GEOGRAFICKÝ ČASOPIS

ROČNÍK XX 1968 ČÍSLO 3

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SLIDE CLASSIFICATION

L'étude a pour objet la classification des glissements. Nous abordons ce problème d'une manière non-traditionnelle. L'attention ne se concentre pas à la structure détaillée du glissement. Nous ne poursuivons pas le but de réduire ce processus géomorphologique à un processus physique. Nous étudions le glissement du point de vue macroscopique. Nous l'étudions en complexe ou système, poursuivant cependant les formes du comportement de ce complexe. En concentrant notre attention aux éléments de ce système et à leurs rapports réciproques, nous pouvons classifier les glissements selon le degré de compacité. Au point de vue des rapports des glissements à leur voisinage, nous pouvons comprendre les glissements en tant que les systèmes fermés ou ouverts. Les glissements se comportant en qualité des systèmes ouverts peuvent être subdivisés encore en glissements à contrôle négatif et à contrôle positif.

1. INTRODUCTION

1.1. The present study is concerned with slide classification. It joins up with our previous study „Slides and System Theory" (17). Hence, we consider as necessary to recall some of our conclusions attained; the aim of our present work is to expound them more extensively.

The author would like to express his thankfulness to Doc. Dr. E. Mazúr, Dr.Sc., for his good will, help and critical remarks related to this elaborate.

1.2. The subject matter of our previous work were slides. We have approached the theme in an untraditional way. We have tried to construct abstract systems which should serve as a starting point to the study of concrete slides. We shall adhere to this method also in our present work.

1.3. We have tried to apply on slides the system suggested by S. A. Schumm and R. W. Lichty (15). We have examined slides from the viewpoint of two systems, i. e. of the dynamic and the equilibrum system, differing by their dimensions of time and space. Slide in the dynamic system has properties different from those in the equilibrium system. We arrived at two different definitions of slide.

1.4. The dynamic system of the hillslope was defined in a way that would enable it to answer the question „What happens?" It was defined by not too great dimensions of time and space. The dynamic system can be fairly approximately thought to be a hillslope with a surface of a few square kilometres subject to our observation for a time of a few years.

Time, in the dynamic system of slope, was an irrelevant variable. Rock type, rock structure, mantle rock, climate and the form of the hillslope were independent variables. Hillslope processes were dependent variables. Our aim was to give a definition of slides and to rule them out from the mass-movement type processes. Non-sliding processes are, from the viewpoint of the dynamic system, continuous both in time and space. They go on almost incessantly in the entire dynamic system. They are under the full control of the independent variables of the dynamic system.

Slides are, from the viewpoint of the dynamic system, markedly discontinuous with respect to time and space. They occur only in some parts of the dynamic system of the hillslope and this only in a certain span of time. Though they are influenced by the independent variables of the dynamic system, they are not fully controlled by them; indeed, on the contrary, the independent variables stand under the influence of slide. Slides always markedly alter the form of the hillslope. Feedback occurs. Hence, to the notion slide belong not only processes but also forms.

1.5. We are able to study slides in the framework of the dynamic system; however, we are not able to give them a satisfactory explanation. We are bound to resort to the concept of memory, to the history of he hillslope. We have to find the answer to the question „What happened?" For this reason, we have studied slides also from the viewpoint of greater dimensions of time and space, from the viewpoint of the equilibrium system of the hillslope. This system has been defined by dimensions of time and space which should alter the structure of its variables. Time, rock type, rock structure, climate were independent variables. The form of the hillslope and hillslope processes change their position. They constitute on one occasion an independent variable, on another occasion a dependent variable. From the viewpoint of the equilibrium system, an interpretation of slide started to take shape. The slide obtains features of a phenomenon based on law. It is bound to a certain time and space. It appears that it stands in opposition to the state of equilibrium.

1.6. In our study of slide from the viewpoint of two time-space systems we have arrived at two definitions of this phenomenon. We can avail ourselves of two possibilities of slide classification. We can classify them from the viewpoint of the equilibrium system of the hillslope and also from the viewpoint of the dynamic system of the hillslope.

As to the equilibrium system, we can investigate into the conditions of the origin of slides, we can try to cope with the complicated principle of nucleation [concerning the principle of nucleation cf. K. E. Boulding (6)] and to classify them on this basis.

In our present study we shall try to classify slides from the viewpoint of the dynamic system. The processes falling under the definition of slide from the aspect of the hillslope dynamic system can be classified according to their behaviour. In this respect, two basical viewpoint offer themselves. They are called by A. D. Hall, R. E. Fagen (8, p. 21): „macroscopic vs. microscopic views of systematic behavior". Further, they say: „One technique for studying systems which are exceedingly complex is is to consider in detail the behavior of certain of its subsystems. Another method is to neglect the minute structure and observe only the macroscopic behavior of the system as a whole".

1.7. Now we are facing the complicated problem how to classify further one member from the complex of hillslope processes, how to classify slide. Here we would touch at least concisely upon a wider problem, the problem of classification of geomorphological processes. Among the works which are the most advanced in this direction, is the work by N. A. Strahler „Dynamic Basis of Geomorphology" (16). N. A.

Strahler makes this classification leaning on physical principles. He characterizes them as different types of shears which occur according to the laws of soil mechanics or hydrodynamics. He distinguishes the processes according to the stresses by which they are provoked and according to mechanical properties of the materials.

Like every classification, this one, too, ends by an aggregate of concept relating already to concrete phenomena. The aggregate of concepts is linked with concrete processes in the field. There is no concrete process contrary to physical principles. Hence, we are allowed to classify every process on this basis. The aggregate of concepts fully covers all concrete phenomena.

Slides constitute movements of elastic or plastic material. To our notion of slide would belong processes which are described by N. A. Strahler as „slumps", „slides", „large-scale creep phenomena" and some „earth flows" and „mudflows".

1.8. Each slide can be classified on the basis of the physical principle. However, in physical classification we do not operate with notions such as interaction, complexity, whole, control and the like, i. e. with terms by which wholes or systems are characterized. Results of physical classification cannot be processes representing a whole, a system, i. e. complex processes. Results of physical classification can be only simple processes which cannot reasonably be mentioned as wholes or structures. The question is, however, whether these notions are without sense also with respect to slides?

1.9. Some slides start as movements of elastic blocks. Later, during movement, the blocks disintegrate. The movement obtains features of a plastic flow. Cases of this kind are described by Ackermann E. (1), B. Kayser (10), O. Maull (13), L. B. Leopold et al. (11, p. 341) write as follows: „Slides and rapid detachment of large masses of rock and debris are often associated with or are the precursos of flows of earth and debris". A. Rapp (14, p. 152) describes one type of slide as „sheet slide". He further writes: „Many of them developed into mudflows". Another type of slide is called by him „bowl slides" (p. 150). Movement in the upper part has another character than movement in the lower part. N. A. Strahler also writes about dependence of the type of movement on the changing magnitude of the particles (16, p. 928).

1.10. We have defined slide (1.4.) as a process which is discontinuous both in time and space. This process is markedly delimited both in time and in space. The few examples mentioned demonstrate that slide is a whole which is internally differentiated. Its differentiation appears both in time and in space. Leaning on physical principles, we can classify only the different parts of this whole, its microstructure (cf. 1.6.).

We cannot — by means of physical principles — define the way how these parts become combined in time and space, how they become joined together into a whole, a system. Important systemic properties escape our perception. In order to be able to determine these properties we are bound to study slide as a whole, we have to look at it from the macroscopic point of view (1.6.). In the following chapters we shall dedicate our attention to slide classification from this point of view.

In the second chapter the relationships between parts of the system — the slide will be discussed. Our attention will be concentrated particularly on emergent properties, i. e. properties which are not properties of parts but appear only after these parts becoming joined into a whole.

The third chapter will deal with the relationships of the system — the slide, with respect to its environment, and with emergent properties becoming manifest in the interaction of the system and its environment.

2.1. Therein above we have concisely pointed at slide being a whole which is internally differentiated both in time and space (1.9.). Slide as a whole constitutes a quantity of rocks with a certain volume, moving downward the hillslope, possesing a certain kinetic energy. This whole is composed from parts reciprocally differing by their physical properties. The changes of properties in one of the part provoke changes also in other parts of the slide. Hence, the parts are connected by bonds by which the system, the slide is tied together.

This definition of ours is near to the definition of the system set up by A. D. Hall, R. E. Fagen (8, p. 18). „A system is a set of objects together with relationships between the objects and between their attributes".

2.2. We have described the slide to be a phenomenon discontinuous in time and space (1.4.). Sketching it very roughly, we can describe the slide as follows. From a quantity of rocks, being previously static for a long time, a part of it starts to move downward the hillslope in a certain moment. Into this movement masses of originally static rocks become involved. Later a gradual decrease of the volume of the moving mass takes place. The movement slows down, the different parts become static again. Sliding gradually abates until its end. During the entire process the mass in movement is markedly separated from the static rocks.

This process has the character of an interaction of the slide with the environmental static rocks. The environment of the system — of the slide — is constituted by static rocks on which the slides moves on. The environment is defined by the mechanical properties of the rocks, their form and potential energy (cf. Chapter 3).

Environment is defined by A. D. Hall, R. E. Fagen (8) as follows: „For a given system the environment is the set of all objects a change in whose attribute are changed by the behavior of the system (p. 20)".

2.3. The above mentioned changes in kinetic energy of the sliding mass can be understood as a „simple growth" (cf. K. E. Boulding 6, p. 66). He writes: „. . . within the realm of common human experience all growth run into eventually declining rates of growth" (p. 66), „. . . all empirical growth curves exhibit the familiar ‚ogive' shape" (p. 67).

In this section we shall discuss solely the slide itself, without taking into account its environment. Hence, we are bound to abstract from changes occurring from the interaction of the slide with its environment, from changes in the energy of the mass sliding down. Slide energy will be considered as constant.

2.4. Differentiation of the slide on the parts occurs both in time and in space (1.9.). Let us look at these processes at first separated from each other. We shall follow slide differentiation in space, abstracting from differentiation in time.

Slide is a threedimensional body. Theoretically, the differentiation of this body on the part can go on in three directions, into depth, length and with. However, the body moves down the hillslope under the action of gravitation. The gravitational stress acts in two directions, vertically on the hillslope (the radial component) and parallely with the hillslope (tangential). Slide will differentiate principally in these two directions. It will differentiate in depth and in length.

Owing to slide differentiation in depth, a multi-layer formation comes into being. Slide in a given moment (S_1) can be considered as vector. Its first component defines the highest layer (L_1). The last component defines the deepest layer (L_n).

$$S_1 = ({}^1L_1, {}^1L_2, \dots {}^1L_n)$$

Owing to longitudinal differentiation, in the gradient direction, the diferent layers do not constitute homogeneous wholes either. Each of them represents a vector. The first component (P_1) defines that part of the given layer which is situated nearest to the watershed. By the last layer is marked the part situated nearest to the base of the hillslope (P_n)

$$L_1 = ({}^1P_1,\ {}^1P_2,\ \ldots {}^1P_n)$$

Each part (P) is defined by two properties. It constitutes also a vector. The first component (r) defines the mechanical properties of the material. The second one (e) defines its kinetic energy.

$$P = (r,\ e)$$

The kinetic energy is defined by the mass (m) and velocity (v) of the material in movement, $E_k = m.\ v^2/2$. The mass is defined by specific gravity and volume. Specific gravity will be considered as a constant factor. Volume can be defined by three components: length, width and depth of the part.

2.5. The differentiation of the slide in space can be expressed by a complicated vector. The slide is thus defined statically. The vector does noet reflect changes in time. This dynamic aspect of the slide can be determined in the way that the slide is anew defined in the subsequent moment. The entire slide (S) is defined again as a vector. It will be constituted by vectors characterizing its momentaneous partial states (S_{1-n}) in time order. In other words, these are transformations of the original momentaneous state (S_1)

$$S = (S_1,\ S_2, \ldots\ S_n) \text{ or } S = (S_1 \rightarrow S_2 \rightarrow \ldots\ S_n)$$

We have attained a hierarchy of vectors or systems. The highest system is the slide (S). Then follow subsystems — momentaneous states of the slide ($S_1, S_2, \ldots, S_n$), layers of the slide ($L_1, L_2, \ldots, L_n$), parts of the slide ($P_1, P_2, \ldots, P_n$).

Now, our attention is focused on the lowest subsystem, the part of the slide. The first component defines the mechanical properties of the material. According to N. A. Strahler (16), there exist three basical types of material. Elastic, plastic and liquid materials. However, between the basical types there are transitions (cf. L. B. Leopold et al., 11). Movements of liquid material do not belong to the category of slide. Now we have before us four types of material: elastic material, material having the properties of elastic and plastic material, plastic mterial, and finally material constituting transition from plastic liquid material, four basical types of movement, *A, B, C, D.*

A. „Landslides" are movements of elastic material. The sliding earth consists of some few blocks. The blocks, seen in proportion to the entire volume, are big.

B. „Debris slides". Elastic blocks are still moving. However, the number of the blocks is considerable. The single block, as seen in proportion to the slide volume, is insignificant. In spite of the elasticity of the blocks, the slide as a whole has often the character of a plastic flow.

C. and D. „Earthflows" and „Mudflows". These flows are movements of plastic material. The consistency of the earthflow is greater. The movement has the character of a laminary flow. The consistency of the mudflow is smaller. Frequently there are occurrences of turbulency. Mudflows constitute a state of transition towards fluvial process.

We have taken into account only four variables *A, B, C, D.* The question is whether each variable is apt to be changed into any other variable.

From A to D there is a decrease of cohesion or internal friction of the material. There is no chance for A to become changed into D, overleaping B, C. This is not possible in the reverse sense, either. Transformation will always have the character of a gradual change. The question is whether this change can take place in both senses, from A to D and from D to A?

An integer block can disintegrate into smaller blocks during movement. The movement will obtain increasingly marked features of a plastic movement. This character is apt to become even more marked by increasing contents of water. Hence, transition from A to D is possible. If consistency and internal friction increases in the plastic material in movement to such an extent that the yield limit transgresses the gravitational stress, elastic tensions will come into being in the material, and the movement gets stopped. (cf. N. A. Strahler, 16). Transformation from D to A is not possible in the framework of the incessantly moving material, in the framework of the slide.

In the framework of the slide, in the framework of the incessantly moving material only transformation from D to C is possible, a change of plastic material of lesser consistency into a plastic material of higher consistency. Here a kinematic graph can be drawn up.

$$A \rightarrow B \rightarrow C \rightleftarrows D$$

The transformation of our four variables is a closed unambiguous transformation. The displaying point can be brought to a stop in any stage. Identical transformation $A \rightarrow A$, $B \rightarrow B$ will occur. The slide will go on, but there will be no change in the type of movement. Should non-identical transformation occur, the displaying point will move from A to D, and it will come to a stop in the cycle $C \rightleftarrows D$.

The other component signifies the kinetic energy of the part. The energy of the different parts can both increase and decrease. There can be changes both in the volume and in the velocity However, the energy of the slide as a whole remains constant (cf. 2.3.).

The part itself of the slide has only two properties. By linking these parts into superordinated systems, the new properties, i. e. structure and wholeness will gradually appear. These emergent properties become in the most marked way manifest on the highest level, on the slide as a whole (S).

2.6. The degree of wholeness is determined by the number of the bonds between the elements of the system. If the number of elements is given as n, the highest possible number of bonds will be $n^2 - n$. Each element is linked with all the other elements. If the number of the bonds is n, each element will be linked with only one of the other elements. At a lower number of bonds the system will disintegrate into isolated parts (cf. W. R. Ashby, 3,4/20). The degree of wholeness can be determined after each transformation of the vector. It is given by the percentage of the changing components of the vector. The components which do not undergo changes during transformation — the invariants — are not at all linked with other components (cf. W. R. Ashby, 3).

2.7. Now let us deal with the emergent properties that become manifest when slide is comprehended as a whole, differentiated both with respect to time and space. We shall define slide (S) by four momentaneous states (S_1, S_2, S_3, S_4). Each of the momentaneous states is defined by four components (P_1, P_2, P_3, P_4)[1]. This can be recorded.

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[1] Each momentaneous state can be comprehended equally as a one-, two- *or* up to four-layer slide. This depends on how its parts will be grouped, e. g.

$$S = [S_1 \rightarrow S_2 \rightarrow S_3 \rightarrow S_4]$$

$$S = [({P_1}, {^1P_2}, {^1P_3}, {^1P_4}) \rightarrow ({^2P_1}, {^2P_2}, {^2P_3}, {^2P_4}) \rightarrow ({^3P_1}, {^3P_2}, {^3P_3}, {^3P_4}) \rightarrow ({^4P_1}, {^4P_2}, {^4P_3}, {^4P_4})]$$

2.8. Here we shall follow at first only changes in the first component, i. e. changes in the mechanical properties of the material. The second component will be subjected to identical transformations.

The energy of the entire slide is constant. It will be assumed that the energy of each component will represent 25 % of the total energy; neither velocity nor volume of the part remains unchanged. Four basical situation can occur:

$$1.\ S = [(A, B, C, D) \rightarrow (\mathbf{B}, \mathbf{C}, \mathbf{D}, D) \rightarrow (\mathbf{C}, \mathbf{D}, D, D) \rightarrow (\mathbf{D}, D, D, D)]$$
$$2.\ S = [(A, A, A, A) \rightarrow (A, \mathbf{B}, \mathbf{B}, \mathbf{B}) \rightarrow (A, B, \mathbf{C}, \mathbf{C}) \rightarrow (A, B, C, \mathbf{D})]$$
$$3.\ S = [(A, A, A, A) \rightarrow (A, A, A, \mathbf{B}) \rightarrow (A, A, \mathbf{B}, \mathbf{C}) \rightarrow (A, \mathbf{B}, \mathbf{C}, \mathbf{D})]$$
$$4.\ S = [(A, B, C, D) \rightarrow (\mathbf{B}, B, C, D) \rightarrow (\mathbf{C}, \mathbf{C}, C, D) \rightarrow (\mathbf{D}, \mathbf{D}, \mathbf{D}, D)]$$

The first two cases have a common feature. In the first transformation more variables got changed[2] than in the last one. The degree of wholeness is on the decrease. At the beginning the slide has a high degree of wholeness. After the last transformation only isolated parts do remain. This process is a process of progressive segregation (cf. A. D. Hall, A. E. Fagen, p. 22). However, there is a difference also between the first and the second case. In the first case some of the variables disappear. Finally, after the third transformation, the only variable is repeated four times. These, from the viewpoint of mechanical properties equal parts are not linked reciprocally. We are allowed to speak of four independent slides with equal mechanical properties. This is progressive segregation of the „decay" type (8). We shall call this process „convergent segregation".

In the second case new components come into being. After the third transformation there are four different variables available, i. e. four independent slides with different mechanical properties. This process is progressive segregation of the „growth" type (8). We shall this process „divergent segregation".

Both in the third and in the fourth case the degree of wholeness is on the increase. We are allowed to speak of progressive systematization (8, p. 22). The slide, after the last transformation, constitutes a system with a higher degree of wholeness than it was at the start.

In the third case progressive systemization proceedes from a non-differentiated system towards a system which is internally differentiated. This is the only slide consisting of four parts which possess different mechanical properties. We shall call this process „divergent systemization". In the fourth case the process is reversed. At the start it is a differentiated system, at the end it is homogeneous. This is the only slide consisting of four parts which possess equal mechanical properties; we can describe it also as a slide which is internally non-differentiated. This systemization we shall call „convergent".

$$S_1 = ({^1L_1}, {^1L_2}) = [({^1P_1}, {^1P_2}), ({^2P_3} . {^2P_4})]$$
or
$$S_1 = L_1 = ({^1P_1}, {^1P_2}, {^1P_3}, {^1P_4})$$

[2] In bold type.

2.9. Now let the first component of each part to be subjected to identical transformation. Change will occur in the second component, i. e. in the kinetic energy of the part. The energy of the respective part can both grow and decline. However, the energy of the whole slide will be constant (2.5); for this reason the energy of some parts will be always compensated with the decline of energy of other parts.

Changes in energy can manifest themselves in two ways. One part or several parts of the slide come to the foreground. The prevailing amount of slide energy will be concentrated into these parts. These, from the energetic viewpoint first-class parts can be represented by parts with great volumen or by fast moving parts. Slide energy will be concentrated into growing or accelerating parts. This process we would call centralisation (cf. A. D. Hall, R. E. Fagen (8), p. 22). The process is a reversed one if energy differences become equalized. This process we would call decentralisation.

2.10. Concluding we can summarize that if we comprehend slide as a system, several emergent properties come afore which we can consider as classificatory properties. These are: segregation (two types), systematization (two types), decentralisation and centralisation.

These properties can appear singly, they can alternate in time and space, and they can appear also simultaneously (cf. A. D. Hall, R. E. Fagen, 8).

3. SLIDE AND ENVIRONMENT

3.1. In our treatise we have, up to the present, dealt with slide as a system without environment, being concerned only with its internal structure. In our further dealing with the theme, we shall discuss the relationships of this system to its environment.

3.2. Slide constitutes a mass of rocks in movement. It is a threedimensional body in movement. It has a certain form, a mass (m), velocity (v), a certain kinetic energy (E_k). $E_k = m. v.^2/2$. Slide creeps down on a complex of static rocks. This static body is defined by form, mass (m) and potential energy (E_p), $E_p = m. g. h.$ (g = gravitation, h = height). It constitutes the environment of slide in the widest sense of the word (cf. 3.5.).

Slide and its environment are separated by the sliding plane.

3.3. In a certain moment, part of the static rock becomes separated from it, slide comes into being. It starts to move downward on the sliding plane, the hillslope. This movement lasts a certain time. The slide becomes dislocated to a certain distance and there it stops. At that place it becomes re-integrated into the complex of the static rock.

At the moment of its coming into being, the energy of the slide is a potential energy. In the course of the sliding down this energy gradually turns into kinetic energy. Slide as a process is defined by kinetic energy. In the stage of the slowing down of sliding, its kinetic energy gradually turns into potential energy. Slide as a form is defined by potential energy.

The slide process is a system having a certain kinetic energy. This energy is subjected to changes in the course of the time, it increases or decreases. Sources of energy are the environmental static rocks. The aim of this study is not to elucidate the turning of potential energy into kinetic one and vice-versa. Neither is its aim to elucidate the coming into being of a slide, the process and form of the slide, or to deal with problems of nucleation (cf. 1.6.). We do not raise the question why does energy change but we ask how does it change.

3.4. The potential energy of the slide coming into being is defined by its height above the base of the hillslope, by the mass and gravitation stress. The effect of gravitation stress depends on the form of the hillslope and on the mechanical properties of the material (cohesion and internal friction). Energy, in the moment of the slide's coming into being, is controlled by environment.

The influence of environment on slide does not come to an end in the moment of the slide's starting moving. The gradual change of potential energy into kinetic one remains at least partially under the control of the environment. It is controlled by the shape of the sliding plane (Fig.1.).

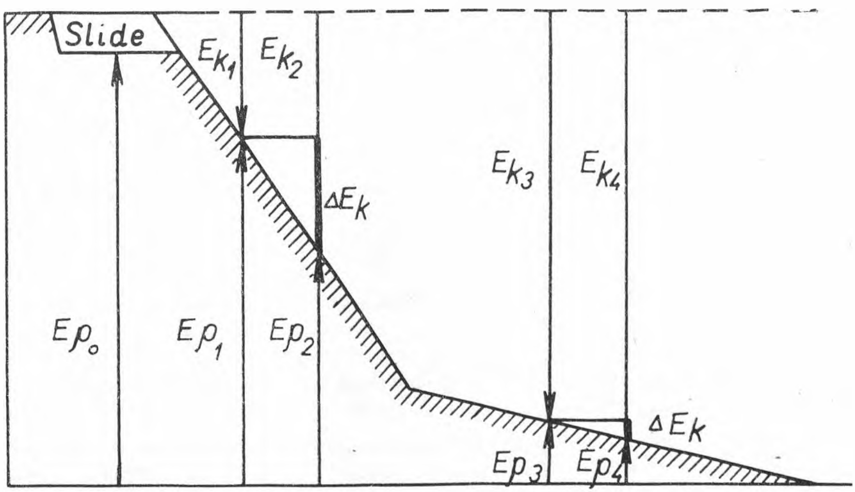

Fig. 1.

An essential characteristic of slide is its feedback action on environment. The shape of the hillslope gets changed by slide (1.4.). During the process of sliding also the mechanical properties of the sliding material are subjected to changes (1.9.). The turning of potential energy into kinetic one is controlled on the one hand by environment, on the other, however, also by the slide itself. The energetic balance is dependent on the interaction of the slide with its environment.

3.5. We have dealt, even if merely very roughly, with the way of energetic changes, and with the interaction of the slide with its environment. From the existence of this interaction itself two consequences can be drawn. In he first place, we are able to define more accurately the environment of the slide. The environment of the slide is not constituted by the entire complex of static rocks, the entire hill, mountain, but only by that part of it with which the slide stands in interaction (cf. 2.2, 3.2.).

3.6. Slide as a system is defined by kinetic energy. If this system stands in interaction with its environment, it makes sense to speak of the slide as a system which is either open or closed to energy. One is allowed to compare it with basical system models according to the definition of L. von Bertalanffy (5). The principal source of energy for the slide is its environment as defined above (3.5.) Slide represents rock movement. A source of secondary importance may be water precipitation. It is to be noted that these system properties, closeness or openness, refer only to slide. A system including both slide and environment, would be always a closed system. Its energy (potential) would decrease (cf. A. D. Hall, R. E. Fagen, 8, p. 23).

3.7. In slide classification we shall lean on the above mentioned system properties, emergent properties. One group of slides will represent a closed system, the second one will include open systems.

Of course, there are many kinds of open systems. L. von Bertalanffy speaks of the hierarchy of such systems. Also A. D. Hall, R. E. Fagen (8), make distinction between them. L. von Bertalanffy (4) writes: „Feedbacks, in man-made machines as well as in

Table 1

1. Closed slides	1. 1. Degenerating slides		1. 1. 1. 1. convergent type 1. 1. 1. 2. divergent type
	1. 2. Adaptive slides	1. 2. 1. shallowing slides	1. 2. 1. 1. convergent type 1. 2. 1. 2. divergent type
		1. 2. 2. shortening slides	1. 2. 2. 1. convergent type 1. 2. 2. 2. divergent type
		1. 2. 3. narrowing slides	1. 2. 3. 1. convergent type 1. 2. 3. 2. divergent type
2. Transitional slides	2. 1. Centralizing slides	2. 1. 1. shallowing slides	2. 1. 1. 1. convergent type 2. 1. 1. 2. divergent type
		2. 1. 2. shortening slides	2. 1. 2. 1. convergent type 2. 1. 2. 2. divergent type
		2. 1. 3. narrowing slides	2. 1. 3. 1. convergent type 2. 1. 3. 2. divergent type
	2. 2. Decentralizing slides	2. 2. 1. deepening slides	2. 2. 1. 1. convergent type 2. 2. 1. 2. divergent type
		2. 2. 2. lengthening slides	2. 2. 2. 1. convergent type 2. 2. 2. 2. divergent type
		2. 2. 3. widening slides	2. 2. 3. 1. convergent type 2. 2. 3. 2. divergent type
3. Open slides	3. 1. Augmenting slides	3. 1. 1. deepening slides	3. 1. 1. 1. convergent type 3. 1. 1. 2. divergent type
		3. 1. 2. lengthening slides	3. 1. 2. 1. convergent type 3. 1. 2. 2. divergent type
		3. 1. 3. widening slides	3. 1. 3. 1. convergent type 3. 1. 3. 2. divergent type
	3. 2. Accelerating slides	3. 2. 1. subsurface slides	3. 2. 1. 1. convergent type 3. 2. 1. 2. divergent type
		3. 2. 2. surface slides	3. 2. 2. 1. convergent type 3. 2. 2. 2. divergent type

organisms, are based upon structural arrangements. Such mechanisms are present in the adult organism, and are responsible for homeostasis. However, the primary regulability, as manifested, for example, in embryonic regulations, and also in the nervous system after injuries etc., is based upon direct dynamic interactions".

It is not easy to apply a hierarchy of this kind on slides. We think, however, that the existence itself of hierarchy can be expressed also in slide classification. We divide slides, behaving like open systems, into two groups.

G. Vickers distinguishes between two types of control of systems, a negative and a positive control. „Positive control is a means whereby courses are chosen and kept so as to reach goals. Negative control is a means whereby courses are changed so as to escape threats" (18, p. 4.).

4. SLIDE CLASSIFICATION

4.1. In the previous chapter, classification of slides was made according to changes occurring in kinetic energy. Kinetic energy of the slide can increase and decrease. These changes can be comprehended as simple growth. A positive or negative simple growth of a certain phenomenon is, as a rule, accompanied also by structural growth (cf. K. E. Boulding, 6). Structural changes were classified in the second chapter. Now we will try to find a relationship between these two classifications.

4.2. The important relationship between simple growth and structural growth evades classification based on physical principles. From the viewpoint of earth mechanics there is no essential difference between a greater or smaller slide. Neither is there an essential difference between faster or slower material movement. L. B. Leopold et al. (11, p. 344) write: „Because this mode of movement is set off from other kinds of mass movement in terms of relative velocity only, no clear-cut distinction really exists between this and more rapid rates of flow".

Several authors (V. C. Finch, 7, E. P. Jemeljanova, 9, A. K. Lobeck, 12, O. Maull, 13) have called attention to the importance of these differences. However, they did not express them with higher accuracy. They were speaking of differences in the volume and velocity of the material in movement, but not of differences in structure.

4.3. Starting out from what has been said above (4.1.) we are going to approach slide classification itself. On the highest level of classification will be classified slides according to their relationship to environment. On lower levels they will be classified according to their internal structure, according to the changing reciprocal relationships between their parts. Only on the lowest level will the mechanical properties come to the fore. Our classification (Table 1) looks as follows:

1. *Closed slides.* Slides of this kind behave like closed systems. Their kinetic energy declines unambiguously to zero. The slide — as a system — disintegrates. It is subjected to the process of progressive segregation. These slides are without any control. Change in slide structure occurs. The slide exerts influence on its environment. However, neither changes of this kind do exert influence on the unambiguous decrease of energy, on the gradual disappearance of the slide. The duration of the whole process is very short. It is a markedly non-recurring process. Unambiguous decrease of kinetic energy is the dominant characteristic of such slides.

1.1. *Degenerating slides.* Slide disappearance is accompanied by a decentralisation process. During the disappearance of the slide its parts remain equivalent from the viewpoint of energy. Energy decrease is equal in all of them. The whole slide comes to a standstill all entirely. No distinction can be made between the more mobile parts of the slide, having a higher kinetic energy and those with lesser motility, having a lower kinetic energy. This will be possible not earlier than at the first appearance of control symptoms. With degenerating slides one classification level falls short. Their cassification will be possible on a further level.

1.1.1.1. *Degenerating slides of the convergent type.* The degenerative process has the character of decay type segregation. During the process of degeneration there is a fading away of the differences of the mechanical properties of the slide parts.

1.1.1.2. *Degenerating slides of the divergent type.* The degenerative process has the character of growth type segregation. In the course of the degeneration the differences of the mechanical properties of the slide parts become more marked.

1.2. *Adaptive slides.* Slide disappearance is accompanied by a centralisation process. The slide differentiates into parts with higher and lower kinetic energy. The slide does not disappear at once. In comes to stop in parts. Other parts go on moving. Adaptive slides have a longer duration than degenerating slides. In adaptive slides there seem to be already the first symptoms of a control. The slide alters it structure and its relationship to environment so as to maintain movement at least in some of its parts. Anyway, the energy of the whole slide declines unambiguously. Not for one sole moment does it persist on one level. It is therefore difficult to speak of a control of the slide as a whole. The appearing symptoms of a control refer only to some parts of the slide. These symptoms of control, the differentiation of the slide into parts unequal from the energetic point of view constitute an essential property of adaptive slides. In their classification one cannot leave out of consideration this new property. As compared with degenerating slides where there were no symptoms of control developed, adaptive slides will possess one more level of classification.

1.2.1. *Adaptive shallowing slides.* Kinetic energy remains conserved for the longest time in the highest situated layers of the slide. The deepest situated layers are the first to stop, the highest ones are the last to come to a stop.

1.2.1.1. *Adaptive shallowing slides of the convergent type.* During the shallowing process of the slide, differences in the mechanical properties of the slide parts are apt to fade away. This is a process of convergent segregation.

1.2.1.2. *Adaptive shallowing slides of the divergent type.* During the shallowing process of the slide, differences in the mechanical properties of the slide parts are apt to become more marked. This is a process of divergent segregation.

1.2.2. *Adaptive shortening slides.* Kinetic energy remains for the longest time conserved in parts situated nearest to the base of the hillslope. The parts to come first to a stop are those situated near to the watershed.

1.2.2.1. *Adaptive shortening slides of the convergent type.* The slide shortens. Differences in its mechanical properties fade away. This is a process of convergent segregation.

1.2.2.2. *Adaptive shortening slides of the divergent type.* The slide shortens. Differences in its mechanical properties become more marked. This is a process of divergent segregation.

1.2.3. *Adaptive narrowing slides.* As first, the slide parts situated on its circumference are coming to a stop.

1.2.3.1. *Adaptive narrowing slides of the convergent type.* The slide is narrowing. Differences in its mechanical properties fade away. This is a process of convergent segregation.

1.2.3.2. *Adaptive narrowing slides of the divergent type.* The slide is narrowing. Differences in its mechanical properties become more marked. This is a process of divergent segregation.

2. *Transitional slides.* Slides of this category do not behave like closed systems. They already exhibit features of open systems. Their energy does not decline unambiguously to zero. The slides — as systems — do not disintegrate. These slides do already control their course. Their control is a negative one. Transitional slides alter their structure and their relationship to environment in a way that they always avoid the threat of disappearance. At the beginning, their energy may decline like in adaptive slides. At variance with them, however, it gets stabilized on a certain level. It does not fall below this level, neither does it grow. Seen from this point of view, we are allowed to speak of kinetic stabilization, or of slides kinetically stabilized. The process of kinetic stabilization can be accompanied by a process of centralisation or decentralisation. An essential characteristic of these slides is their constant energy. The energetical change occurring in one part of the slide is compensated by a reversed change in another part of the slide. However, compensation is possible only if the parts of the slide are reciprocally interconnected by relationships, if the slide represents a system with a relatively high degree of wholeness. Kinetic stabilization is, therefore, accompanied by a process of progressive systematization.

2.1. *Centralizing slides.* The process of kinetic stabilization is accompanied by a process of centralisation. The slide volume decreases. On the other hand this change is compensated by a higher velocity of the slide. Energy gets centralized into several accelerated parts. These are diminishing and accelerating slides. They can be further classified according to the place where the energy of such slide gets concentrated.

2.1.1. *Centralizing-shallowing hlides.* Energy gets concentrated in the highest situated layer of the slide.

2.1.1.1. *Centralizing-shallowing slides of the convergent type.* Differences in the mechanical properties of the parts of the slide fade away. This is a process of convergent systematization.

2.1.1.2. *Centralizing-shallowing slides of the divergent type.* Differences in the mechanical properties of the parts of the slide become more marked. This is a process of divergent systematization.

2.1.2. *Centralizing-shortening slides.* Kinetic energy gets concentrated into the parts situated nearest to the base of he hillslope.

2.1.2.1. *Centralizing-shortening slides of the convergent type.* Differences in the mechanical properties of the slide parts fade away. This is a process of convergent systematization.

2.1.2.2. *Centralizing-shortening slides of the divergent type.* Differences in the mechanical properties of the slide parts become more marked. This is a process of divergent systematization.

2.1.3. *Centralizing-narrowing slides.* Kinetic energy gets concentrated into the parts situated near to the longitudinal axis of the slide.

2.1.3.1. *Centralizing-narrowing slides of the convergent type.* Differences in the mechanical properties of the slid parts fade away. This is a process of convergent systematization.

2.1.3.2. *Centralizing-narrowing slides of the divergent type.* Differences in the mechanical properties of the slide parts become more marked. This is a process of divergent systematization.

2.2. *Decentralizing slides*. The process of kinetic stabilisation is accompanied by a process of decentralisation. Slide velocity decreases. Decreases in velocity is compensated by volume growth of the slide. Energy becomes scattered. These are slowing down and largening slides. The process of decentralisation can take different courses.

2.2.1. *Decentralizing-deepening slides*. The volume of the slowing down slide growth into depth.

2.2.1.1. *Decentralizing-deepening slides of the convergent type*. Differences in the mechanical properties of the slide parts fade away. This is a process of convergent systematization.

2.2.1.2. *Decentralizing-deepening slides of the divergent type*. Differences in the mechanical properties of the slide parts become more marked. This is a process of divergent systematization.

2.2.2. *Decentralizing-lengthening slides*. The decelerating slide growth into length.

2.2.2.1. *Decentralizing-lengthening slides of the convergent type*. Differences in the mechanical properties of the slide parts fade away. Convergent systematization.

2.2.2.2. *Decentralizing-lengthening slides of the divergent type*. Differences in the mechanical properties of the slide parts become more marked. Divergent systematization.

2.2.3. *Decentralizing-widening slides*. The decelerating slide growth into width.

2.2.3.1. *Decentralizing-widening slides of the convergent type*. Differences in the mechanical properties of the slide parts fade away. Convergent systematization.

2.2.3.2. *Decentralizing-widening slides of the divergent type*. Differences in the mechanical properties of the slide parts become more marked. Divergent systematization.

The process of kinetic stabilisation accompanied only by a process of centralisation or decentralisation is limited. A lasting decrease in slide volume and/or velocity cannot be incessantly compensated by growth of velocity and/or volume. Despite compensation, slide energy starts to decrease after a certain time. Kinetically stabilized slide will turn into adaptive or degenerating slide. However, with alternating processes of centralisation and decentralisation, kinetic energy may by maintained on a given level. There is, of course, a third way. Kinetic energy of the slide may grow.

3. *Open slides*. Slides of this category behave like open systems, without, however, their energy getting stabilized on a given level. The control of such slides is a positive one. slides change their structure and their relationship to environment so as to make their kinetic energy to grow. A negative energetic change occuring in any part of the slide is reflected in energetic changes in many other parts of it. Of course, such changes are always positive ones. They surpass the negative effect of the first change. Positive energetic change occurring in any part of the slide entails an equal effect. Positive change in one part becomes multiplied in positive changes of further parts. Such slides are kinetically non-stabilized, their kinetic energy grows. Seen from this point of view, we are allowed to speak of growing slides. Slide growth is possible only if the slide constitutes a system with a high degree of wholeness, higher than in transitional slides. Slide growth is probably analogous to structural growth as suggested by K. E. Boulding (6). Thus, the principle of non-proportional change (6, p. 71) will be valid. The growth of kinetic energy will not apply in equal measure to both of its components, volume and velocity.

3.1. *Augmenting slides*. The growth of such slides refers mainly to their volume. Here, too, the principle of non-proportional change can be applied.

3.1.1. *Augmenting-deepening slides*. Slide volume grows mainly into depth.

3.1.1.1. *Augmenting-deepening slides of the convergent type*. Differences in the mechanical properties of the slide parts fade away. This is a process of convergent systematization.

3.1.1.2. *Augmenting-deepening slides of the divergent type.* Differences in the mechanical properties of the slide parts become more marked. Divergent systematization.

3.1.2. *Augmenting-lengthening slides.* Slide volume grows mainly into length.

3.1.2.1. *Augmenting-lengthening slides of the convergent type.* Differences in the mechanical properties of the slide parts fade away. Convergent systematization.

3.1.2.2. *Augmenting-lengthening slides of the divergent type.* Differences in the mechanical properties of the slide parts become more marked. Divergent systematization.

3.1.3. *Augmenting-widening slides.* Slide volume grows mainly into width.

3.1.3.1. *Augmenting-widening slides of the convergent type.* Differences in the mechanical properties of the slide parts fade away. Convergent systematization.

3.1.3.2. *Augmenting-widening slides of the divergent type.* Differences in the mechanical properties of the slide parts become more marked. Divergent systematization.

3.2. *Accelerating slides.* Energy growth in such slides refers mainly to their velocity. Velocity of all parts does not change equally.

3.2.1. *Subsurface slides.* Acceleration occurs in layers situated deeply under the surface.

3.2.1.1. *Subsurface slides of the convergent type.* Differences in the mechanical properties of the slide parts fade away. Convergent systematization.

3.2.1.2. *Subsurface slides of the divergent type.* Differences in the mechanical properties of the slide parts become more marked. Divergent systematization.

3.2.2. *Surface slides.* Acceleration occurs in layers situated on the surface.

3.2.2.1. *Surface slides of the convergent type.* Differences in the mechanical properties of the slide parts fade away. Convergent systematization.

3.2.2.2. *Surface slides of the divergent type.* Differences in the mechanical properties of the slide parts become more marked. Divergent systematization.

When speaking of the notion of an open or growing slide, naturally the question arises whether the growth of such slide is limited. Slide growth is possible only at a high degree of wholeness; it must be accompanied by a process of progressive systematization. The process of systematization and thus also slide growth is limited by the magnitude of the slide (cf. K. E. Boulding, 6, p. 72). In a big slide, its distantly situated parts do not exert reciprocal influence each on the other. With further growing of the slide, the degree of its wholeness decreases. A process of progressive segregation sets in, the slide disintegrates into isolated parts. Slides that have attained the limits of their structure, are called threshold slides. Independent slides that have come into being by disintegration of threshold slides, always belong to the categories as characterized above. They behave like closed, transitional or open slides.

From the Slovak translated by V. Heller

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