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THE CONCEPT OF EARTH RELIEF GENESIS: ITS COMMON AND HIDDEN (OR TRUE) MEANING

ABSTRACT: UFIMTSEV G.F., *The Concept of earth relief genesis: its common and hidden (or true) meaning*. (IT ISSN 0391-9838, 1997).

One of the most common concepts in geomorphology is that of the genesis of earth relief. The most usual meaning of the term «genesis», which we commonly use in the elaboration of our theories is restrictive, only partial. According to this meaning genesis is the beginning of things and phenomena. In earth science the concept of genesis, which can be used for every investigation, includes all the events in the history of the formation of a landform. These are its origin, development, modifications and even its extinction. Therefore the genesis of earth relief includes all that we know about a landform and the origin, the beginning, of phenomena is simply one of the phases of genesis.

If we consider the sequence of the so-called «five questions of science» (what? when? where? from where? why?) it can be said that the concept of genesis in its widest sense allows us to give a definitive answer to all five questions, including the last, which requires investigation of the ultimate end of things, even if natural phenomena do not necessarily have an end.

Three contradictions are intrinsic in the concept of earth relief genesis:
1) Elaborating a scientific theory in the field of earth science one answers firstly the last of the questions of science (why), and paradoxically this way of proceeding brings about satisfactory results.
2) As the beginning of things (for example of relief forms) materially escapes us, why in retrospect do they seem to be in a definitive state?
3) In science in general the concatenation of phenomena in successions of cause and effect is the most valid way of establishing temporal relations between the phenomena. In geomorphology however things are different because morphological sequences define the temporal relations between relief forms, without there being necessarily a cause and effect relationship.

Examination of these contradictions allows us to shed light on a hidden and true meaning of the concept of earth relief genesis, which describes the spatial distribution and space-time states of the relief form.

The inescapable aim of our research must be the understanding of genesis, or rather the spatial organization of earth relief.

KEY WORDS: Geneis, Earth relief, Spatial-temporal distribution, Geomorphological research.

RIASSUNTO: UFIMTSEV G.F., *Il concetto di genesi del rilievo terrestre: significato comune e nascosto (o veritiero)*. (IT ISSN 0391-9838, 1997).

Uno dei concetti più comuni in Geomorfologia è quello di genesi del rilievo terrestre. Il significato più usuale del termine «genesi», quello che noi impieghiamo comunemente nell'elaborazione delle nostre teorie è limitativo, parziale. Secondo questa accezione la genesi è l'inizio delle cose e dei fenomeni. Nelle Scienze della Terra il concetto di genesi, utilizzabile per ogni oggetto di indagine, comprende tutti gli eventi della sua storia di formazione: l'origine, lo sviluppo, le modificazioni e persino l'estinzione. Quindi la genesi del rilievo terrestre include tutto ciò che noi sappiamo riguardo ad esso, e l'origine, l'inizio, dei fenomeni è semplicemente una delle fasi della genesi.

Se si considera la sequenza dei cosiddetti «cinque quesiti della Scienza» (che cosa? quando? dove? da dove? perché?) si può dire che il concetto di genesi nella sua accezione più ampia ci consente di dare compiuta risposta a tutti e cinque i quesiti, compreso l'ultimo, che richiede di indagare il fine ultimo delle cose, anche se non necessariamente i fenomeni naturali hanno un fine.

Tre contraddizioni sono insite nel concetto di genesi del rilievo terrestre:
1) Elaborando una teoria scientifica nel campo delle Scienze della Terra si risponde per primo all'ultimo dei quesiti della Scienza (perché), e paradossalmente questo modo di procedere conduce a risultati soddisfacenti.
2) Poiché l'inizio delle cose (ad esempio delle forme del rilievo) è materialmente sfuggente, come mai esse in retrospettiva sembrano in uno stato definito?
3) Nella scienza in genere la concatenazione dei fenomeni in successioni di cause ed effetti è il modo più valido per stabilire rapporti temporali fra i fenomeni stessi; in Geomorfologia, invece, le cose stanno diversamente, in quanto le sequenze morfologiche definiscono i rapporti temporali fra le forme del rilievo, senza che fra queste vi sia alcun rapporto causa-effetto.

L'esame di queste contraddizioni ci consente di fare luce su di un significato nascosto e veritiero del concetto di genesi del rilievo, che serve per descrivere la dislocazione spaziale e gli stati spazio-temporali del rilievo.

Il fine imprescindibile della nostra ricerca deve essere la comprensione della genesi, o più propriamente dell'organizzazione spaziale del rilevo terrestre.

TERMINI CHIAVE: Genesi, Rilievo terrestre, Distribuzione spazio-temporale, Ricerca geomorfologica.

INTRODUCTION

It is very common for there to be different terms indicating the same scientific concept. The reason for this diversity of terminology lies in the development of conceptual systems, in changes in scientific paradigms with time

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and partly in the limitations imposed on scientific activity by political institutions. It can be said that variation in the terminology used for concepts is a sign of the independence of scientific activity, without which science itself cannot exist. We (scientists) repay this independence with conceptual and terminological creativity.

Scientific concepts and terms have another important peculiarity. They often have deep (and true) meanings that cannot be found in dictionaries or specific glossaries. It is precisely this hidden meaning of scientific concepts that ensures their effective use, despite the fact that there is a contradiction between their common meaning and the term that is used. This is true for one of the most common concepts in geomorphology, the origin (genesis) of relief, as it is for many other concepts in the field of earth sciences. Therefore a detailed analysis of the concept of relief genesis might be useful for many other sciences related to geomorphology.

The spatiotemporal conception of relief genesis formulated previously (Ufimtsev, 1991) can be examined from a geographical or from a methodological perspective. The methodological perspective can be translated into a philosophical opinion about the spatiotemporal distribution of relief genesis. As far as the methodological perspective is concerned, it is clear that certain general notions are needed to formulate the concept of the spatiotemporal nature of landforms. Three basic concepts can be proposed: 1) the spatial organisation of relief, 2) its morphological sequence, 3) its hierarchical relationships. Above all, the question arises as to the relationship between these concepts and another fundamental concept in geomorphology, that of the origin (genesis) of relief, which occurs in all our theories. The results of a preliminary analysis of this problem (Ufimtsev, 1992) have given rise to an animated discussion in the Russian journal «Geomorphology», and has made it necessary to examine the question in greater depth, that is, of the «spatiotemporal structure of earth relief in relation to its genesis». Some aspects of this problem were defined in an article dedicated to the characteristics of the fundamental scientific conceptions on which geomorphological theories are based (Ufimtsev, 1992a). We consider that geomorphological theories are based on two fundamental scientific conceptions: 1) the theory of the geographical cycle of W.M. Davis (1962), based on the existence of single orogenetic phases involving genetic and evolutive bands and on the idea of a finalistic development, and 2) the theory of lithodynamic channels which was formulated synthetically by N.A. Florensov (1978) and makes broad use of geological data and the idea of cyclical development.

The concept of the origin of relief, in a figurative sense, permeates the content of geomorphological inquiry and is inherent in our theories which form the basis of morphological analysis in its initial stage. This fact brings out the importance of a genetic approach in geomorphology and at the same time inspires us and puts us on our guard. Indeed, to develop theories of relief genesis and its individual manifestations it is indispensible to collect a large amount of data on morphology and age. However, our genetic theories end up acquiring a greater significance than the data collected, so that certain questions arise spontaneously: 1) are we not perhaps really going too far with genetic theories? 2) does the concept of relief genesis not have perhaps a deep meaning that makes its use indispensible in the initial phases of geomorphological inquiry? (fig. 1). In this paper some considerations will be made on some aspects of the concept of relief genesis inherent in the second question.

THE CONCEPT OF RELIEF GENESIS

Genetic theories and the spatiotemporal distribution of earth relief can be related in various ways. This implies that the concept of genesis can be used in many different ways in geomorphological analysis. Above all, one can speak of relief genesis in space and time, and this type of approach can be extremely useful in geomorphology.

In the second place the concept of relief genesis can often be used apart from space and time. This brings about the widespread opinion that establishing relief genesis is the main aim, and the only one worthy of attention, of morphological analysis. Furthermore, genetic interpretation is usually included in our theories, and, what is more, in the initial phase of our research. This circumstance can be defined as an early genetic «apparition» in the course of inquiry, and occurs when we discover that the result of a study consists exclusively in a high-sounding disquisition on the origin of earth relief and its development. Such speculation remains extraneous to the spatiotemporal structure of earth relief, which can also be undefined in this case. In the type of approach being analysed now the concept of the genesis (origin) of relief acquires a divine meaning and actually becomes an object of wonder. However let us remember that man has much more reliable proof of the existence of the divine.

A third type of approach can be defined thus: the spatiotemporal genetic interpretation of relief and its forms is a component of the description of its structure. It is the content itself of geomorphological maps that directs us towards this third type of approach.

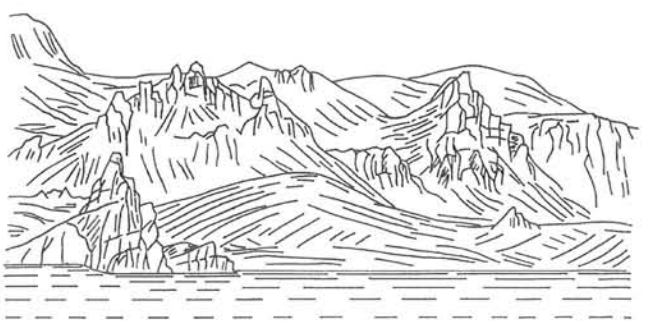

FIG. 1 - Materially elusive relief beginning: the insular mountain on the western coast of Lake Baikal near Peschanaya Bay may be formed (1) for account of pedimentation or (2) erosion of deep pocket of weathering crust of rapakivi granites.

The geomorphological maps showing genetically homogeneous areas possess the most complete content, because they convey as many notions on morphology as on the structure of relief. Yet while the positional relationships and the character of the divisions between strata allow us to determine the order of their formation, a morphological succession represents a discrete phase in the evolution of earth relief. All this information on earth relief contained in geomorphological maps is accompanied by genetic interpretations of the constituent elements of the relief itself. Relief genesis, or rather, the concept of relief genesis is the key to the legend of geomorphological maps. Consequently the concept, with this significance, constitutes a fundamental datum in the interpretation of the spatiotemporal structure of earth relief, a datum that is present in the geomorphological map.

One of the most effective ways of clarifying the true importance of the concept of genesis in earth sciences would seem to be that of comparing the recognised definition of this concept with some scientific opinions. The discovery, through such a comparison, of contradictions, might open the way to reasonable speculative results (given that in this case we cannot speak of «truthful» results). Let us proceed by reasoning about apparently banal questions. How is it that geologists make the distinction between intrusive, metamorphic and sedimentary rocks at the initial stage of their research? This subdivision is based on already complex concepts, while at an early stage of analysis a distinction should be made between stratified, massive and schistose rocks. Surprisingly, geological and geomorphological dictionaries and Russian glossaries in no way justify such an early use of the concept of genesis.

According to the Russian dictionary of geological terms (Russian glossary, 1973) by genesis we mean the origin of a geological formation. This interpretation is identical to the one found in the majority of general Russian dictionaries: that of S.I. Ozhegov (Russian glossary, 1986), that of foreign terms (Foreign words glossary, 1954) the dictionary of Logic (Kondakov, 1971) and others. It is a perfect synonym of the English term «origin» (source, beginning, origin), and in the explanatory dictionary of English geological terms (M. Gary ed., R. Mc Afee, K. Wolf, 1977) it is defined as the beginning of the coordinates, but in fact is used to designate origin, genesis. It is evident that this meaning of the term in question is restrictive, partial and is in any case the one we commonly use in the development of our theories: genesis is the beginning of things and phenomena. However, this is not the only meaning of the concept of genesis.

A wider interpretation of the concept of genesis allows us to define it as the moment of origin and subsequent developments. This is the definition found in the Soviet Encyclopaedic Dictionary (1989) associated with the classic definition. In the Explanatory Dictionary of German Geological Terms (Marawsky, 1980), we again find a similar definition (genese: origin, development). In this case the punctuation is important; G.U.). In the Russian Glossary of Geomorphological Terms (Timofeev & *alii*, 1977) earth relief genesis is defined as the origin of the forms of the relief of the earth's surface, but this term and that of «evolution of relief» of Ya. S. Edelschtein are found to be synonymous. From this definition it follows that clarifying earth relief genesis is one of the main tasks of geomorphology, but it is evident that we have chosen our main task with surprising superficiality, leaving open the possibility of taking into consideration other tasks. We therefore have to ask ourselves if our knowledge of the real meaning of the concept of earth relief genesis and its use in our theories is correct.

In the opinion of M. Bunge (Bunge, 1962) science is able to answer the following questions: what? when? where? from where? why? We can speak in a figurative sense of the five questions of science (fig. 2). The first four questions have an objective connotation (spatial and temporal). Only the last one is a strictly scientific question. Inquiring into the why of things implies the task of exploring their beginning, origin, using the more restrictive concept inherent in the definition of genesis. To answer this question we need therefore to have the answer to the preceding four, and to know the spatiotemporal structure of the phenomena observed or, if we choose another point of view, its positions in time and space (fig. 2).

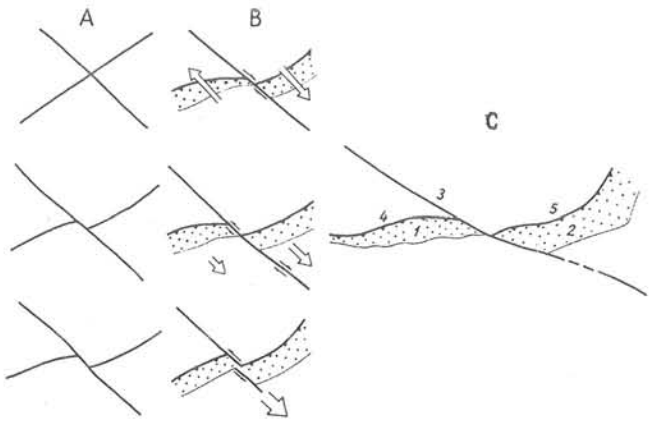

FIG. 2 - Different initial positions (A) and different types of tectonic dislocations (B) may explain the correlations (C) between Tunka (1) and Baikal (2) rift valleys which are separated by the Main Sayan fracture zone (3). 4 - Tunka fault, 5 - Obruchev fault.

THE CONTRADICTIONS INHERENT IN GENETIC THEORIES

The first contradiction we can point out in genetic theories in the field of earth sciences is that we always give an answer to the last of the questions of science first. However paradoxical this might seem, it is precisely this circumstance that is favourable to the subsequent development in the discussion and leads to satisfactory results. We could comment on this fact in various ways, but the author believes that the most appropriate is the following. Above all, when we first answer the last question of science, our answer often does not have a finalistic connotation. Conse-

quently the explanations put forward are not genetic, but in this case structural, etc. Otherwise, having a simple mentality that commonly attributes one cause to all the phenomena observed, we create a myth (Bunge, 1972) (fig. 3).

In the second place we should make it clear that in the earth sciences the concept of genesis was provided by D.P. Grigorjev (1962). This concept, applicable to any object of inquiry, includes all the events of the history of its formation, in which individual interconnected phases can be distinguished: origin, development, modifications and even extinction. The genesis of the phenomena we study includes therefore everything we know about them, and although it is their chronological placing that mainly attracts the attention of scholars, we should consider the fact that the origin itself (beginning) of the phenomena is simply one of the phases of genesis. To exhaust all the aspects included in a complete definition of the concept of genesis requires a profound knowledge of the phenomena studied, but it is only in this way that we can hope to give a different answer to the last of the questions of science. So what, then, is our genetic knowledge at the beginning of a scientific inquiry, or, to be more precise, what happens if we use, for example, inappropriate language to explain genetic problems?

At this point it might be better to disregard geomorphology and earth sciences, which all have the same problems. According to I. Prigogine and I. Stengers (1986) the close alliance between theory and practice, the intermingling between the aspiration to characterize the universe and the desire to understand it are features of modern science. Passing over an analysis of the first tendency of modern science (alliance between theory and practice), let us turn our attention to the second. The desire to understand the universe does not imply the necessity to explain it, to express an opinion about its origin, precisely because the entire universe is endless. Moreover, it seems to have been a tendency of science in general, throughout its history, to adhere to the following formula: great minds have understood the universe but their pupils and apologists have explained it. Unless we are mistaken, we can therefore suppose that the question may be posed in a new way: understanding or origin? It means that we must make a choice either in favour of a restrictive definition of the concept of genesis or prefer a broader formulation of it that coincides more or less with an understanding of the phenomena investigated.

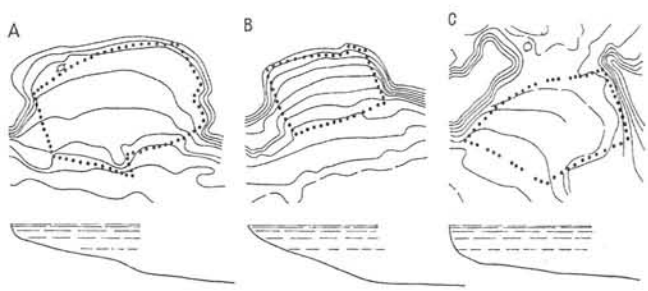

FIG. 3 - Genetic sequence of transformation: middle sized marginal subsided blocks of inital Okhotsk Sea shelf near its northern coasts. Below - transverse profiles of submarine coastal slopes. (A) Shelting Gulf, (B) Zabeyaka Gulf and (C) sea bottom between Zavyalov Island and Kony Peninsula.

The second contradiction inherent in our genetic theories appears clearly in the words of Teilhard de Chardin (1987): from the outset he presents us with the fundamental condition of an experiment, for which the beginning of any thing has the tendency to become materially elusive. And further on: «In nature there is no more delicate and misleading concept than the beginning of things... is it therefore not surprising that things in retrospect seem to be in a definite state?».

As in other scientific disciplines so also in geomorphology we are dealing with a materially elusive concept in its initial phases: that of earth relief. The skill of dealing with materially elusive problems in their initial phases is peculiar to geomorphologists as well as to geologists. The theory that postulates that problems are materially elusive in their initial phases has a fundamental significance both for the understanding and for the explanation of phenomena. The simplest examples from geomorphology show clearly that each earth relief form presents itself in a definite state, yet we cannot materially reconstruct its evolutive history. For example, let us consider the genetic sequences of the forms of earth relief. W.M. Davis's theory (1962) of the geographical cycle was formulated by means of genetic sequences. Although morphological and structural differences between the marginal elements of the genetic sequences are observed, their principal elements are always classifiable into a limited number of types of relief forms, and it is precisely for this reason that relief forms can be considered to be in a definite state. The evolutive sequences of earth relief can also be considered in a definite state because, although these include widely differing categories of relief forms, their initial elements are in a definite state, and are homogeneous from a spatiotemporal point of view. Thus we can speak more or less correctly of the succession with time of relief forms or groups of them, but we will always have to deal with a materially elusive beginning of the same. This fact, in turn, makes it essential to clarify the essence, at the same time real and hidden, of the concept of earth relief genesis.

Let us now examine the third condition inherent in genetic theories in the field of earth sciences, the cause-time distinction, taking a further step towards the aim of our study. It is well known that the best way to discover the temporal relationships between the different elements being investigated is the concatenation of phenomena in successions of cause and effect (Reichenbach, 1962). In successions of this type every object is the cause or contains the cause of the appearance of what follows it or what is formed after. The cause-effect successions of phenomena can therefore be easily understood if the temporal relationships between them are known, given that the earlier elements cannot be the cause of those appearing after.

This contradiction represents a difficulty for scientific research in all disciplines, and geomorphology is no exception. Studying the relationships between the age of the elements of earth relief and the cause that produced them, there is the risk of falling into a «logical circle». Geology

and geomorphology are in part immune to this risk, thanks to the fact that the objects of their inquiry have their own chronological collocation. In geology in a stratigraphic sequence (Maien, 1989) the older-more recent relationship between strata coincides with the upper-lower relationship and is defined by Steno's law. The fact that two levels are in succession does not require that there be a cause-effect relationship between them, because this type of relationship is not typical of stratigraphic sequences and the strata have only spatial and, above all, temporal relationships with each other.

An analogous situation is also found in morphological sequences (Ufimtsev, 1986). On the earth's surface the forms of relief have spatio-temporal relationships with each other. The morphological sequences define the temporal relationships between the forms of relief, without there being any cause-effect relationship between them. For example, the remains of ancient pediplain surfaces in the upper part of relief forms, although they are the oldest traces of morphogenetic action, are not the cause of the modelling of slopes along the sides of the valleys. The spatial organisation of a morphological sequence has only a temporal significance, and cause-effect relationships can exist between the elements of a sequence, as, for example, in the slope-valley bottom systems, but they are not the main ones.

The significance of the spatial organisation of a morphological sequence of earth relief, and also that of a stratigraphic series of geological bodies, prevents us in part from committing errors and falling into «logical circles» in the formulation of genetic theories or general explanations. If we find a valid answer to the five questions of science by answering the last question we already have an idea of the geological age of the relief itself.

THE ANALYSIS OF RELIEF GENESIS

The evolutive and genetic sequences of transformation of relief forms (fig. 1, 2, 3, 4) are methods that are widely used to characterize earth relief, but we can also mention other methods. One of the most common is that of genetic analogy, which consists in the transference of the genetic knowledge that we have of one object to a second object.

FIG. 4 - Evolutionary row of forms: Dyrenskaya intermediate step on the western flange of Barguzin ritt, SE Siberia. Low-mountain massif (on the lett) is successfully changed by separated mountains (in the centre) and system merged alluvial fans. The situation points out a description of intermediate step and expansion for account of it of rift valley.

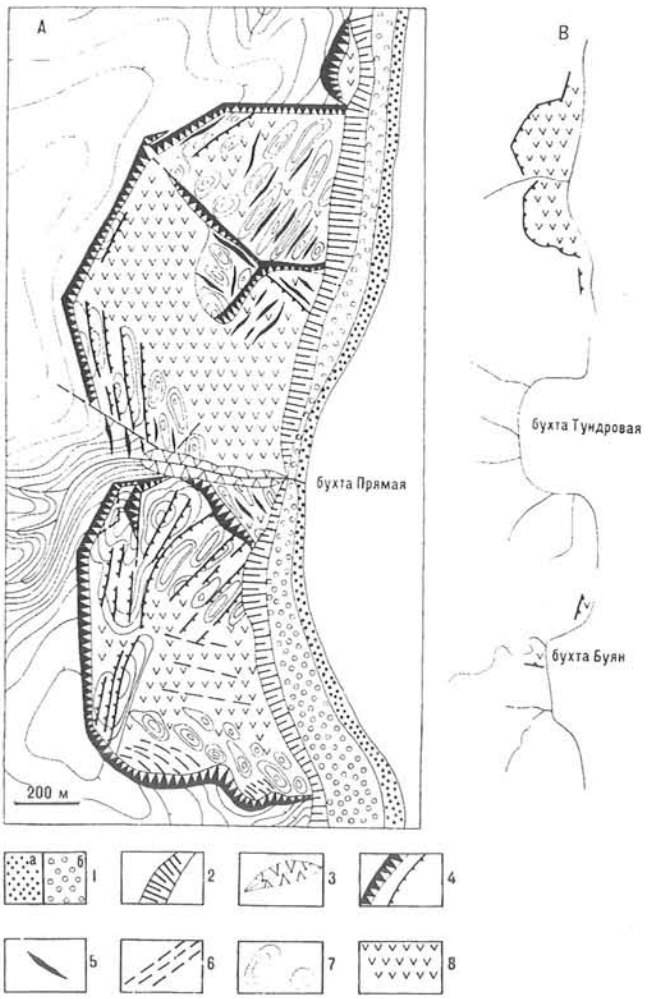

FIG. 5 - Genetic analogy: subsided step on eastern shore of the Bering island (A) as a form of near-surface tectonics and comparison of small bays on island shores with it (B). 1 - beach (a) and low marine terrace (b); 2 - abrasion scarp; 3 - watergap; 4 - fault scarps; 5 - narrow trench; 6 - displacers with small amplitude; 7 - domes and ridges; 8 - surface of subsided block.

This method has two variants: in the first the genetic modalities are considered identical on the basis of a similarity of the morphological elements (fig. 5), while in the second one of the elements was formed after the advent of human cultures, and the mechanism of its formation can be correlated to forms of relief similar to it. To this second category belong, for example, the various forms of relief interpreted as traces of prehistoric earthquakes (fig. 6), called paleoseismic dislocations, which show close morphological analogies with the forms induced by modern earthquakes.

The results of an inquiry into relief genesis are generally based on the analysis of forms and elements of geological structure. The relationship between the form of relief and its geological structure can be of two types: direct, when particular forms of relief are the geomorphological expression of the nature of geological bodies (fig. 7, 8), which makes it possible to carry out a genetic reconstruc-

FIG. 6 - Fault-collapse above the northern shore the Serigas Cape, north-western coast of the Okhotsk Sea which is morphologically similar to the blocks of caving in the epicentral area of the 1957 Gobi-Altai earthquake.

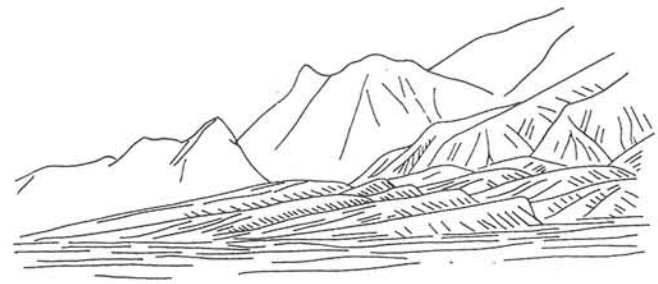

FIG. 9 - Inclined piedmont ridge formed by Cenozoic molassa (foreground) near the northern flank of the Tersky-Alatau ridge dome. Southern shore of the lake Issyk-Kul near vil. Ton (Northern Tien Shan). Piedmont ridges are the result of dome expansion and of involving of the marginal part of a basin in uplift.

tion, or indirect, when we observe anomalous correlations that enable us to establish a relationship between relief genesis and tectonic movements (fig. 9).

The genetic analogy (fig. 10) is based on the transference of a notion from one object of the relief to another.

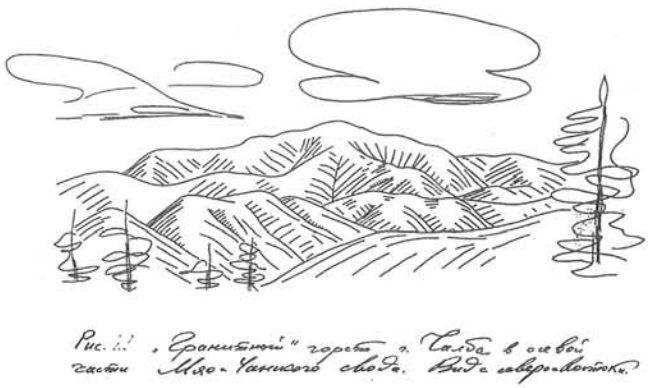

FIG. 7 - Massif of the Chalba Mountain in the central part of the Myao-Chana Dome, Far East of Russia - autonomously uplifting block formed in Mesozoic granites for density deficit.

It might be opportune to dedicate a few words to reminding ourselves of the need for the geomorphologist to be on his guard against «false friends» when he attempts a genetic reconstruction. The first of these is the principle,

FIG. 8 - Massif of the Mashuk Mountain in Pyatigorsk, Northern Caucasus; an example of near-surface intrusion of drop-like form being squeezed after getting cold for account of horizontal compression of the upper part of lithosphere.

already examined, according to which the beginning of each thing has the tendency to become materially elusive. It is therefore necessary to emphasize that there is a wide range of convergent relief forms, which are morphologically analogous or similar to one another, but are of different origin. One example could be the various types of insular mountains. Often one of the two morphologically analogous forms is characterised by the fact that together with a common process of formation there is another process that changes the characteristics of the relief forms. In these cases we can speak of subconvergent relief forms (fig. 11a and b). The modification of the natural conditions in which the contour finds itself favours the genetic reconstruction of the researcher.

If there are «false friends» for the geomorphologist there are also «true» friends, such as the regularity in the dislocation of relief, in a figurative sense, its «morphological clearness» (fig. 13). In these cases the genetic interpretation is not based on hypothetical reconstructions or geomorphological «fairy-stories» (fig. 14).

Moreover, it should be appreciated that our explanations could be erroneously finalistic or genetic, because it

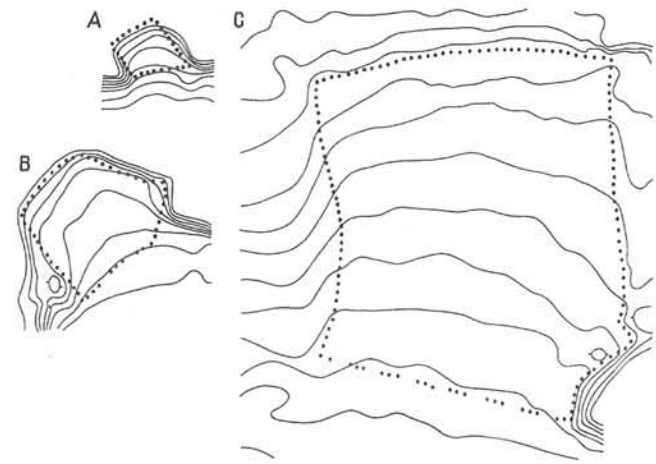

FIG. 10 - Genetic sequence of similarity: small (A), middle (B) and large (C) subsided blocks in the coastal northern part of the Okhotsk Sea.

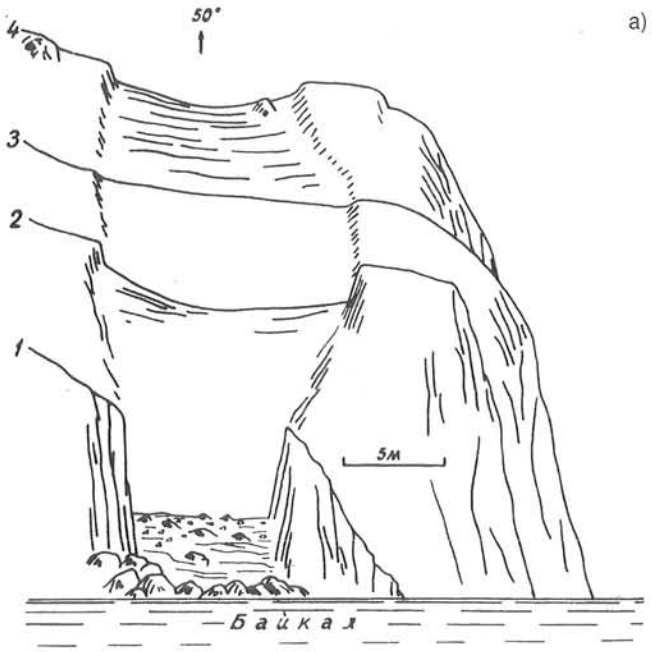

FIG. 11 - Micrograbens above near-surface zones of extension, formed for tectonic subsidence on the Zamogoy Island, Baikal Maloye More strait (a) or additionally deepened for account of denudation, western shore of the Kent Mountain Massif in Central Kazakhstan (b).

is not necessarily the case that all things have an end in the Universe, given that the Universe itself has no cause (Bunge, 1962). Although we abuse genetic terms in our descriptions of the elements of earth relief, we must realise that the explanations that we formulate do not always answer the question «why?». Among all the types of posssible explanations the finalistic ones occupy an important, but not predominant, position (Bunge, 1962). Furthermore, science in its logical development proceedes from the explanation of the cause to an understanding of the phenomena investigated, that is to say, from a primitive to a normal mode of reasoning (fig. 5).

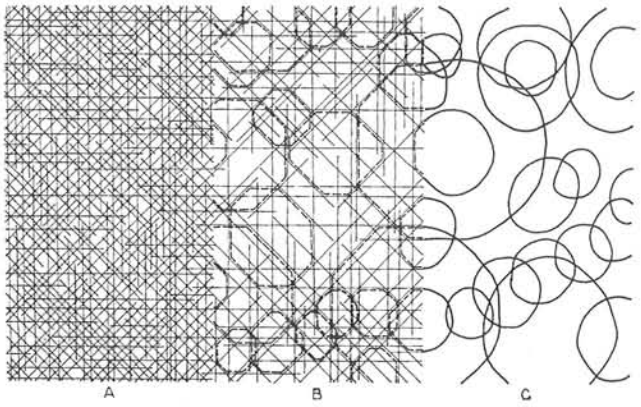

FIG. 12 - Network of diagonal and orthogonal lineaments (A) measured; visible under certain conditions of earth surface lighting and moisturing (B). Mark on cosmic photoes, free system of circular forms (C).

CONCLUSIONS

In geomorphology we can interpret the concept of earth relief genesis in two different ways. In a restrictive way, according to which genesis means the origin of a relief form, and in this case we can only try to establish what the beginning (which will be materially elusive) of the form was, and thus formulate an initial answer to the last of the questions of science. The second way is based on a wider meaning of the concept of genesis, as the origin, the spatial dislocation and the evolution in time of earth relief. This meaning allows us not only to define and formulate a precise opinion about the origin of relief, but also to understand its spatiotemporal structure as a whole. The search for a materially elusive origin is of no importance in this second type of approach.

Which of the two ways is preferable? The personal opinion of the author can be easily understood from what has been said so far, but each person can approach the problem of the definition of the concept of earth relief genesis following his or her own speculative criteria. One fruitful speculative approach is to compare the terms used in geomorphology with the scientific concepts that they express. It is always extremely useful to «take a stroll around» geomorphological terminology.

For example, the slope of a fluvial valley subject to solifluxion is called briefly «solifluxion slope». Information is

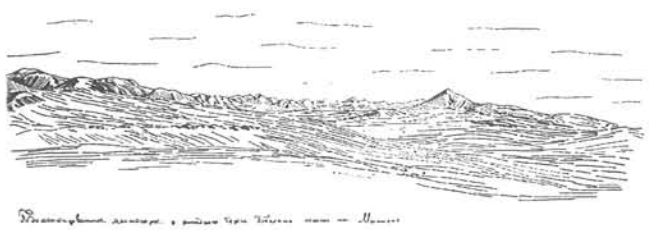

FIG. 13 - Regular landscape: low-mountain relief and pediments with insular mountains of the western shore-side of the Balkhash Southern Kazakhstan.

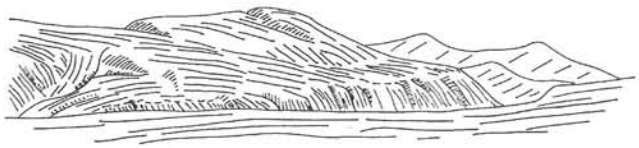

FIG. 14 - Watergap as a result of channel overflow over pediment pass (on the lett) under tectonic distortion of earth surface. Olkhon Island on the Baikal lake.

given about the geometry of the morphotype under consideration, but its origin linked to processes induced by flowing water is implied. The adjective defines the processes that are predominant in a secondary stage and are responsible for its final aspect. The term, with the shades of meaning implicit in it, contains elements concerning the origin, geometry and evolution of the morphotype, and corresponds to the broader meaning of the concept of genesis.

The term «planation surface» immediately evokes the image of a slightly undulating or flat surface, formed by the progressive erosion of large volumes of rock and denudation of vast surfaces. The term contains elements concerning the geometry, the spatial dislocation and the origin of this form; the terms «pediplain» and «peneplain» contain the elements for their definition according to the same logical schema.

Analysing geomorphological terms with the purpose of clarifying the semantic links implicit in them, we observe that they contain information about the origin, the spatial dislocation, the geometry and the evolutive tendency of the relief forms. These different components contain the definition of the concepts in different combinations and according to different relationships between the parts. However, it is not difficult to persuade ourselves that they provide a wide interpretation of the genesis of forms, and consequently enable us to understand more fully the forms of earth relief; this end is pursued through an interpretation of geological terms in a genetic context. A diversion, even if a brief one, into geomorphological terminology has persuaded us that within the ambit of our work we use the concept of genesis with the following meaning: origin and subsequent evolution, with auxiliary information regarding spatial distribution and morphology. At the conclusion of this logical procedure we have a paradoxical situation: if we adhere to the common restrictive definition of genesis in our research, we are setting ourselves the wrong goal, but at the same time we are making a correct choice. Certainly, this paradox is not of great importance for practical purposes, yet it induces us to concentrate our efforts on the search for the true, hidden meaning of the concept of relief genesis.

What has been said so far leads us to the conclusion that by means of the concept of earth relief genesis it is possible to interpret the spatiotemporal dislocation of earth relief forms. It is important to stress that the concept of genesis unites within itself spatial and temporal meanings, and that thanks to this we are able to define relief fully, yet although this definition has a genetic meaning, it does not necessarily have at the same time a causal meaning. If such is the case, it seems to be clear why we first answer the last of the questions of science: in all the phases of geomorphological analysis we find this completeness in the spatiotemporal organisation of earth relief, and constantly correct our idea of it as our work proceeds. It is precisely for this reason that the essential aim of our research must be to understand genesis, or more strictly, the spatial organisation of earth relief.

The concept of earth relief genesis can be considered from two points of view: methodological and philosophical. In the first case it is possible to interpret the spatiotemporal dislocation of the forms of earth relief in broad outlines. From the philosophical point of view, through the concept of earth relief genesis, we succeed almost unconsciously in determining what can be called the spatiotemporal condition of relief.

The unitary condition of earth relief from a spatiotemporal point of view (Ufimtsev, 1991) is obtained by using the following key concepts: good spatial organisation, hierarchical succession, morphological succession and genesis (origin) of earth relief. In our opinion the space-time of earth relief is pentadimensional: it is characterised by three Euclidian spatial coordinates, a hidden coordinate of a Rhiemanian convex space (hierarchical succession) and temporal coordinate (morphological succession) (Ufimtsev, 1991). Yet globally the space-time of earth relief, in its inseparableness, is characterised by states that are described through the concept of earth relief genesis. We can therefore assert that the «world» of the relief of the earth's surface is the world of dimensions and states. The geometrical aspect of the system of coordinates used to represent the unitary space-time magnitude of relief is the one illu-

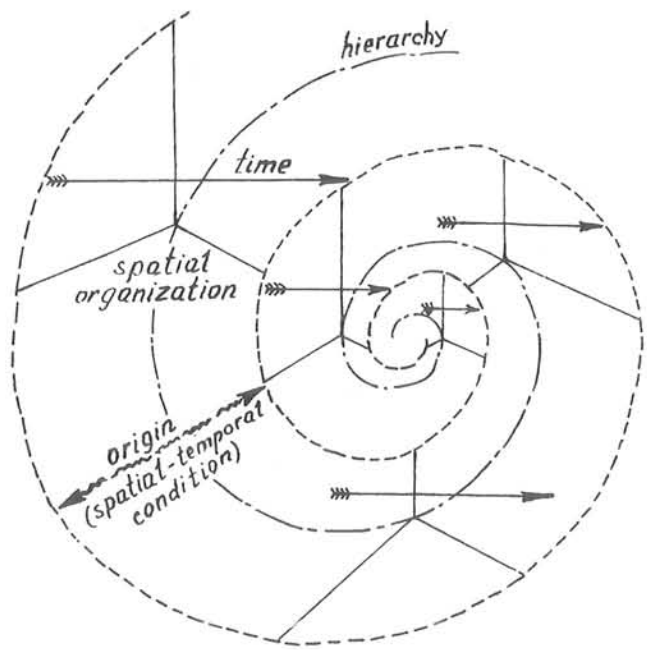

FIG. 15 - Coordinate system for description of space-temporal relief structure.

strated in fig. 6, in which some ideas of A.S. Eddington (1934) are exploited. The coordinate in the form of a spiral is used for hierarchical succession in a state of lines of levels of organization of relief (fig. 15). At the limit of each of these we use the Galilean coordinates of zero space curvature. However, the general modalities of distribution of space-time magnitude can only be brought out by means of the concept of genesis.

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