography and problems involved in using the results of medico - geographical research in the economy and public health. It also charted directions for the future development of medical geography and coordination of work in this scientific discipline. The next conferences were devoted to specific problems: *the second* conference (1965) treated *the geographical milieu and public health*; *the third* (1968) dealt with *the geography of human disease* and outlined a program for *compilation of a medico - geographical atlas*; *the fourth* conference (1973) was concerned with the establishment of a *medico - geographical cadastre*; *the fifth* (1979) was on *medico - geographical regionalization and forecasting*; and the sixth conference (1983) dealt with *procedural questions of medical geography*. Very visible results were achieved during those years in the field of medico - geographical regionalization: thus, for example, 78 medico - geographical atlases and maps were printed in 1977 alone. Significant results were also obtained in creation of a medico - geographical cadastre, which had to incorporate all reliable data about the influence of natural, economic, and sanitary conditions of a given territory on the level of public health in it and be compiled on the basis of multiple medico - geographical investigations of individual localities.

Processes of social renewal were considered at the *seventh conference of medical geographers* (1987), at which the following questions were examined:

- Theoretical and procedural questions of regional medical geography and medico - geographical management;
- Medico - geographical research in the framework of development and realization of complex regional programs;
- Regional medico - geographical atlases and maps; and
- Medico - geographical study of the World Ocean.

The next conference (held in October of 1991) was devoted to *realization and ways of increasing the effectiveness of medico - geographical research*. The main themes treated at the conference were as follows:

- The role of basic medico - geographical research in improving the ecological conditions of different regions;
- Utilization of the results of medico - geographical research in prevention of disease;
- Medico - geographical research in the domain of regional *public health* programs; and
- Ways of increasing the effectiveness of medico - geographical research and medico - ecological education of the population.

Considerable attention was devoted to *ecological aspects of medical geography* at this conference and in the years to follow.

United States. The first published works in the area of medical geography of the country appeared in the 18th Century.

We note a work published in 1776 on the relationship between *disease and weather conditions* in South Carolina (L. Chalmers) and a paper reporting the results of research on the interconnection of soil, climate, weather, and disease in that state (D. Ramsey, 1796). The year 1798 witnessed the publication of one of the first medico - geographical maps in the world, which showed the incidence of yellow fever in the vicinity of New York City. Communications in the area of medical geography continued to be published throughout the next century. As in other countries, this field at that time was most often referred to as medical topography. Up until the middle of the 20th Century, these studies were mostly of a descriptive nature and included such capital works as "**The Geography of Disease**" (E.B.A. McKinley, 1935) and the three - volume "**Global Epidemiology**" (J. S. Simmons et al., 1944 - 1954).

A turning point in the development of medical geography in the United States occurred when this science started to be viewed in terms of the *ecology of human disease*, a concept that was developed by the leading American medical geographer J. M. May (1950, 1954/55, 1958) proceeding from the premise that *groups of risk factors* - organic, inorganic, and socio - cultural - exist in the environment. Later on, the traditional direction involving study of disease ecology and interaction between the *environment* (as altered by man) and *public health* came to be increasingly supplemented by detailed consideration of what can be termed geographical health protection.

Socially oriented associative investigations represent a characteristic feature of medical geography in the United States, such investigations being useful in planning the network of medical institutions, their distribution, and financing. These investigations rely on the use of computers and methods of mathematical statistics (modeling).

Medico - geographical cartography has undergone intensive development, and its widespread automatization was initiated already in the 1960's. Automatized cartography is used to study the distribution of mortality, organize medical services, and process data on the environment (R. W. Armstrong, 1972), as well as to forecast disease incidence (G. F. Pyle, 1971) and assign doctors where needed (G. W. Shannon, G. F. A. Dever, 1974). Published in 1975 was the "***Atlas of Cancer Mortality in Districts of the USA: 1950 - 1969***" (T. J. Mason et al., 1975), which was compiled with the aid of computers.

Other characteristics of medical geography in the United States also need to be stressed. To be specific, appreciable growth occurred during the 1970's and 1980's in the fields of *epidemiological geography* (R. W. Armstrong, 1973; M. S. Meade, 1977), historical epidemiology (G. W. Shannon, R. G. Growley, 1980), and *geographical epidemiology* (J. M. Hunter, 1978; V. B. Robinson, 1978; M. L. Miller, 1979).

The first course in medical geography was introduced in 1969. During the period 1970 - 1984, 149 senior dissertations, 139 master's theses, and 51 doctoral dissertations (19 in the ecology of disease, 21 in the geography of health protection, and 11 in the geography of nutrition and hunger) were approved. American medical geographers, incidentally, have been constantly involved in work of the Commission on Medical Geography of the International Geographic Society and taken part in international symposia on problems of medical geography. The first symposium in this area was organized in North Carolina, and papers presented at it were published in an anthology entitled "***The Geography of Health and Disease.***" Published six years later were papers presented at another symposium, this one devoted to conceptual and procedural questions of medical geography.

Great Britain. The first medico - geographical investigations in the country appeared at the end of the 18th Century. Their development was primarily stimulated by the need to protect the health of British citizens scattered throughout the nation's many colonies. These studies were carried out exclusively by doctors. The first stage in the development of medical geography in Great Britain involved research on influence of the climate of tropical countries on human health (J. Lind, 1791). During the next stage, attention was focused on various diseases in England itself (J. Hennen, 1830; H. Marchall, 1832; J. Forbes, 1834). In the 19th Century, questions of the theory of medical geography began to be elaborated in the papers of English scientists, and the link between certain components of the geographic environment and the distribution of human disease was investigated. Works in this area of science were illustrated by maps of the distribution of individual diseases.

The first half of the 20th Century was characterized by further development of nosogeography and medico - geographical cartological studies, while the first decade since the end of the Second World War witnessed the appearance of works treating the connection of certain diseases with the environment, the role of specific environmental factors in mortality, and local medico - geographical phenomena. A series of papers dealt with geographical aspects of various problems such as the influence of background radiation on health (W. M. Court - Brown et al., 1960), significance of the type of water supply (E. Allen - Price, 1960), and the link between mortality and hardness of drinking water (M. D. Crawford et al., 1968). The year 1963 was marked by publication of "**The National Atlas of Mortality from Different Diseases in Great Britain**" (G. M. Howe), whose appearance for English investigators signified the end of the stage of accumulation of factual material and beginning of a new period in the development of medical geography of the country. The state of development of English medical geography in the given period is characterized fairly accurately by two books of the leading English geographer L. D. Stamp: "**Some Aspects of Medical Geography**" (1964a) and "**The Geography of Life and Death**" (1964b). Among other things, Stamp wrote as follows: "*Medical geography is still a no - man's land, a fertile soil waiting to be plowed. Whereas we have only scratched its surface in different places, future tilling will yield fruits of great significance to humanity.*"

The development of medico - social geography in Great Britain began in the middle of the 1970's (D. R. Phillips, 1971). There followed a gradual increase in the number of studies in this area employing various methods of modeling and characterized by more and more appreciable multidisciplinary collaboration among investigators. We note in conclusion the large number of works by A. Learmonth, including his capital monographs "**Disease and Hunger**" (1975), "**The Geography of Health**" (1981), and "**The Ecology of Disease**" (1988). It goes without saying that great contributions in the area of cartography were made by "**The Atlas of Cancer in Scotland**" (1975 - 1980); "**Incidence of Disease and the Epidemiological Perspective**" (J. Kemp et al., 1975); and the "**Atlas of Disease Distribution: An Analytical Approach to Epidemiological Data**" (A. D. Cliff, P. Hagett, 1988).

British geochemists of the 1980's made a significant contribution to knowledge about the geochemical characteristics of certain provinces. Their results were published in the anthology "**Environmental Geochemistry and Health**" (ed. by S. H. U. Bowie and I. Thornton, 1985).

France. Three periods can be isolated in the history of development of medical geography in France.

The first period, from the beginning of the 18th Century to the 80's of the next century, can be characterized as the time of formation of medical geography. During that period, more than 820 medico - topographical studies were carried out and a significant number of investigations were conducted that dealt with problems of pathology, acclimatization, and influence of natural conditions on human health. The term **medical geography** itself appeared in the French literature in 1817 in a paper of J. J. Virey, who gave the following definition: "*Medical geography - geografia medica - represents a description of the Earth's surface with reference to the influence of every region on the health, vital functions, and diseases of plants, animals, and (mainly) human beings inhabiting it.*" Among studies of this stage, the most attention was attracted by a capital two - volume work of J. Boudin entitled "**Manual of Medical Geography, Medical Statistics, and Endemic Diseases**" (1857).

The second period lasted from the 80's - 90's of the 19th Century to the 20's of the 20th Century. During this period, the discoveries of Pasteur and Laveran revealed the unknown causes of many mass diseases, and rapid development occurred in bacteriology, scientific epidemiology, and parasitology.

The third period is closely linked with the name of M. Sorre, one of the greatest geographers of France. Sorre marked the beginning of this period with a series of works dealing with influence of the geographic environment on the human organism. In 1928 he introduced the concept of the "*pathogenic complex*" to medical geography, treating it more fully in a special article entitled "**Pathogenic Comples and Medical Geography**" (1933). Published in 1943 was Sorre's major work "**Biological Principles of Human Geography. Section on Human Ecology**." With this work, Sorre was the first to take an ecological approach in medical geography. The indicated works represented the theoretical foundation of medical geography and cartography in France and were of great influence on its further development.

Unquestionably one of the most important medico - geographical works published in the country was the "**Regional Pathology of France**," the author of which was R. Marot (1958). On the basis of extensive data collected in collaboration with geographers, biologists, geologists, and ethnographers, the author was able to determine pathogenic comples characteristic of individual regions and create a medico - geographical regionalization of France. We note too the major work of H. Picheral "**Physical Space and Health: Medical Geography of the South of France**" (1976); and "**The Geography of Nutrition**" by R. Livet (1969).

Also of great significance for the development of medical geography in France was the symposium "**Geography and Health**," which was held in 1984 in Montpellier. Discussed at this meeting were a wide range of questions, including theoretical problems, nosogeography, regional medical geography, geography of health protection, and medical geography of cities.

Germany. The first study in medical geography was a work by F. Hoffmann on "diseases specific to certain nations and regions" (1705). Dividing diseases into endemic and epidemic, Hoffmann developed the concept of endemic diseases, basing it on the geographical conditions of localities, characteristics of nutrition, and the way of life led by the inhabitants of concrete regions. A fairly long time after this, the foundation of a new scientific discipline, **endemiology**, was laid in a fundamental work on endemic diseases by J. F. Cartheuser (1771).

Published between the years 1792 and 1795 in Leipzig was the major work of L. L. Finke "**Experiment in General Practical Medical Geography**." Medical geography in this work was treated as a new science taking as its subject study of influence erted by the geographical conditions of countries and way of life of their populations on public health, illness, prevention, and therapy. The fundamental work of A. Hirsch (1859 - 1864) "**Instructions for Historico - Geographical Pathology**" represented another major step in the history of medical geography. Practically all diseases known at the time were described in it by continents and countries.

Edited by H. Zeiss, an atlas of the distribution of endemic diseases in countries of Europe, the Mediterranean, and the Middle East was published in Germany during the period 1942 - 1945. The years from 1952 to 1961 saw publication of a three - volume atlas of the worldwide distribution of epidemic diseases. This atlas was edited by E. Rodenwaldt and H. J. Jusatz, and its publication not only represented a significant event in modern medical geography, but also gave a new impulse to medico - geographical cartography. The atlas did not simply indicate the ranges of diseases and their dynamics: it also considered various etiological, bio - geographical, physico - geographical, and ecological factors of influence on the distribution of diseases.

China. From the end of the 1960's, Chinese geographers took an active part in studying the distribution and natural settings of ailments (Keshan and Kashin - Beck diseases) caused by low environmental content of selenium (Tan Jianan, 1985). In general, the medical geographers of China have devoted considerable attention to diseases linked with *selenium and other trace elements* (in some regions of the Hubej Province, selenium content in the environment is hundreds and thousands of times higher than the usual concentration); *endemic goiter* (Yu Zhihen, 1987); and *fluoroses and caries* (Yue Songling, 1980). The major work "**Atlas of Endemic Environmentally - Linked Diseases in the People's Republic of China**" was published in 1989.

A second direction of nosogeographical research in China is concerned with *malignant neoplasms* (Wong Jaoping, 1983). Especially great attention has been focused on cancer of the esophagus and liver, as well as on the link between cancer and the environmental content of trace elements (silicon, cobalt, nickel, and selenium). The "**Atlas of Cancer Mortality in the People's Republic of China**" was published in 1981.

Investigation of infective and parasitic diseases represents a third direction of nosogeography in China, while study of cardiovascular diseases (Wu Yingkai, 1979) constitutes a separate direction.

Chinese medical geography enjoyed especially intensive development during the last decade of the millennium. A clear contribution to this was made by the Commission on Medical Geography, which was formed in 1990. The Commission organized the first symposium on problems of medical geography that same year and the second symposium the next year.

In conclusion, it must be stressed that medico - geographical research has been conducted and is being carried out not just in the countries mentioned above. Furthermore, an enormous role in development of medical geography in the world has been played by the

Commission on Medical Geography, with its international journal "**Geographia Medica**," which has been published since 1969.

History of Medical Geology

It is evident from the foregoing text that many factors of the geological environment were considered geographical and were studied predominantly by geographers and doctors throughout the three centuries of medical geography. With recognition of their indisputable contribution, several examples can be cited in support of this assertion.

1. During the period 1977 - 1983, Chinese medical geographers studied the distribution of endemic fluorosis on the territory of China and established a correlation between high fluoride content in groundwater and paleogeographic factors. In their opinion, local trace element - related medical problems are caused by arsenic, barium, and thallium. In study of the nosogeography of cancer, moreover, the correlation of this disease with trace element content in the external (geological) environment was carefully analyzed. Broadly developed in China, the given direction of research was termed *chemico - medical geography*[1].
2. Mongolian medico - geographers made a significant contribution to study of the geographical setting of endemic diseases by indicating unevenness of trace element content in soil of the country and characteristics of the distribution of rickets, hyperthyroidism, and diseases of the teeth in different regions.
3. A whole series of papers by Dutch authors have been devoted to investigation of the territorial correlation between the incidence and distribution of malignant diseases on the one hand and geochemical and geophysical factors (drinking water quality, occurrence of peaty - muddy soils) on the other.
4. A number of papers by Welsh medical geographers dealing with the influence of background radiation on health, the link between mortality and hardness of drinking water, etc., in fact had a geological slant.

That the exceptions prove the rule, i.e., that geologists were sporadically involved in multidisciplinary research, is indicated by the following examples drawn from the medico - geographical literature.

1. At the University of Trondheim in Norway, a multidisciplinary group for medical geography was formed in 1982 that included geographers, doctors, epidemiologists, geologists, and geochemists. With its Department of Environmental Chemistry, the Norwegian Board of Geology compiled a database on biologically active chemical elements in the environment of

[1] A more adequate term in our opinion would be *geochemico-medical geography*, since trace elements are for the most part constituents of rocks, soil, and groundwater.

concrete territories in the framework of the Geographical System of Information about Mortality in Norway.

2. Among the fairly few papers in the field of medical geography printed in Canada up to 1970, we note those of the geologist H. V. Warren on the geography of disease (1964, 1965) and an article by the geobotanist C. Laverdierr on the distribution of poison ivy (an agent of skin cancer) in Quebec.
3. The participation of geologists in creation of the "**Regional Pathology of France**" (Marot, 1958) has already been mentioned.
4. A wide range of specialists - geographers, doctors, geologists, biologists, cartographers, etc. - took part in the work of symposia on medical geography held in Prague in 1976, 1977, 1982, and 1985.

In addition, the term **geomedicine** has been used several times in the medico - geographical literature, but it can be seen to have a geographical connotation. For example, this was the case with the "**Geomedical Map of the World**," compiled in 1980 under the supervision of O. Kratochvil, and articles in which Y. Verhasselt (1976, 1977) employed the term **geocancerology**, meaning by it the use of territorial analysis of malignant diseases to establish their dependence on environmental factors. It is also interesting to note that at the scientific meeting known as XV Congres international d'Hydrologie, de Climatologie et de Geologie Medicales held in Belgrade in 1936, only one paper from the field of geology was presented (M.Lukovic, 1936).

From a more detailed analysis of the history of medical geography, it can be concluded that geographers and doctors in the course of long - term complex investigations have touched upon a whole range of geological factors and thereby created a good basis for accelerated development of medical geology. With the development of medical geology, what has nevertheless constituted an appreciable "omission" in world science as a whole will be corrected, since medicine will gain a much fuller and more adequate interpretation of the role played by inorganic (nonliving) nature in human disease.

An especially important proposal in this context was put forward already in 1931 by Zeiss, who considered it quite proper to develop **geomedicine** as a direction of science separate from medical geography. We have already spoken of this. Unfortunately, the given proposal did not meet with widespread acceptance.

In 1952 the Heidelberg Academy of Sciences formed the Center for Geomedical Research, staffed by 40 specialists. The Center belonged to the Department of Mathematical and Natural Sciences and for the most part carried out medico - cartographic studies. In addition to the "**Atlas of Worldwide Distribution of Epidemic Diseases**" edited by E. Rodenwaldt and H. J. Jusatz (1983), this institution published geomedical monographs devoted to Libya, Afghanistan, Ethiopia, Kuwait, Kenya, Korea, Sri Lanka, Thailand, Nigeria, Uganda, and Tanzania.

The Central Association of German Geographers in 1981 held a symposium in Mannheim that considered the geomedical consequences of environmental changes. Certain activities in the geologo - geographical field were being carried out already in Eastern Germany under the auspices of the Institute for Geography and Geoecology (I. Honsch), and in Austria at the Subdepartment of Geomedicine at the University of Graz, which was chaired by the well - known medical geographer W. Sixl.

The efforts of the German school of the 1930's had no repercussions in other countries and none at home after a certain time. Thus, the advent of a more integral elaboration of the principles of theory, subject matter, and procedure of medical geography had to wait until the last two decades of the 20th Century and beginning of the new millennium.

To be specific, two decades ago the Norwegian J. Lag promoted the term **geomedicine** in works published in 1980 and 1983. Broad international activity in this field was initiated some time later. Thus, a new international working group in the geosciences has been established to meet the needs of ecological planning (COGEOENVIRONMENT) and is now using a scientific approach to study the influence of external factors on the geographical incidence of health problems in man and animals. This approach consists of a multidisciplinary effort taking into account the results of different sciences, above all the geosciences and medicine.

Medical Geography and Medical Geology in Yugoslavia

The need to create and develop **medical geography** in Serbia was first discussed only in 1998 at a special meeting of the Serbian Geographic Society when a paper on the subject was presented by Z. Jovicic. However, this goal has not yet been fully realized. Worthy of mention here are the individual contributions of A. Radic ("**Principles of Medical Geography**," 1969), Z. Jovicic ("**Principles of Medical Geography in Serbia: a Theoretical - Procedural Concept**," 1998), and Z. Djordjevic ("**Medical Geography of Malignant Tumors of the Urinary Bladder in Serbia**," Master's Dissertation, 1980).

The justification for work in the area of **medical geology** was already noted by the great Serbian scientist J. Pancic, a popularly renowned physician, botanist with an international reputation, and author of the first book on geology in our country. Exceptionally knowledgeable in all three of the sciences mentioned, Pancic already in the middle of the 19th Century appealed in writing to local doctors calling on them to pay attention to "*mineral things" in the ground.* In the Introduction to his book "**Mineralogy and Geology According to Naumann and Beudant**" (published in 1867), Pancic wrote as follows: "*.....for what can be more impor-*

tant to man than to learn about everything concerning his existence and existence of the land on which he lives." Similar reflections of J. Zujovic have already been mentioned.

In spite of this, there has been no broader organizational work on formation and development of medical geology in Yugoslavia (or the rest of the world for that matter) up to the present day. The given gap in the system of science is partially filled by numerous contributions of geologists and doctors who have studied individual problems, some of which will be stressed here. Of undoubted particular significance have been symposia organized by the Serbian Academy of Sciences on *endemic nephropathy* (1970, 1977, 1995), *the role of selenium in health* (1993, 1995), and that of *magnesium* (1998, 1999). Pioneer steps in collaboration of geologists and doctors in our country were taken by Z. Maksimovic with papers on the close linkage of geochemical factors and endemic nephritis in Serbia. Maksimovic later led multidisciplinary meetings on selenium and magnesium, and published a number of well received works in the area of geochemistry and related problems of human health. Geochemical research on selenium content in geological formations and waters of our country was carried out for several years by A. Dangic (1993, 1995), and possible hydrogeological causes of endemic nephritis were investigated by J. Peric (1970, 1976/79, 1980, 1982). Important data on trace elements in our geological formations and soil are to be found in the papers of V. Jovic (1990, 1995, 1998, and 1999).

The origin, chemical composition, and balneological properties of mineral and thermomineral waters in Serbia have been investigated for more than a century (S. Daben, 1837; E. P. Lindenmajer, 1856; M. Leko et al., 1922; L. Nenadovic, 1936; V. Vujanovic & M. Teofilovic, 1983; D. Protic, 1995). It should be noted that geologists, chemists, and doctors have collaborated successfully in this. Investigating the content of trace elements in our mineral and thermal waters, Vujanovic and Teofilovic gave logical interpretations as to the genesis of these waters. Their results were published in a number of papers and synthesized in the book "**Spa and Mineral Waters of Serbia**" (1983). A complete review of geological, hydrogeological, geochemical, balneological, and other data on all our more important waters is given in the work of D. Protic "**Mineral and Thermal Waters of Serbia**" (1995). The distribution of the group of alkaline elements, calcium, magnesium, and fluorine in mineral waters of Serbia and their significance for human health were treated by M. Teofilovic (1999).

During the period after the Second World War, Serbia was one of the territories in the world where nuclear raw materials were intensively investigated, and the literature here is very rich. Significant knowledge has been gained in this way about the background state of radioactivity of our geological formations, and it is possible to speak fairly confidently of potential geological risks to public health.

The monograph of M. Babovic "**Geology and Environment Protection**" (1992) was the first book in our country to treat environment protection integrally from the standpoint of geology. Singling out useful components of the geological environment, the author elucidated the role of man in their genesis and exploitation, defined and classified geological wealth from the viewpoint of application, and isolated the most significant geological terms in an attempt to create a well - rounded eco - geological approach to environment protection. This work can accordingly be of greater or lesser usefulness in examination of separate questions in the domain of medical geology.

We note in conclusion that the author of the present book has spoken on *human health in relation to the geological environment* at many meetings of geologists, doctors, and agronomists held in Yugoslavia and abroad. He has in addition published a number of works on the subject (M. Komatina, 1993, 1997, 1998, 2000). Among others were the following: "**Geological Basis for Ensuring Healthy Production and Living Conditions**" (with B. Bozovic and M. Navala, 1997); "**The Geological Environment and Production of Healthy Food**" (1998); "**Principles of Medical Geology**" (1999); and "**Influence of Geological Factors on Human Health**" (2000).

METHODOLOGY OF MEDICO - GEOGRAPHICAL RESEARCH

Modern medical geography is the result of long - term development in the course of which theoretical principles, general questions of procedure, and concrete methods have been elaborated to resolve various practical problems. Having taken a complex path since its formation on the basis of several sciences, medical geography has today preserved certain features of a borderline discipline (science) whose *main purpose is to contribute to society by optimizing* (in the sense of sanitizing) *the human environment so as to achieve the highest level of public health.* Our survey of the methodology of medico - geographical research follows the treatment of Keller, Shchepin, and Chaklin in their book "**Handbook of Medical Geography**" (1993). There are two important reasons for concerning ourselves with the history and methodology of medico - geographical research: *first,* to be able to draw on previous experience for the needs of medical geology; and *second,* to single out interesting results obtained in studying the influence of natural (geological) factors of the environment on human health. In the further text, interaction of medical, biological, geographical, and sociological disciplines in resolving problems of medical geography will be discussed.

Biological and medical disciplines are treated as the subsystem of **geographic medicine** within the general system of contemporary medical geography. This subsystem consists of the following four disciplines:

1. **Human biology**, uniting disciplines whose subject of study is man as a biological species (normal anatomy, normal physiology, biochemistry, immunology, genetics, anthropology, developmental physiology, gerontology, etc.).
2. **Pathogens and sanogens**, with disciplines and specialties affording material for conclusions about biotic and abiotic elements of the environment. These elements play the part of disease agents (pathogens) or represent stimulants or stabilizers of health (sanogens). Included in this block are microbiology, virology, parasitology, vitaminology, biogeochemistry of macro- and microelements, radiology, bioclimatology, balneology, toxicology, etc.
3. **Adaptation and nonadaptation**, encompassing disciplines and specialties that provide medical geography with material for conclusions about the results of interaction of the human population with its environment. They include the science of adaptation, general pathology, pathological anatomy, epidemiology, infective pathology, and other clinical disciplines (ophthalmology, endocrinology, oncology, therapy, etc.).
4. **Disease prevention**, including disciplines concerned with prophylaxis, namely nutritional hygiene, dietology, industrial and communal hygiene, children's hygiene, etc. Of significance for medico - geographical research are data of these disciplines that have a bearing on the nature and extent of anthropogenic pollution of the environment, permissible limits of such pollution, measures for protection and optimization of the environment, etc.

Each of the listed disciplines and specialties has its own system of knowledge and scientific valorization dealing with questions of fundamental significance for it.

At the same time, some of the factual data obtained by each of these sciences are used by medical geography for spatial analysis to discover the nature of territorial distribution (dissemination) of disease agents, trace elements, adaptation indicators, etc. These data constitute the geographic aspect of each of the disciplines (geographic physiology, geographic pathology, etc.), which as a whole can be termed **geographic medicine**.

Use of concrete factual data from the arsenal of the given medico - biological disciplines demands preliminary detailed logical analysis, selection, and generalization of information based on the results of territorial study and cartography. In practical terms, this means that all of the selected facts must have a precise territorial link before they can be plotted on a *factographic map* depicting the whole range of available data on the studied phenomenon. The factographic map thus represents an important basic document.

While employing the factual data it needs from the domain of the medico - biological sciences, medical geography also utilizes conceptual positions of these disciplines. This primarily refers to the results of experimental, field, clinical, and other observations that can be used to develop criteria for anthropo - ecological evaluation of the environment and its influence on the human population. Such material includes, for example, data on the lifetimes and reproduction mechanisms of disease agents in various types of environments, information about the optimal and extreme concentrations of biologically active trace elements in food products and water, etc.

The concept of evaluation is also central to the second subsystem of scientific directions in the framework of the general system of medical geography. The structure of this subsystem includes *geographic, economic, and sociological disciplines and specialties,* and is likewise composed of four provisionally independent groups of disciplines:

1. **Environmental subdivisions**, as established by landscape science and physico - geographical regionalization. Both disciplines are complex and concerned with study of the genesis of geosystems, their contemporary structure and dynamics, and the existence of natural territorial comples of different ranks (natural zones, countries, provinces, landscapes, etc.). Data on differentiation of the Earth's surface into geosystems, their structure and types, and involvement of zonal and azonal factors in their formation are essential for medico - geographical investigations, including research of significance for anthropo - ecological evaluation of quality of the human environment.
2. **Environmental components**, as indicated by specialized disciplines providing information about inorganic and organic components of the Earth's shell (the lithological base, soil cover, floor rocks, climate, and waters), as well as data on migration of chemical elements, characteristics of vegetation, and the animal kingdom of different landscapes. The list of such disciplines includes geomorphology, pedology, climatology, hydrology and hydrogeology, landscape geochemistry, and biogeography. The data of these disciplines are needed for a thorough characterization of geosystems, discovery of correlations within them, and evaluation of positive or negative anthropo - ecological significance on the basis of criteria developed in the framework of the geographical aspect of medical and biological sciences (**geographic medicine**).
3. **Technogenesis and the environment**, as reflected by the data of disciplines treating anthropogenic transformation and economic exploitation of the natural environment. Economic geography and directions of physical geography dealing with construction projects are such disciplines.

Medical geography uses the data of these disciplines to establish conditions that promote the development of natural and technogenic diseases. This information is needed in order to devise measures for optimization of the human environment.

4. **Demography and social organization**, as deduced from the data of population geography, sociology, demography, health protection, and geography of services and culture.

Thus, the disciplines and scientific directions of the second subsystem—the subsystem of **medical geography**—serve medical geography as a source of knowledge about the natural environment, economy, and population of a studied territory. This knowledge is drawn from general scientific (fundamental) information on the basis of anthropo - ecological evaluation of natural and socio - economic phenomena and processes. On the whole, it forms the applied aspect of these disciplines, which cannot be called medical geography in the strict sense, since the examined second subsystem also includes demography, sociology, and health protection.

The methodology of research on the level of systems of medical geography as a whole is based on linked cartographic analysis of all data provided by the examined two subsystems of science in the form of cartographic depictions (factographic maps) of medico - biological content on the one hand and specialized maps of sociological - cartographic content on the other. It is noticeable that linked cartographic analysis and synthesis of data on negative influences of the environment on public health contributes to the resolution of questions of *nosogeography* or the *geography of disease*, which is one of the basic preoccupations of modern medical geography.

Together with data on negative influence, medical geography draws information about positive influence of the environment on public health from the arsenal of both scientific subsystems. Here we have in mind data on so - called *sanogens*, environmental factors that play the part of preconditions which strengthen or stabilize health (physiologically favorable climatic structure, the helio- and hydroresources of a territory, optimal content of trace elements in the environment, presence of vitamins and minerals in meat products, diet structure optimal from both the physiological and hygienic points of view, public water supply in keeping with hygienic norms and requirements, etc.). Sanogeographical research is an integral part of medical geography, and *sanogeography* or *geography of health*—together with *nosogeography* or *geography of diseases*—is considered one of the cornerstones of medical geography as a whole.

According to Keller, Shchepin, and Chaklin (1993), the strength and virtue of modern medical geography lies in its systematic approach to phenomena and processes. To quote from their writings: "*Modern medical* *geography does not lose itself in a sea of facts and petty details, but instead generalizes on broad geographical basis information about a territory obtained both from medical geographers themselves and from specialists in other areas of knowledge. This systemic complex approach was inherited by medical geography from the geographical sciences, where it was formed by the method of trial and error over the several centuries of existence of geography. Modern medical geography in this differs fundamentally from the narrow profiles of directions in a number of biological and medical sciences."*

Two opposed tendencies have caused growing interest in problems of the environment, the territorial - ecological aspect of public health, geographical distribution of human disease, and its pathological and prepathological state. On the one hand, disciplines concerned with the system composed of the environment, man, and health are undergoing a process of sharp integration. On the other hand, their differentiation is just as pronounced. Integration of sciences is dictated by the desire of scientists to obtain a complete picture of the most complex processes and phenomena, whereas differentiation is linked with complication of research methods, colossal increase in the volume of information, etc.

We have thus arrived at the starting point for examination of the relationship between geography and geology that is between medical geography and medical geology.

GEOGRAPHY AND MEDICAL GEOGRAPHY IN RELATION TO GEOLOGY

It is known that *geography* was for a long time the only science dealing with nature, the economy, and population of the Earth. In the course of its historical development, geographical science was transformed from a single unified science whose task was to describe physical space into a branching system of sciences with concrete technical and economic content. The differentiation first of all affected *physical geography* and was stimulated by research on various categories of natural resources (land, water, biological, and other), as well as by the development of landscape science. On the other hand, accelerated development of the economy was accompanied by formation of a number of disciplines in the area of *economic geography*. All of these separate geographical disciplines were closely intertwined with each other, as well as with many branches of allied sciences (geological, biological, economic, historical, etc.). In all of this, geography down to the present day has remained a link between the natural and social sciences, a science that studies various components of the very complex relationship between natural and social elements (I. P. Gerasimov, 1980).

The problem of the subject of geographical study is precisely that geography touches two spheres of existence: nature and society. Speaking of the geographical aspect of the relationship between the natural and the social, Z. Jovicic (1998) had this to say, among other things: "*Because geography treats a large number of different phenomena and forms of nature and society (relief, waters, climate, plant and animal life, the economy, population and settlements, etc.), it cannot be in equal measure competent for all those phenomena and forms, and criticisms as to both the subject and suitability of geographical studies are entirely in order. Some other sciences that also study natural or social phenomena (biology, meteorology, sociology, economics), with their more exact methods, resolve far more successfully than geography certain problems connected with these phenomena. Their basic nature cannot, therefore, be solely a subject of geographical research. This is the main reason why geologists in addition to geographers are involved in the study of relief, meteorologists in the study of climate, biologists in the study of plant and animal life, sociologists in the study of society, etc. Taking the landscape of a region or geographic environment as a subject of geographical research must be understood as an attempt to overcome indefiniteness, which necessarily gives rise to generalization, superficiality, and descriptivism in geographical science...*" Going further, R. P. Moss stresses that geography essentially is a science that for explanations uses laws of other sciences rather than discovering them.

The fact that the subject of geographical study has not been precisely enough defined is especially reflected in the *area of geological research.* Accelerated development of *fundamental geology* in the 20th Century gave rise to a number of precisely defined scientific disciplines: mineralogy, petrology, pedology, paleontology, geochemistry, geophysics, historical geology, tectonics, and their branches. The results of these disciplines in study of the structure, genesis, and historical development of the Earth's crust are certainly impressive. Here too are a whole series of somewhat younger disciplines of *applied geology,* such as the science of mineral deposits, the geology of coals, petroleum and gas geology, hydrogeology, geological engineering, and applied geophysics, with numerous research methods developed to such a point that they are able to resolve all scientific and practical problems connected with the geological environment. Geography would appear to have been arrested by the given developments in a state of greater or lesser inertia in regard to all factors of the natural environment, including geological ones. It goes without saying that **medical geography** has not been immune to such "behavior" and has largely eliminated geology from the chain of vital multi - disciplinary activity.

Overlooked was the fact that the geological environment is the carrier of all mineral aggregates, that all components needed for the development and survival of living nature emanate or are emitted from it. Perception of the geological structure of a certain terrain (or area) is of fundamental ecological significance, since it dictates the actual content, relations, and potentials of the geological environment as the basis for development of life, exploitation of resources, and use of space for production.

According to A. A. Shoshin (1961), *the task of medical geography is to study the natural and socio - economic characteristics of a territory in order to clarify their influence on the state of public health, the incidence of human diseases, and their global distribution.* Based on a number of sciences (including medicine, biology, geography, economics, and sociology), medical geography in treating the natural conditions of some territory has usually synthesized general information without delving far enough into factors of inorganic (nonliving) nature as possible causes of disease or agents of positive influence on human health. Their diversity accounts for the great difficulty encountered by geographers, doctors, biologists, and other specialists in attempting to emphasize some aspect of this large and important area of research. On the other hand, the practice of some epidemiologists to study only the distribution of human diseases without in - depth investigation of the causes and regularities of their incidence in a certain geological environment transforms medical geography into a purely descriptive science capable of recording the more important diseases (especially noninfectious ones), but not of analyzing, extirpating, and preventing them.

In his book "**Principles of Medical Geography in Serbia**" (1998), Z. Jovicic wrote as follows: "*The literature consulted indicates that two basic themes are recurrent in medical geography, namely the influence of the natural environment on health and the role of geographical variability in the distribution of diseases. Geographical analysis and cartographic presentation stand out as the main methods in medico - geographical research. It should be noted that two key expressions—health and disease—are unavoidable not only in connection with our discussion, but also much more widely, in medicine, sociology, biology, psychology, and even philosophy. In conclusion, it is perhaps possible to differentiate two variants of medical geography. Clearly, medically oriented medical geography cannot be denied the right to study the influence of the natural environment on health. On the other hand, geographically oriented medical geography cannot be declared incompetent to analyze the spatial distribution of various phenomena and manifestations, including diseases of course.*"

But the tendency of medicine to impose its approach to research has caused the importance of natural factors in the incidence of disease to be neglected to a greater or lesser extent. The impression is created that medicine in its rapid advancement has increasingly forgotten the inorganic (geological) environment, i.e., the main root from which life on the Planet developed and the ambience in which man lives and works. This should not greatly surprise us. At a time such as the present, when there are many branches of science and fields of scientific endeavors, geology - above all in the sphere of education - has been relegated to a side track, with the result that awareness of the geological environment and its significance is increasingly stunted among scientific workers. No wonder certain investigators of man and human health appear to feel it less and less important whether man as the subject of interest is an inhabitant of the Earth or a being from some other planet. The paths to diagnosis of disease have thus become increasingly more convoluted, while preventive action has been replaced by ever greater medicalization of society[2].

Knowledge of geology fosters a deeper understanding of all that surrounds man. It helps us to recognize the beauties of nature and enables us to overcome superstitious fear in the face of powerful, sometimes terrifying and destructive geological phenomena. It demonstrates the order of the Universe and the transient nature of seemingly eternal mountains, volcanoes, valleys, and lakes. It will help us to conquer many diseases and thereby create conditions for a safer life.

SUBJECT MATTER AND THEORETICAL PRINCIPLES OF MEDICAL GEOLOGY

A great physician of the past, K. Galen wrote that health is a state in which we do not suffer from pain and are not limited in our vital activities. Numerous later definitions of health supplement that thesis by linking the human state with the external environment. There also exist various attempts to classify the level of health and disease. Examining the level of health in the population of the Far North, N. S. Jagya (1980), for example, divided the whole of the examined population into the following five groups: 1) *healthy*; 2) *healthy, with functional and certain morphological changes*; 3) *ill, with long - term (chronic) diseases, but basic functions of the organism intact*; 4) *ill, with long - term (chronic) diseases; 5) bed - ridden seriously ill, invalids of groups I and II.* Such classifications are interesting for evaluation of health in different regions of the same territory and in different seasons of the year, and analyses of the ratio of groups with reliably different levels of health make possible the classification of territories in regard to that characteristic, which is of great practical as well as theoretical significance. A region with predominance of the first and sec-

[2] At the present time, there are more than 10,000 diseases in existence and about 400,000 different medicinal preparations for their suppression.

ond groups according to the indicated classification can be judged to be a *territory with a high level of public health.* On the other hand, a region where a great percentage of the population belongs to the third and fourth groups must be regarded as one marked by a *low level of public health.* It goes without saying that where medico - geographical maps are available, it is easier for medical and other services to take decisions and implement measures aimed at optimizing health of the entire population and its separate groups. Addition of geological elements to such maps makes it possible to discern correlations with geological composition of the terrain and isolate *negative or positive influence of inorganic factors on human health.* **Medical geology** can provide answers to questions in this domain.

Viewed more broadly, the level of public health of a certain territory is formed under the influence of **natural** and **anthropogenic factors**. **Natural factors** include the layer of the atmosphere close to the ground, solar radiation, rocks, soil, surface and groundwater, characteristics of relief, endogenous geological processes, radioactivity, geophysical fields, macro - and microelements in soil and water, vegetation, and animal life. **Anthropogenic factors** include soil pollutants, waste water and other water pollutants, air pollutants, radioactive pollution in the form of nuclear waste, pollutants arising from exploitation and processing of ore, complex harmful influences of urbanization and roads, etc. The influence of man on the environment grows stronger every day, and this leads to rapid alteration (and sometimes complete degradation) of its natural component, which in turn affects humanity itself, including the level of human health. In view of socio - economic conditions and their influence, it can be concluded that investigation of the causes of disease incidence is necessarily a multi - stage process, one full of discoveries, but also disappointments. The approach itself must take into account a number of factors, both ones of narrow interest and broader spatial considerations, which is to say that it should be complex and multi - disciplinary.

By the term natural settings of diseases and pathological states of man, we mean certain properties of the geosystem which acting together with the human organism can be manifested in the form of pathological states or diseases (E. I. Ignat'ev, 1964). A given setting can be used to discover the etiology (or ambience) of diseases that have still been inadequately studied. Here it is necessary to be on the alert for many still undiscovered relationships between diseases and some factor (or factors) of the natural environment. The field of geology is particularly challenging in this context, the more so inasmuch as it has been inadequately investigated, while the Earth's geological structure is variable in space and human life unfolds in the geological environment.

The diversity of natural and social factors affords the possibility of constructing different classifications of diseases. Based on differences in the main natural factors determining the distribution and characteristics of pathological processes, one such classification was given by A. P. Avtsin (1959). As insignificantly modified by A. G. Voronov (1965), it recognizes the following five groups of diseases:

1. *Diseases caused by geophysical (primarily climatic) characteristics of the environment* (sunstroke, heat stroke, snow blindness, altitude sickness, etc.);
2. *Diseases caused by geochemical characteristics of the environment* (endemic goiter, fluorosis, dental caries, etc.);
3. *Diseases associated with biochemical characteristics of food* (avitaminoses, hypovitaminoses);
4. *Diseases caused by poisonous plants and animals, and allergic states* associated with substances and smells of plant and animal origin (bronchial asthma, etc.); and
5. *Diseases* (infections and invasions) *caused by living agents.*

According to Avtsin, the question as to the link between diseases and geographical factors has inevitably confronted every investigator who ever delved more deeply into problems of geographical pathology and medical geography: "*Are we not acquainted with diseases of tropical territories and quite different diseases characteristic of territories with a cold climate? It is well - known that the pathology of high mountains has its own specificities... Have there not been described endemic diseases of human beings, animals, and plants where some disturbance of the balance of chemical elements in the geographic environment acts as the main cause of a certain form of damage? Is it possible to ignore the fact that catastrophic movements in the lithosphere and hydrosphere (earthquakes, floods, tsunamis, landslides, rock and mud slides) cause massive damage of a traumatic nature?*"

It is evident from the classification itself that **geological factors** can be of significance for practically all of the five isolated groups of diseases, being very significant for diseases of the first and second groups - diseases caused by geophysical and geochemical characteristics of the environment[3]. Let us now return to the earlier presented structure of medical geography in order to get a more complete picture of the areas in which geology can make an important contribution. The following three groups of disciplines are in question:

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[3] It must be kept in mind that Avtsin relegated some purely geological factors to the geographical category. As indicated above, this was a generally accepted practice in the literature of medical geography and medical pathology.

- **Pathogens and sanogens**, where geology can provide important data on abiotic and (in some cases) biotic elements of the environment as pathogenic or sanogenic factors;
- **Environmental components**, where geology can provide important information about the lithological substrate, soils, groundwater (slightly mineralized, mineral, and thermal), exogenous and endogenous processes and phenomena, structural forms, deposits of mineral resources and their range of distribution, radioactivity in rocks and groundwater, trace elements (in rocks, soil, and water), geophysical fields, etc. Also about various geological risks such as seismic risks, volcanic activity, slips and slides, rock falls and mud slides, soil erosion, suffosion, and various geochemical risks; and
- **Technogenesis and the environment**, where information about the behavior of rocks, soils, and groundwater during anthropogenic action on the environment (various forms of pollution and destruction) can be of decisive significance in estimating the degree of environmental pollution and devising measures to reduce it, i.e., ways of protecting human health.

To conclude this examination, let us quote from Avtsin's book "**Introduction to Geographical Pathology**" (1972): "*We clearly see the interconnection of all living and nonliving nature, that enormous complex of the troposphere, hydrosphere, and lithosphere which the genius V. I. Vernadskii united in the concept of the biosphere.*" Geology will have performed its scientific and social mission if it carries out complex study of the geological component of the biosphere - the lithosphere - and thereby contributes fully to a better understanding of the hydrosphere and troposphere. The field of geological research is so wide, complex, and significant that there can be no doubt as to the justification of forming a scientific discipline linking *medicine and geology*. Filling the obvious gap in scientific multidisciplinary research along these lines will above all contribute much to medical science, particularly in the matter of disease prevention. It is one of the basic goals of science to bring about a state of optimization and sanitization of the human environment so as to achieve the highest possible level of public health. Medical geology will play its part only through far greater involvement of specialists, organization of international cooperation, and development of research theory and procedure. Two important initial steps can be taken in a relatively short time: 1) results of medical geography can be put to better use; and 2) valuable data of earlier geological research can be thoughtfully reinterpreted to create a modern basis for future research.

It is of indisputable importance to establish coordination of research efforts in geography and geology, i.e., to create agreement between medical geography and medical geology. That will probably be achieved when it is clarified in practice which discipline can better demonstrate both the positive and negative influence of environmental factors on public health, the incidence of human disease, and its distribution. *Time will show that there is no contradiction between medical geography and medical geology. On the contrary, there exists a single joint task - creation of a formula for maximally healthy conditions for human life - in whose accomplishment each science will participate in its own way.*

PROCEDURE OF MEDICO - GEOLOGICAL RESEARCH

As with most other sciences, medicine, biology, and geology experienced rapid and comprehensive development in the 20th Century, and the emergence of many new disciplines is significant in several ways. The precipitous post - war advancement of technology - particularly developments in the fields of electronics and automation, with the advent of powerful computers - has been reflected in the creation of numerous modern research methods on the one hand and the appearance of new possibilities in the matter of quantitative data processing on the other. All of this has resulted in the creation of a very firm foundation of medical geology and enabled it to enter a phase of accelerated development. Above all, medical geology has at its disposal a great many geological methods that have been developed to the point where they can provide answers to the majority of questions considered by practitioners of this new geological (or medical) discipline. Such methods include remote sensing, various field procedures, methods of fundamental geology (petrology, mineralogy, structural geology), geophysical methods, cartographic procedures, methods of geochemistry and other specialized geological disciplines (pedology, hydrogeology with hydrogeochemistry, geological engineering), nuclear methods in geology, etc. (M. Komatina, 1984). It goes without saying that many answers to the questions posed will probably also be obtained using methods of other scientific disciplines (biology, chemistry and bioinorganic chemistry, bioclimatology, pathology, physiology, epidemiology, toxicology, stomatology, veterinary medicine, sanitary hygiene, balneology, medical ecology, geomedical cartography and regionalization, statistics, information technology, mathematical modeling, and medico - geological diagnostics and forecasting).

Many spacious geological regions are known today in the world, and such units have been relegated to different so - called *biogeochemical provinces*. This term was introduced by A. P. Vinogradov in his work "**Biogeochemical Provinces and Endemics**" (1938).

The concept of such provinces makes it easier to understand both the distribution of regions with pronounced incidence of diseases resulting from an imbalance of elements and their significance for health. We note that the majority of geochemical diseases occur in developing countries in the tropical zone. By establishing more precisely the lithological composition and structural alignment of a given terrain, systematically analyzing its various components (rocks, soils, waters, and crops), compiling geochemical and geomedical maps, and ascertaining regional patterns in the incidence of diseases there, it is possible to create a good basis for finding their most important causes. This process includes the establishment of positive as well as negative influence of environmental factors, i.e., it involves their classification from the standpoint of health. Of special significance here is the method of correlational cartography of diseases, with which it is not only possible to establish the regions of their distribution, but also to gain an idea as to the link between pathological processes and certain environmental factors. One of the primary goals of research is to establish the link between natural characteristics of an area of interest and the occurrence of pathological states in it. It is therefore clear that results of medical and medico - geographical investigation of the area must exist parallel with geological data. For example, geology will treat abiotic components of the geological (natural) environment (rocks, soil, and geochemical composition of rocks, soil, groundwater, etc.) of a given territory, and study the migration of pollutants through them; while medical geography and medicine will supply statistical data gathered by health and veterinary services on the incidence of diseases in humans and domestic animals, results of field surveys by physicians, and information characterizing biotic components of the environment (data on plants, animals, agents of infectious diseases in them, etc.).

Inasmuch as multi - disciplinary investigations of complex objects are most often in question, development of a systematic approach is very important for the resolution of medico - geological problems. Such an approach enables multiple studies to be conducted on various processes and phenomena, and makes it possible for all specialists to work toward the achievement of a single common goal, namely joint interpretation (synthesis) of all important elements and forecasting of the behavior of a given system from the data of medical geology.

It is very important to limit the subject matter and task of medico - geological investigations of a given territory. In accomplishing the task posed, we have at our disposal many modern field methods, laboratory procedures, and methods of data processing and interpretation. Here too are the very useful experience and approaches of medical geography, developed in the course of centuries of research on environmental factors. The methods of medical geography and their usefulness in medico - geological research must be carefully analyzed. This applies to results of previous investigations in the areas of medical geography and cartography, which must be correlated with results of past geological research and cartography. Such analysis should enable us to judge how far geology, medicine, biology, and related sciences of interest can be used to estimate as authoritatively as possible positive and negative influences of the geological environment on public health and resolution of various problems in the domain of geo - ecology and medical geology.

Difficulties can arise in seeking the most rational (optimal) way of accomplishing the task at hand. Practice (experience) teaches us to select the investigative approach that is most appropriate in view of specific characteristics of the terrain of interest. Methods and approaches should be chosen that can give the most reliable results in studying the environment and accomplishing our purpose. *Optimization of the investigative process* is achieved through creative management of the project, with adherence to well - known basic principles:

- *Consistency;*
- *Exhaustiveness;*
- *Balance;*
- *Maximal information use; and*
- *Cost efficiency.*

Especially important is cooperation among specialists in different areas of science so as to ensure that they have a clear grasp of their part in the research and are able to accomplish their mission as fully as possible. The research must be planned in such a way that no participant in it is deprived of individuality (serving only as "bricks" in the overall construction), but rather that each is acknowledged to be of independent significance in contributing to the solution of a given problem.

The pattern of contemporary distribution of certain human diseases is so variegated that it is often impossible to establish with any confidence the factors that account for it. Where factors of the natural environment are in question, the only realistic course of analysis is to establish the boundaries of geographical or geological distribution of the suspected cause, characterize the medico - geological region isolated in this way, and finally compare the distribution of individual environmental factors with that of the disease. From the standpoint of geology, it is excusable to limit medico - geological research to relevant geological conditions of the terrain, i.e., to work within the confines of interesting *geological (hydrogeological) regions* or *geological formations*. Such an approach is all the more justified if it is also indicated by the geography of some endemic or other disease. For example, the incidence of endemic nephropathy in Yugoslavia is geographically linked solely with one type of geological formation, namely alluvial deposits, within which the cause of the disease should be sought. Or: the fact that human echinococcosis appears far more frequently than expected in the outer zone of the Dinaric karst is attributable to deficiency of surface water, as a result of which mass infection with *Echinococcus*

Geochemistry of the Tropical Environment" (Sri Lanka, 1999), which deals with the influence of certain essential elements on the health of humans and animals. The authors assert that the etiology of diseases such as dental and skeletal fluorosis or diseases associated with iodine deficit lies in the geochemical environment. They further stress that significance of the chemical composition of soil, water, and rocks in the incidence of diseases in certain tropical regions presents new challenges in medicine and provides justification for seriously concentrating on geomedical research with participation of geochemists and epidemiologists.

The same justification can be cited for **medical hydrogeology**, owing to the plethora of data indicating the significance of slightly mineralized and mineral waters for human health.

Although the given two disciplines have thus found practical affirmation, adequate attention must be paid to their further development in keeping with the demands of medical geology and medical geography. In connection with this, an interesting proposal was put forward by J. S. Jean (Taiwan, 1999), namely that **biomedical hydrogeology** be formed as an independent discipline.

An epidemic of enterovirus broke out on the territory of Taiwan in 1998. About 300,000 persons contracted the infection in the course of that year and the next. This magnitude of the epidemic calls to mind several similar instances recorded previously in Hungary (1978), Bulgaria (1975), and Malaysia (1997). It is highly probable that the cause lay in pollution of the soil and groundwater occasioned by the burial of more than five million dead pigs infected with afthovirus throughout the entire country, mainly in coarse - grained sediments of plains along the banks of rivers. "*Research in locating the source of pathogens and devising measures to prevention and control the epidemic disease involve biology, medicine, and hydrogeology. Thus, I have coined the term* ***biomedical hydrogeology***" *(J. S. Jean, 1999)*. In order to stress the significance of such a multi - disciplinary approach, the author cited the relationship between the hydrogeological environment and Blackfoot disease, an endemic disease known in southern Taiwan already before 1990, when arsenic was discovered in artesian well water used for drinking purposes. Tests confirmed the disease to be caused by elevated content of arsenic in groundwater and also indicated that its specific influence on health depends on the existence of other substances in the water, as well as on the hydrogeological conditions themselves. For example, negative effects were particularly pronounced in the case of artesian water occurring at a great depth, but were absent where water was drawn from shallow wells with a variable level.

occurs in the course of close contact with dogs under poor conditions of sanitation.

The investigative process unfolds in phases. The *first phase* involves acquisition and study of data obtained in previous investigations - geological, geographical, biological, medical, etc. A basis for planning and more precise guiding of research efforts is created in this way. Field and laboratory investigations are carried out in the *second phase*. The *third phase* involves data processing with textual and graphic interpretation. The goal of these activities is to discover basic correlations and regularities governing the link between *public health and the geological environment*, i.e., to determine which factors of the studied geological environment directly or indirectly affect the level of public health in a given region.

A distinction is drawn between fundamental and applied medical geology. It is logical first of all to resolve certain theoretical and procedural questions through fundamental investigations, create a medico - geological picture of an area or geological environment that reflects its regionalization, and establish geological locations (typical test grounds) on which it is relatively easy to study the pathogenic or sanogenic role of certain geological factors or geological formations. In other words, **fundamental medical geology** is concerned with development of theoretical principles and procedures of research, basic regional explorations of terrains, general analysis of the influence of individual geological factors (formations) on human health in a country or selected territory, etc. A foundation is thereby created for further (detailed) research directly linked with more restricted sites or certain practical problems.

Applied medical geology is used to study basic regularities governing influence of the geological environment or individual factors on public health in a concrete region, i.e., to establish factors which dictate the level of public health in that region. From the assembled data, measures can be devised for environment improvement and health protection. These ends are primarily realized as a result of *detailed medico - geological research*, whereas *specialized investigations* yield information about specific organic and inorganic components of the natural environment.

The very fact that medical geography has been so preoccupied with studying what are largely geological factors, while information about those factors has contributed to the discovery of pathogens and sanogens, justifies the existence of both medical geology as a whole and some of its disciplines. Inasmuch as the geochemical composition of rocks, soil, and groundwater has for years been at the center of interest of doctors, geographers, and to some extent geologists, it can now be considered that **medical geochemistry** has already existed for a long time. We note the significant work of C. B. Dissanayake and R. Chandrajith "**Medical**

GOAL, TASK, AND SIGNIFICANCE OF MEDICAL GEOLOGY

It is usually hard to answer the important question as to how favorable a certain area is for life. Investigation of the causes of disease represents a particularly complicated task full of uncertainty. The given problem can be successfully resolved only through a multi - disciplinary approach to it. But this does not mean that it is not necessary to extract the maximum from every contingent scientific discipline, especially in domains where that discipline can make a significant contribution. Finding the true (basic) cause of a disease or establishing the positive action of a given terrain on human health would certainly make it much easier to diagnose the disease itself and point to more effective ways of treating it, i.e., facilitate preventive work.

A favorable circumstance is that geology, as the science dealing with the inorganic world, offers diverse possibilities in this area. To be specific, the regularities of occurrence of certain geological environments and factors that can cause disease or strengthen the organism's defensive capabilities are most often well expressed. It is therefore possible within the framework of a geotectonic or structural unit (or geological formation) of interest to establish correlations between geological factors and the data of field and laboratory medical studies. In other words, the regionalization of an area of interest to us with respect to the degree of influence of geological factors on public health (geo - medical regionalization) can - in conjunction with maps, atlases, and regionalization schemes already created by medical geographers - be of great usefulness both for further medical research and practice, and in the areas of commerce, urbanization, and health protection.

The principal goal of medical geology is to study basic laws of influence of geological environment to human health, precisely to distinguish among geological factors those which can be the main causes of certain diseases or have a positive effect on human health. Medical geology contributes in this way to optimization of the environment and realization of the highest possible level of public health on the Planet. The existence of this new discipline and persons specializing in it will promote far better use of the information gained in voluminous fundamental and applied geological investigations, which represents another step forward in the efforts of world science in general. It goes without saying that the advances and experience of medical geography, medicine, biology, and other allied sciences have been utilized in laying the foundations of medical geology. Such a base allows for the fastest development of those branches of medical geology that treat factors of the geological environment, geochemical and other processes, and the procedure of research undertaken for special purposes.

It is the task of medical geology to study influence of the geological environment on the health of man as a social animal. To accomplish this task, it is necessary to develop methods and criteria for medico - geological evaluation of an area of interest to us, differentiate the geological environment from the standpoint of its influence on public health, and get a picture of the area's medico - geological regionalization. This is important for scientifically based optimal (coordinated) exploitation of geological resources and transformation of the geological environment in the interests of healthy living. The experience and results of medical geography can be of great assistance here, and analysis of the extensive data of past geological research from the geomedical angle is also useful. In addition to this, much can be gained through faster progress in geo - ecology, medical geochemistry, medical hydrogeology, and other disciplines. When developed to the level needed, medical geology will be able to produce results of great usefulness to the economy and health protection authorities. An especially important function is to indicate danger of a geological nature.

The significance of medical geology is manifold. This has already been discussed, and here we will stress only the importance taken on by medico - geological research in connection with the increased interest being shown by medicine in somatic (noninfectious) diseases, especially malignant neoplasms and diseases of the internal organs. A notable contribution in this field has already been made by geochemistry through the naming of certain geological elements (trace elements in rocks, soil, and water, for example) among etiological factors of primary significance. The very fact that the incidence of malignant tumors is unequal in different geographical regions of the world presents a challenging field for medico - geological research aimed at discovering correlations and regionalization of territory on the basis of established geological and medical parameters. Especially interesting here are microregions in which the carcinogenic situation is noticeably more expressed than in the surrounding territory. *Will medical geology be able to solve part of this global riddle?*