IS UNIFORMITARIANISM NECESSARY?

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ABSTRACT. Uniformitarianism is a dual concept. Substantive uniformitarianism (a testable theory of geologic change postulating uniformity of rates or material conditions) is false and stifling to hypothesis formation. Methodological uniformitarianism (a procedural principle asserting spatial and temporal invariance of natural laws) belongs to the definition of science and is not unique to geology. Methodological uniformitarianism enabled Lyell to exclude the miraculous from geologic explanation; its invocation today is anachronistic since the question of divine intervention is no longer an issue in science. Substantive uniformitarianism, an incorrect theory, should be abandoned. Methodological uniformitarianism, now a superfluous term, is best confined to the past history of geology.

HISTORICAL DEVELOPMENT

Limited in their interpretation of nature by rigid exigencies of the Mosaic chronology, nineteenth century catastrophists postulated a succession of great upheavals culminating in a "general flood which swept away the quadrupeds from the continents, tore up the solid strata, and reduced the surface to a state of ruin" (Buckland, 1823, p. 224). Their world view extended beyond a simple theory of geologic change; it encompassed a methodological procedure, excluded from the modern definition of science, which permitted direct providential control of earth history. Thus Buckland, whom Gillispie (1959, p. 98) styles "chief architect of the catastrophist synthesis", speaks (1837, p. 436) of "the direct agency of Creative Interference" and quotes his colleague Whewell regarding the control of organic history by "creative power transcending the operation of known laws of nature".

With Buckland's conclusion to regard geology as "the efficient Auxiliary and Handmaid of Religion" (1837, p. 441), Lyell and the uniformitarian school could not agree. To become a science, they affirmed, geology needed not only an empirical theory unencumbered by Biblical preconception, but also a methodology which affirmed the potential natural explanation of terrestrial development and relegated intrinsic mystery to its proper theological realm. The uniformitarian assault was launched from two logically distinct platforms, and the cardinal geologic principle arising from its victory is a dual conception.

Firstly, Lyell strove to replace the paroxysmal theory with a notion of cumulative slow change produced by natural processes operating at relatively constant rates. He writes to Murchison in 1829 of his belief that causes "never acted with different degrees of energy from that which they now exert" (K.M. Lyell, 1881, v. 1, p. 234). Despite considerable wavering, *Principles of Geology* generally asserts that rates of change have been constant: "If in any part of the globe the energy of a cause appears to have decreased, it is always probable that the diminution of intensity in its action is merely local, and that its force is unimpaired, when the whole globe is considered" (1830, v. 1, p. 164-165; all quotes from first edition). Moreover, though he bowed to Darwin's evidence in later editions, his original denial of progression in organic history reflects a belief in uniformity not only of rates but of material

conditions themselves. Thus, uniformitarianism in the first sense—substantive uniformitarianism—is a testable theory of geologic change.

But Lyell was even more interested in controverting the catastrophist methodology which affirmed that geology "could never rise to the rank of an exact science" (1833, v. 3, p. 3); for it could lead only to "hypotheses, in which we see the ancient spirit of speculation revived, and a desire manifested to cut, rather than patiently to untie, the Gordian knot" (p. 6). He thus postulated another, very different, type of uniformity that asserted the invariability of natural laws in space and time as a necessary condition to his contention that reference need only be made to observable processes in explaining past changes. The main force of this proposition was to eliminate supernatural explanations of material phenomena; for this uniformity denies divine intervention (the suspension of natural laws) and affirms that elucidation of earth history belongs to the domain of science, not, as Buckland might have preferred, to quasi-theological inquiry suited more for proving God's grace than understanding natural processes: "Our estimate [Lyell writes], indeed, of the value of all geological evidence, and the interest derived from the investigation of the earth's history, must depend entirely on the degree of confidence which we feel in regard to the permanency of the laws of nature" (1830, v. 1, p. 165; see also Hutton, v. 2, p. 257; and Playfair, p. 421-422). Once accepted, this uniformity ended the dichotomy between a contemporary world operating under constant and verifiable natural laws and a past incapable of purely scientific explanation. The entire geologic record, with all its evidence of vast upheaval and mass extinction, was, for the first time, integrated within the sphere of empirical investigation. Thus, uniformitarianism in the second sense -methodological uniformitarianism-is a statement of proper scientific procedure in general, independent of any particular substantive theory.

The two concepts were not unrelated in Lyell's mind, since he regarded the discrediting of catastrophist theory as prerequisite to the establishment of truly scientific procedure in geology. Yet they remain logically distinct because we may formulate a theory of *natural* catastrophic change that denies substantive uniformitarianism but which, as any scientific theory, must affirm methodological uniformitarianism in requiring that the agents of change be empirically verifiable.

Hall (1843, p. 525) clearly made this distinction in the closing paragraphs of his famous report on the Fourth Geological District: "Though we witness no such extensive or gigantic agencies of transport, as must have existed during former periods [his denial of substantive uniformitarianism], still the law is the same, and the ultimate effect will be attended with like circumstances [his affirmation of methodological uniformitarianism]". In this vein, modern authors have proposed "a milder catastrophism" (Parks, 1925, p. 425), "Neokatastrophismus" (Schindewolf, 1962), or "die Synthese Cuvier/Lyell" (von Bulow, 1960, p. 173). All these proposals utilize methodological uniformitarianism to controvert the more rigid aspects of substantive uniformitarianism. (Though I have distinguished the two concepts by name, geologic literature has consistently designated both simply as "uniformitarianism"—hence the chronic confusion.)

LATER INTERPRETATION

The ambiguity might have been avoided had Lyell given names to his conceptions. The term uniformitarianism, however, was coined by Whewell in a review of Lyell's second volume: "Have the changes which lead us from one geological state to another been, on a long average, uniform in their intensity. or have they consisted of epochs of paroxysmal and catastrophic action interposed between periods of comparative tranquility? These two opinions will probably for some time divide the geological world into two sects, which may perhaps be designated as the Uniformitarians and the Catastrophists" (Whewell, 1832, p. 126). Whewell speaks here of substantive uniformitarianism. Nonetheless, many great nineteenth century geologists, realizing that an exaggerated uniformity of rates was untenable, began to apply his term to Lyell's methodological principle. Dawson (1894. p. 106) writes: "There has thus been uniformity with change and progress, but while the laws of nature and the operations under them have been uniform in kind, we must beware of supposing that they have been uniform in rate". And Davis (1895, p. 8) adds: "Uniformitarianism, reasonably understood, is not a rigid limitation of past processes to the rates of present processes, but a rational association of observed effects with competent causes". Meanwhile Lord Kelvin, in his "Doctrine of Uniformity in Geology Briefly Refuted", continued to confine the term to a rigid substantive uniformitarianism which "assumes that the earth's surface and upper crust have been nearly as they are at present in temperature, and other physical qualities, during millions of millions of years" (Thomson [Lord Kelvin, 1894, p. 6); and King (1877, p. 454) contended that "uniformitarianism claims one dynamic rate past and present".

This pseudocontroversy has continued to the present day as debunkers of uniformitarianism attack the substantive theory while supporters uphold the methodological principle.

Thus Krynine (1956, p. 1003), documenting temporal changes in rates and material conditions, dubbed substantive uniformitarianism a "dangerous doctrine". Zangerl and Richardson (1963, p. 4) dismissed Krynine's objections as "rather pointless" to their methodological definition of uniformitarianism: "The fundamental laws of physics and biology were no different in the past from what they are today". Krynine's contention is indeed irrelevant to this definition, but this is because his attack was directed at something quite different—substantive uniformitarianism. There is no disagreement here, only confusion arising from the use of one term for two concepts.

Further among opponents of the substantive theory, Read (1957, p. 173) contends that "uniformitarianism cannot be true for all time", while Baker (1938, p. 163) holds that "differences in degree, for practical purposes, amount to a refutation of the Lyellian thesis". Among supporters of the methodological principle, Moore (1958, p. 2) defines uniformitarianism as "the conclusion that nature's laws are unchanging," while Longwell and Flint (1955, p. 385) consider it "probably the greatest single contribution geologists have made to scientific thought". Furthermore, a common tendency to dismiss uniformitarianism with a maxim that "the present is the key to the past" solves nothing; for this supposed explanation is as ambiguous as the original term itself. The

present is a key either because we can extrapolate observed rates or conditions to past times (leading to substantive uniformitarianism) or because we establish our natural laws by observing present processes and then extrapolate the laws (leading to methodological uniformitarianism). Both postulate uniformity, but, according to whether this be a uniformity of rates of the material processes themselves or of the abstracted laws by which they operate, two distinct concepts arise.

STATUS OF THE CONCEPT

What then is the status of these two concepts now masquerading under the same name? Substantive uniformitarianism as a descriptive theory has not withstood the test of new data and can no longer be maintained in any strict manner. To choose just one example, the history of life is by no means uniform as witnessed by frequencies of extinction and origination of taxa plotted against time (Newell, 1963; Schindewolf, 1962). Moreover, too rigidly held, this or any other testable theory is transformed into an a priori assumption, stifling to the formulation of new hypotheses which may better explain certain data. For example, a modern supporter of substantive uniformitarianism (Hawkes, 1958, p. 405) writes: "The idea of polar wandering in a series of relatively short spurts from one stable position to another—the 'random walk of the poles'—is heady wine to place before the paleogeographer! It constitutes a departure from the doctrine of uniformitarianism". Surely it is preferable to judge this proposal on its own merit rather than by reference to a preconceived idea of nature's course.

Methodological uniformitarianism as a statement of scientific procedure remains vital to geologic inquiry. However, the assumption of spatial and temporal invariance of natural laws is by no means unique to geology since it amounts to a warrant for inductive inference which, as Bacon showed nearly four hundred years ago, is the basic mode of reasoning in empirical science. Without assuming this spatial and temporal invariance, we have no basis for extrapolating from the known to the unknown and, therefore, no way of reaching general conclusions from a finite number of observations. (Since the assumption is itself vindicated by induction, it can in no way "prove" the validity of induction—an endeavor virtually abandoned after Hume demonstrated its futility two centuries ago.)

The American philosopher C. S. Peirce denied the necessity of an invariance assumption by claiming that an inductive conclusion is self-corrective since additional observations on a recurring sequence of events lead to progressive refinement and closer approximation. In geology, however, our problem is extrapolating from observed to unobservable causes, not the enumeration of a totally observable sequence. To illustrate: The proposition that glaciers produce striations on certain rocks can be affirmed for *present* instances by studying individual cases and determining the frequency with which such striae are glacially caused. An approximate result will be continually corrected and refined as more and more instances are studied. However, the cause of striations produced in former periods is, in principle, unobservable. Only by assuming the invariance of laws regulating causal sequences can we induce

from the effects of modern glaciers that striations in ancient rocks were similarly caused.

Ager (1963, p. 34) uses uniformitarianism synonymously with induction. Since the ecological responses of extinct species cannot be inferred by a simple enumerative induction from living animals (the only ones whose responses can be directly observed), Ager's claim that uniformitarianism has limitations in such instances amounts to an acknowledgment that the evidence required for the desired induction simply does not exist in the modern world. This is the limitation to which induction is subject in any historical inquiry which attempts to explain material configurations that are non-recurring in time.

Another common statement of methodological uniformitarianism is that reference need only be made to presently-observable causes in explaining past changes. To this proposition, the assumption of spatial and temporal invariance of natural laws forms a necessary condition since we otherwise have no warrant for asserting that modern processes acted similarly in past ages. Yet this assumption is insufficient since it provides no reason to deny that other natural processes now inoperative were then effective. This denial requires a simplicity principle stating that we will postulate no unnecessary theoretical processes as long as observable ones can successfully explain past changes. As Lyell himself said (1830, v. 1, p. 105): "It [doubt] should stimulate us to farther research, not tempt us to indulge our fancies in framing imaginary systems for the government of infant worlds.

Thus, we see that methodological uniformitarianism amounts to an affirmation of induction and simplicity. But since these principles belong to the modern definition of empirical science in general, uniformitarianism is subsumed in the simple statement: "geology is a science". By specifically invoking methodological uniformitarianism, we do little more than affirm that induction is procedurally valid in geology. But since we consider geology a science, this affirmation has already been made by definition. Saying it again is at best superfluous and at worst confusing since it leads to the inference that our science has a powerful and unique guiding principle all its own. The unity of procedural assumptions, which binds the empirical sciences together, should not be obscured by terminology specific to one discipline.

As a special term, methodological uniformitarianism was useful only when science was debating the status of the supernatural in its realm; for if God intervenes, then laws are not invariant and induction becomes invalid. It was useful for those who, as Lyell, needed a guide to combat what we now consider unscientific notions of divine intervention and the resultant discordance of past and present modes of change. Their battle has been won, and the weapon which secured the victory deserves to be honorably retired, lest it appear like the crossbow in a nuclear age. The term today is an anachronism; for we need no longer take special pains to affirm the scientific nature of our discipline. Paradoxically, in suggesting that this term now drop from use, we pay a most fitting tribute to its vital role in the history of geology.

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