

Hettner's remarks and his arguments. In these he deals with the concepts of Davis—which he considers are not precisely enough formulated—especially the concept of morphological age; further, he points out that inadequate attention has been paid to the character\* of the rock and to the exogenetic processes; and finally he considers the application of the theory to specific cases. At one point only does he touch upon the problem of method, and that is when he levels the reproach against the cycle of erosion that it rests upon inadequate assumptions as to the exogenetic processes. That reproach has already been considered above. But so far as the erosion cycle is concerned, this is only *one* side of the question; for, as has already been shown, it makes further very definite assumptions about the endogenetic processes. Apparently Hettner considers them to be correct and admissible, since he does not examine them also. But the possibility that the deductive method used for the cycle of erosion may be based upon inadequate assumptions does not permit the passing of judgment upon the applicability of deduction itself to the whole sphere of morphological research<sup>12</sup>. In addition, this statement may be made: *In morphology, as in any other branch of knowledge concerned with physical problems, deduction as a means of research is not only permissible, but also imperative; unless we wish to renounce the greatest possible exactitude and completeness in the results, and to exclude our branch of learning from the rank of an exact science, a rank which it both can and should acquire in virtue of the character of the questions with which it deals.* It is merely a matter of finding out where, in the process of investigation, we should resort to the method of deduction; and above all making sure that correct and complete data are then provided for it. The provision of these is, as before, exclusively the domain of inductive observation; it only can accomplish this, the deductive process never. It is by no means the deductive character of the method itself which makes it impossible to go along the American way of applying the cycle of erosion, but the incompleteness and, as will presently be shown, the incorrectness of the assumptions made. Thus opposition to the deductive method as a tool for use in morphological investigation has been unable to do serious harm to the theory of the erosion cycle, and it is not to be expected that it will ever succeed in doing so.

We now turn to the assumption made about endogenetic processes when applying the concept of the cycle of erosion.

#### (b) RELATIONSHIP BETWEEN ENDOGENETIC AND EXOGENETIC PROCESSES

Exogenetic and endogenetic forces begin to act against one another from the moment when uplift exposes a portion of the earth's crust to

[\* See p. 19 for what this term comprises; or glossary.]

denudation. So long as uplift is at work, denudation cannot be idle. The resulting surface configuration depends solely upon whether the endogenetic or the exogenetic forces are working the more quickly. Were there no denudation, a block, however slowly it is rising, might in course of time reach any absolute height; and its increase in altitude would be limited solely by the physics of the act of formation, provided that it is inherent in this not to continue indefinitely. It is rather like the way in which an impassable limit has been set to the increase in height of volcanoes by the extinction of volcanic activity, which often comes to an end prematurely, as soon as a certain height has been reached, because lateral effusions replace the summit eruptions. However, it is from the outset that exogenetic breaking-down at the earth's surface works against endogenetic building-up, i.e. denudation works against uplift, in-filling by sediments against subsidence. It is easily to be understood that an actual elevation can come into existence only if uplift does more work in unit time, and so is working more rapidly, than denudation; a hollow appears only when subsidence takes place more quickly than sediment is supplied, than aggradation. *This state of affairs forms the substance of the fundamental law of morphology: the modelling of the earth's surface is determined by the ratio of the intensity of the endogenetic to that of the exogenetic displacement of material*<sup>13</sup>.

A brief survey of the earth's surface shows that this ratio very often changes, or has changed, to the prejudice of the exogenetic forces; the accumulation of a volcanic cone is possible only because it takes place more rapidly than the removal by denudation of the accumulated material. Faults can become visible as unlevelled fault scarps, for instance in the zone of the rift valleys of East and Central Africa<sup>14</sup>, only when the formation of faults takes place more rapidly than levelling by denudation. Generally speaking, the origin of any outstanding elevation, any mountain mass, is bound up with the assumption that mountain building is more successful, i.e. works more rapidly, than denudation. Thus the varied altitudinal form of the land shows that in many cases the work of denudation is lagging behind the endogenetic displacement of material, here more, there less, or has done so in the past. *The one consistent feature, however, common to every region, is that the activity of exogenetic happenings is subordinate to that of endogenetic processes.* This relationship, most impressively brought to the observer's notice by the different kinds of relief and the different altitudes occurring at the earth's surface, forms the basis of morphological analysis. For if the exogenetic forces are less active than the endogenetic movements, then their effect, the earth's whole set of land forms, must also in its main outlines accommodate itself to whatever law has its visible expression