PROBLEMS OF GEOMORPHOLOGY IN THE LIGHT OF THE XIII INTERNATIONAL GEOGRAPHICAL CONGRESS

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The XIII International Geographical Congress, held in Moscow, clearly proved that interpretation of the mechanism of formation of relief forms, their development and the dynamism of this process still remains a task for geomorphologists. However, while the general geomorphological research of classical natural geography has artificially divided up relief investigations into geomorphological analysis and synthesis, up-to-date geomorphological trends in research are characterized by a dialectic interpretation of relief development, in which the dynamic interactions in space and time of all the endogenous and exogenous factors are expressed in an integrated manner, and which at the same time is also able to synthetize the structural and sculptural elements of the developing relief in a contradiction-free development unity valid for the entire Earth.

Investigation of the interactions of endogenous and exogenouss processes has therefore remained one of the most important areas of geomorphology up to the present day. Prior to the Moscow congress, however, the literature dealt in general only with one side of this question: the mechanism of action via which the endogenous forces act on the exogenous processes and their intensities. ASEYEV, BRONGULEYEV, MURATOV and PSHENIN have now finally subjected the other side of the question to examination: the reaction of the exogenous processes, or more exactly complete denudation and accumulation, on the movements of the Earth's crust. RASVOROVA elaborated the measurement of the magnitude and intensity of denudation for highland regions, while GAMS analyzed the climatogeomorphological aspect of the question in work dealing with the regularities and orders of magnitude of erosional processes of a climatozonal nature. The results already go far beyond the previously-assumed isostatic connectional relations.

However, it also emerges from the themes of the lectures at the congress that a vivid debate is still evoked by the comparative assessment of the roles of climatic geomorphology and structural geomorphology. This problem was otherwise highlighted by the work of SIMONOV in 1972. Attention has further focused on *morpholithogenetic* research analyzing the connections of *morphosystems* (combinations of relief forms which arise in definite morphostructures on the action of regional climatic factors) and of the relief and the nature of the rocks on a climatic geomorphological basis. *Engineering-geomorphological* research and geomorphological mapping, which has direct economic consequences, and which in Hungary already boasts of a considerable past and important results (PÉCSI 1971), also received appre-

ciative recognition in the congress evaluations classifying the modern tasks of our science.

It has become obvious that up-to-date geomorphological approaches can not do without the methods of classical geomorphology (geomorphological analysis, comparative geomorphological analysis, morphometry, etc.), but at the same time the method of analytical study of the *microforms* now receives emphasis in the search for possibilities of the indeed complex evaluation of the relief. Analytical morphogenetic data-assessment increasingly more frequently utilizes *mathematical-statistical* methods too.

On the basis of the discussions here, two topics in particular must be stressed: *catchment analysis,* and the *geomorphological analysis of slopes by a morphometric method.*

An accurate description of the geometry of the surface is a recurrent problem of geomorphology, particularly in running-water erosinal areas. One exact approach to this is possible via study of the elementary water-catchment basins, as is done in morphometry. However, numerical definition of the importance and the connection of the individual factors still remains questionable. For just this reason, particular value should be attached to the research of ONESTI and MILLER, who used a correlation method to examine the trends and the closeness of the connection between the topological indices of the hydrogeographical network and the hydromorphological characteristics.

Even at present, many experts claim that development of the mature catchment areas is already independent of time. This view, however, arising from misinterpretation of the cycle-study of DAVIS, has been credibly refuter by ABRAHAMS, with the use of previously unemployed parameters.

A fundamental question in the study of slopes remains unchangingly the evaluation of what slope types develop on the action of what ednogenous and exogenous forces. According to the reports of VOSKRESENSKI and SIMONOV, however, analysis of two, interrelated, basic problems connected with the morphometry of slopes can nowadays be made exact with mathematical methods too. These problems are as followe:

a) Typization of slopes on the basis of morphology, genetics and age; this has primarily been solved by MENSUA, IBANEZ and GALIBERT.

b) The question of the development of slopes, tackled by BALTENAU by recording of mass-movements on slopes of different types over long periods of time (by quantitative assessment of the orders of magnitude of the intensity of derasion).

A problem still awaiting solution, however, is the working out of mathematical correlations for the connections between the morphology of slopes and their petrological structures.

Aeolic processes have been investigated from two aspects. The effect of wind erosion has been analyzed quantitatively in the laboratory (SUZUKI, TAKAHASI) and under natural conditions (KESH, FEDOROVICH). On the other hand, the regularities of sand movement and the effects of these have been analyzed (e.g. by MAINGUET for desertification), and the genetic types of sand forms produced by combinations of several factors have been distinguished and classified (BORSI, TSOAR).

It is understandable that a number of research workers have dealt with the geomorphological characteristics of glacial and periglacial regions, since the present

age is withessing the economic utilization of these areas in both the Soviet Union and N. America: for example, in connection with oil production, mineral mining, energy production, the construction of pipeline networks, the establishment of towns, etc. (PISSART, MAICKAY, ROSENFELD). In the study of nivation processes too, the main emphasis was on the quantitative evaluation of their effects (LUCKMEN, THORN).

An encouraging feature is that, following our Hungarian initiatives, the denudation processes of *karst regions* are now being investigated in a number of countries in *microareas,* since it is actually at this level that the connection of the effects of the factor components may be traced most efficiently (FENOLON, GAMS). Accordingly, typization based on a comparative analysis of karst regions of the different continents appears to be of great promise (NIKO).

Within the main themes it is worthwhile to consider more closely the views relating to *structural geomoprhological research,* and more particularly to *morphostructural analysis.* It was pointed out earlier by Soviet authors that one of the fundamental potential possibilities of morphostructural analysis lies precisely in its dynamic and historical approach, which treats the tectonic changes in form of the crust details and the interactions of the denudative and accumulative processes, not only in the present, but in the geohistorical past too, as an evolutionary unity (GERASIMOV, MESHERYAKOV 1967). If the connection of the surface relief and the geological structures is examined by such an approach, the essential genetic features of the development of reliefs reflecting the interactions of exogenous and endogenous forces are revealed. In this process, however, the Soviet author referred to attribute the leading role to tectonic forces, that is with their basic assumption they restrict the climatic geomorphological conceptions to a certain extent.

In connection with this, it is known that mainly the French geomorphologists (TRICART, CAILLEUX 1965) earlier saw the progressive trend of geomorphology in climatic geomorphology. In their view, the unity of the denudation processes can be depicted only on a climatic basis. They therefore approach the conception of GERASIMOV only insofar as they too stress the morphostructural elements in the system of relief forms; however, this highlighting is performed on the basis of climatic conditions differenctiated according to the climatic zones.

At any event, the essence is that morphostructural analysis examines the discrete morphostructures as large forms of complex genetics, favoured by the tectonic movements of the Earth's surface, and developing in interaction with the denudative and accumulative processes. The relevant phase groups of GERASIMOV are of interest. In his view the first group of relief types is comprised of the *geotectures* (oceans, continents) created as a result of geophysical energies in the first interval of the geomorphological cycle. The next group is the actual *morphostructures,* which developed in the "joint zones" of the oceans and continents (plains, highlands) in the second period. The third relief type is the group of *morphosculptures,* which were produced and further shaped in the final phase. In the deeper waters they are of accumulation structure, while in the shallower tropical oceans coral-based superstructures too were formed. On the continents, the geomorphological facies system was at the same time made more complete by glacial and fluvial agradation, and by aeolic accumulation.

The fruitfulness of the morphostructural examinations interpreted in this way was borne witness to in very varied manners by the lectures at the congress. It was

pointed out by MAC, for instance, that on the basis of the correlation of the structural relief and the neotectonic areas one must distinguish between the rising morphostructures (crystalline blocks, monoclinic surface structures) and the sinking morphostructures (areas covered by a thick layer, and possessing a reduced relief). The highland morphostructures can be differentiated on the basis of their preorogenetic and orogenetic developments in the epigeosynclinal zone (DUMITRASHKO). By analyzing in detail the relief formations of the Soviet Union, the geographic collective directed by ASHEYEV has demonstrated those modifications within the structures which were induced bilaterally by neotectonism and exogenous processes.

New results were also yielded by the morphostructural investigation of the continental shelfs. KONDAKOVA, KUZNYETSOV, ULITSKI, CHIASHTYAKOV and SHCHERBAKOV pointed out that the formation of the relief of the seabottom is indicative of polygenetic developmental peculiarities, that is the configurations of the bottom relief are formed by the denudative-accumulative factors and the dynamisms of the recent tectonic energies in interaction.

The study of *morphostructures* developing as a result of the exogenous processes of the morphostructures also played a significant role in the lectures of the congress. It proved that, with the aid of comparative geomorphological analysis, our surface-morphological knowledge can be increased as regards many useful theoretical and practical findings same genetics in their basic faetures. BRAVARD and LILIENBERG presented a comparative study of the Caucasus and the Alps as an illustrative example. It emerged that the morphostructures of these ranges differ considerably from one another even in their sculptural elements, as a consequence of neotectonic movements and climatic differences. The simpler topography of the Caucasus is ascribed mainly to the less humid climate, and the more complex relief of the Alps predominantly to the local concentration of erosional processes.

GERASIMOV further developed this theory, and pointed out that the investigation of complex types of relief formations must be highlighted in the analysis of morphosculptures. The development of complex relief forms (fluvial, glacial, aeolic morphosculptures) can be understood only by consideration of the acting, and in no way commutative physicogeographical factors. And it is precisely as a consequence of the factorial complexity in the polygenetic morphosculptures that the connection between the development of the variety of forms and the zonal characteristics can not always by typified. It is true, however, that division of the complex relief types into further subgroups can be solved only by detailed analysis of the microforms. Further development of the classification in such a direction therefore already follows simply regional climatic principles.

It also became clear at the congress that structural geomorphological analysis can not divorce itself from the results of the global plate-tectonic theory either (GERASIMOV, ZHIVAGO, KORZUYEV): the plate movements give rise to stresses of such an extent in the crust that they are accompanied by considerable geomorphological consequences in both the oceanic and the continental regions. However, the differences between the morphological elements and geological structures are more significant in the oceanic than in the continental regions: the relief of the ocean regions is young and continually renewed, primarily with volcanic morphostructures. Sediment-thickening can be observed on the oceanic edges. (The slope conditions necessary for this can be explained by dynamic reasons.)

Great interest was aroused at the congress by the proof of the proposition that structural geomorphological analysis can be used to purpose in the discovery of *oil- and gas-bearing layers* (SOKOLOVSKI, VOLKOV, PALIENKO, SHEIN, ORBERA, CARBERA). One of the principles of the practical application is that useful information is obtained during the analysis about the *relief-forming effect of neotectonic movements.* Numerous authors contributed valuable methodological studies on the definition of the modes of application and on the detection of the localizations of accumulations of mining values (including layer water) connected to the layer-structural elements (FORD, ORME, PÉCSI, SCHULTZ, GRACHEV, SVARICHEVSKAYA, AZBUKINA, MALAKOVSKI, BAEVA, MIHANKOV, SHEIN, ORBERA, SKUBLOVA, VIVO-ESCOTO).

The reconstruction of neotectonic movements and the study of their relief-forming effects has therefore become an important question in geomorphological research. But such studies can also have other consequences. At times, for example, the neotectonism results in the block elevation of individual morphostructures, which may be followed by intensive vulcanism or deep magmatism. In certain regions, such as in Japan or the Canadian Mackenzie Mountains, discrete morphotectonic zones can be distinguished, in which the complex types of tectonic relief run so parallel with the areas of different seismicities that they even provide a basis for the regional prediction of the seismicity (KAIZUKA).

An important key to the practical applicability of the theoretical results lies in *aerial photographic interpretations,* via the application of the morphometric method to these, which makes possible the accurate mapping of large areas and the recognition of relief anomalies occurring in them (curvatures of longitudinal layer-sections, distortions of the staged angle of slope of river terraces, etc.). The investigation of such local structures must naturally always be compared with the geological and geophysical results too, and with the information from special, large-step geomoprhological mapping. On the basis of *mutually agreeing information,* a definite means is available for the differentiation of local structural regions, which means a substantial step forward in the discovery of oil- and gas-bearing areas. It should be noted that, commissioned by the OKGT, the Natural Geographical Department of Szeged University carried out such examinations in the region of the S. E. Hungarian Plain as long ago as 1967, and our experience fully supported the practical usefulness of the research of neotectonic structures with geomorphological methods.

Geomorphologists are devoting increasingly more attention to the utilization of *morphometric target-maps.* The are no longer only the basic or auxiliary maps for complex geomorphological maps, but are also suitable independently for the solution of individual target-problems. A good example of this is the map-series of FILOSOFOV, GONZALES and PEREZ—HERNANDEZ.

In connection with geomorphological mapping, an outstanding main question otherwise still remains in the production and correlation of a symbol-key for maps of different scales (ARISTARHOVA, BADEA, GANYESIN, GELLERT). A common standpoint was not reached by the congress in this respect. Our own view is still that the symbol-key of the detailed map-series (1:1,000,000 scale) for the Danube valley, and the geomorphological map-series (1:50,000), produced by the Geographical Research Institute of the Hungarian Academy of Sciences under the direction of PÉCSI and internationally accepted, should be regarded as the guiding principle.

The above brief outline of the general problems of geomorphology, morphostructural analysis, the study of the importance of neotectonism, the need for a mathematical description of geomorphological processes, and modern geomoprhogenetic mapping trends, can naturally not give a complete picture of the manifold, closely-interrelated research directions of this branch of science. Our aim was merely to present some of the new themes which determine the present routes and possibilities for the further development of geomorphological research, and with the aid of which up-to-date geomorphological research can further extend the bonds of mutual interest of geographical science and practice.