

# ARTICLES

## HISTORICAL DEVELOPMENT OF THE CURRENT UNDERSTANDING OF THE GEOLOGIC COLUMN: PART II

Richard Ritland  
*Professor of Biology*  
*Andrews University*  
*Berrien Springs, Michigan*

### WHAT THIS ARTICLE IS ABOUT

*In Part I (Origins 8:59-76) of this series on historical interpretations of the geologic column, the author discussed the early developmental stages in the science of geology. After the basic concepts of geological principles were formed, a period of reinterpretation of the earth's crust followed. Part II discusses these times.*

*Notable geologists, including William Buckland, Adam Sedgwick, Roderick Impey Murchison, and Charles Lyell, began to view the earth's formation in terms of very long ages. Though none would accept an atheistic origin for the earth, all felt compelled to believe that Scripture was an inadequate guide to aid their interpretation of the features in the geologic column. God was still considered to be the founder and originator of life. The uniformitarian principle postulated by Hutton years earlier became nearly universally accepted, and the Noachian flood was not considered to be a suitable explanation for the geologic column.*

*In order to answer the problem of increasing complexity within the geologic column, a multiple-creation hypothesis was developed by a number of geologists. God was still actively involved, but the six-day creation week was substituted with a form of progressive creation. The concept of Darwinian evolution which involved gradual change from one species to another was not widespread, and the diversity seen in the geologic column was attributed to multiple-creation events.*

*Realizing that these concepts damaged a literal interpretation of Scripture, conservative Christian scientists reacted understandably in vigorous defense of more traditional views. A time of heated debates and discussions ensued. These exchanges resulted in a polarization of views concerning earth history, a legacy that our current generation continues to inherit.*

### FORMULATION OF THE GEOLOGIC COLUMN

Few, if any, brief periods in the history of science have witnessed a series of breakthroughs and advances comparable to those encountered in the science of geology between 1785 and 1820. The very basic tools essential for study of the crust of the earth had been created and were now in place (see Part I in *Origins* 8:59-76). The nature of igneous and sedimentary rocks, and the processes by which they may be formed (volcanism, weathering, erosion, sedimentation, etc) were clarified. The value of guide fossil assemblages in mapping, correlating, and arranging strata in chronological order had been discovered and successfully applied on a regional scale. Comparative anatomical studies of living vertebrates had provided for the first time a powerful

tool, a key for both meaningful classification and accurate identification of living and fossil forms, hence also terrestrial rock formations. Comparable studies of marine and fresh water invertebrates and plants were in progress. There was a new devotion to exact methods and descriptions. The application of such rigorous methods to fossils elevated the study of geology and of fossils to a respected position.

In the next generation, 1820-1850, we encounter the team of professional geologists who were active when the geologic column was formulated as a system for stratigraphic classification. Our consideration is limited to selected leaders, chiefly from Great Britain, where the greatest advances were made during these decades and where there was the deepest and most general concern for the harmony of science with Scripture.

Most of the geologists included in this section described and named series of fossil-bearing strata which were accepted as the basis for divisions of the geologic column as understood today — periods, epochs, etc. (see Table 1). Most were catastrophists. All accepted multiple creations, a concept Murchison as well as Buckland had been active in developing, and which was quite generally adopted by catastrophists of the 1820s to 1850s. All opposed transmutation of species (evolution).<sup>1</sup> Several were initially trained in theology, moving from thence into the developing science of geology. Werner's Neptunism tended to stultify progress on the continent, where his influence persisted for some years, hence the greatest advances were in Great Britain.

### **William Buckland (1784-1856)**

The Reverend William Buckland, who occupied the chair in geology at Oxford, was the foremost English geologist in the decade of the twenties and continued to be held in high esteem throughout his long career. He had studied theology at Oxford, and during the twenties was one of the leading proponents of diluvial geology and a "chief architect of the catastrophist synthesis."

From newly discovered caverns Buckland described with considerable precision a diverse assemblage of hitherto unknown vertebrates from England including hyenas, lions, tigers, elephants, rhinoceroses, hippopotamuses and nearly two dozen kinds of birds. These remains and others from caves, fissures and alluvial deposits seemed to Buckland (e.g., 1823:726-727) to provide compelling evidence for the universal deluge. Consequently Buckland (1823) described as a discrete geologic unit the diverse gravels, sands, and other alluvial deposits above the Tertiary and below the obviously subrecent deposits, attributing them to the universal deluge. The name given, Diluvial or Diluvium, had been used for similar deposits by Conybeare, Phillips and others, but had not heretofore been accompanied by a regional diagnostic description. Lyell renamed this epoch Pleistocene in 1839 (Zittel 1901:538).

Although Buckland's flood geology (1819:24) was immensely attractive, with wide appeal to many of his contemporaries, it was not particularly conservative by some theological standards. There was adequate confirmation of the Mosaic record provided by the abundant evidence of a universal

**TABLE 1**  
**SELECTED CLASSIFICATIONS OF ROCK STRATA**

	ARDUINO 1759	WERNER 1790s	WILLIAM SMITH 1789, 1812, 1815	CONYBEARE & PHILLIPS 1821-1822	DE LA BECHE 1833		
TERTIARY	— Volcanic	ALLUVIAL	Volcanic	Alluvial	Modern Group		
				Diluvial			
SECONDARY	STRATIFIED (FLÖTZ)	STRATIFIED (FLÖTZ)	STRATIFIED (FLÖTZ)	Upper Marine	Erratic Block Gr.		
				(Freshwater: London Clay Plastic Clay)			
				SUPERIOR ORDER of TERTIARY	SUPERIOR ORDER of TERTIARY	Chalk	Cretaceous Group
						Chalk Marie Green Sand Weald	
				SUPERMEDIAL ORDER	SUPERMEDIAL ORDER	Brick-Earth	Oolitic Group
						Purbeck, Portland Coral Rag. Cornbr.	
				MEDIAL ORDER (Carboniferous)	MEDIAL ORDER (Carboniferous)	Upper Oolite Under Oolite Red-ground	Oolitic Series
						Magnesian Limestone Coal Measures	
				SUBMEDIAL ORDER	SUBMEDIAL ORDER	Mountain Limest.	Purbeck, Portland Coral Rag. Oxford Onferior Oolite - Lias
						Red and Dunstone	
UNSTRATIFIED	UNSTRATIFIED	Granite, Sien Gneiss	New Red Sandstone				
		Granite					
PRIMITIVE	PRIMITIVE	Granite, Sien Gneiss	Red Sandstone Gr. Red Marl Muschelkalk Red Sandstone Zechstein				
		Granite					
PRIMARY	PRIMARY	Granite, Sien Gneiss	Carboniferous Gr. Coal Measures				
		Granite					
UNSTRATIFIED	UNSTRATIFIED	Granite, Sien Gneiss	Millstone-Grit Carboniferous or Mountain Limest. Old Red Sandstone				
		Granite					
UNSTRATIFIED	UNSTRATIFIED	Granite, Sien Gneiss	Transition Limest.				
		Granite					
UNSTRATIFIED	UNSTRATIFIED	Granite, Sien Gneiss	Serpentine Sienite Greywacke Clay Slate				
		Granite					
UNSTRATIFIED	UNSTRATIFIED	Granite, Sien Gneiss	(Inferior strati. Nonfossilif.)				
		Granite					
UNSTRATIFIED	UNSTRATIFIED	Granite, Sien Gneiss	Serpentine. Trap Granite, Volcan.				
		Granite					

TABLE 1 (Continued)

	LYELL 1841	J.P. SMITH 1854	HITCHCOCK 1860 US	1981
POST- PLIOCENE	Recent	(River and Lake Deposits)	Alluvium	Quaternary
	Post-Pliocene	Pleistocene	Recent Pleistocene	Recent Pleistocene
TERTIARY	Newer Pliocene	Pliocene	Pliocene	Pliocene
	Older Pliocene			Miocene
	Miocene	Miocene	Miocene	Oligocene
	Eocene	Eocene	Eocene	Eocene Paleocene
SECONDARY	Cretaceous	Cretaceous	Cretaceous Chalk Gault Greensand	Cretaceous
	Wealdon	Oolitic	Jurassic Wealdon	Jurassic
	Oolite or Jura		Oolitic	
	Lias		Lias	
	Trias or New R Sandstone	Triassic	Triassic	Triassic
	Magnesian Limestone	Permian	Permian	Permian
	Carboniferous Coal Measures	Carboniferous Coal measures	Carboniferous Coal Measures	Carboniferous Pennsylvanian
	Millstone Gr Mountain Limestone	Millstone Gr Mountain Limestone	Millstone Gr Mountain Limestone	Mississippian
	Old Red Sandst or Devonian	Old Red Standst (Devonian)	Devonian Upper Middle Lower	Devonian
	PRIMARY FOSSILIFEROUS	Silurian	Upper Silurian	Upper Silurian (9 units)
		Lower Silurian (Cambrian)	Lower Silurian (4 units)	Ordovician
		Lowest Silurian (Cumbrian)	Cambrian	Cambrian
Cambrian				
	META-MORPHIC	AZOIC	PRE-CAMBRIAN	

catastrophic deluge and the recency of man, two *essential* matters. Moreover, in the crust of the earth on every hand Buckland discerned evidence of design by an all-wise Creator. On this topic he wrote extensively (especially 1819, 1836). Attempting to answer his critics who still felt Scripture was violated, he suggested that early epochs were passed over by the sacred historians “who for moral purposes, had only to let us know there had been a beginning.” The word “beginning” as used by Moses, Buckland suggested, may have been used “to express an undefined period of time which was antecedant ... to the creation of the present animal and vegetable inhabitants,” confining the “detail of his history to the preparation of this globe for the reception of the human race” (Buckland 1819:22-23, cf. Gillispie 1951:102-110).

As further support of his attempted harmonization of geology and Genesis, Buckland appealed to John Bird Sumner, “a divine whose rational and sober piety no person will venture to dispute” (later appointed Archbishop of Canterbury):

*No rational naturalist would attempt to describe, either from the brief narration in Genesis or otherwise, the process by which our system was brought from confusion into a regular and habitable state. No rational theologian will direct hostility against any theory, which, acknowledging the agency of the Creator, only attempts to point out the secondary instruments he has employed.... But we are not called upon to deny the possible existence of previous worlds, from the wreck of which our globe was organized ...* (Buckland 1819:26).

An additional insight into ways geologists attempted to harmonize science and Scripture is well illustrated in a paragraph from the introduction to the book in which the Carboniferous Period is named (cf. Figure 3) and established by Rev. W. D. Conybeare (Conybeare & Phillips 1822:L), a friend and associate of Buckland:

*Before we examine the bearings of physical science on Revelation, our ideas should first be settled as to what may be reasonably expected from Revelation in this respect. Both its opponents, and some of its defendants, often argue as if it should have included the discovery of a system of physical truth; which it would not be difficult to show, gives an entirely erroneous view of its professed object; to treat, namely, of the history of man only, and that even but as far as affects his relations to his Creator, and the dealings of Divine Providence in regard to him.*

These various arguments of Buckland, Sumner, Conybeare and many others in the geological mainstream and the clergy suggest the kinds of thinking which prevailed while the geologic column was being hammered out. But many were not convinced that such arguments were safe or sound, as we shall note later.<sup>2</sup>

As the impact of later geological studies was felt, particularly those of Lyell and of Agassiz on glaciation (Figures 1-2), Buckland had much less to say on the effects of the flood, actually devoting some of his energies in later years to moderating and “explaining away some of the diluvial extravaganzas of his youth” (Millhauser 1959:46).



**FIGURE 1.** View of terminal moraine from a glacier which descended from the hills to the right of the area pictured. One of several moraines described by Buckland (1841) after he, together with Agassiz, first recognized evidence of glaciation in the British Isles (Fall of 1840). Near Thornhill, north of Dumfries, Scotland.

**FIGURE 2.** Cut through the moraine showing unsorted rock matrix.



**FIGURE 3.** Two scale tree stumps from a cluster of 11 stumps and 8 prostrate trunks exposed on a surface approximately 35 by 75 feet. These are among a variety of fossils typical of the Carboniferous system which was described by Conybeare & Phillips in 1822. Victoria Park, Glasgow, Scotland.



### **Adam Sedgwick (1785-1873)**

Reverend Adam Sedgwick, for more than fifty years Professor of Geology at Cambridge University, and Sir Roderick Impey Murchison (1792-1871), Director-General of the British Geological Survey (1855-1871), were geological heavyweights whose numerous major scientific contributions and whose cooperation and conflicts in disentangling the complexities of the lower Paleozoic contribute unforgettable pages to the annals of the history of geology. From this rich and fascinating history only a few additional points are selected that especially bear on the development of the geologic column and the ongoing conflict between interpreters of geology and interpreters of Genesis, often the same persons interpreting both.

In the mountainous country of Wales, and in the Lake District of Cumberland and Westmoreland, there occurs a vast series of variously deformed, folded and faulted rocks with the most complicated structure and relations of any in Britain (Figures 4-5). While it was recognized that they were older and must belong to the "Transition Series," "the chaos of the greywacke" remained obscure long after the basic sequence of Britain had been worked out and mapped. This was exactly the kind of challenge that appealed to Sedgwick, unquestionably one of the keenest field observers of his time. In 1831 he spent two field seasons in North Wales, identifying units, tracing out flexures, displacements and structural relations until he succeeded in resolving the "chaos," in working out the sequence and the major subdivisions which later were to become part of his basis for the Cambrian system.

Of importance to those who may have the impression that geologists erected the geologic column to accord with their ideas of how a succession of fossils should occur, Sedgwick here, as in the comparable sequence in the Lake District to the north, which he had studied ten years earlier, disentangled the sequence entirely without the use of fossils. Only later when the fossils represented were studied was this additional information included in the description.

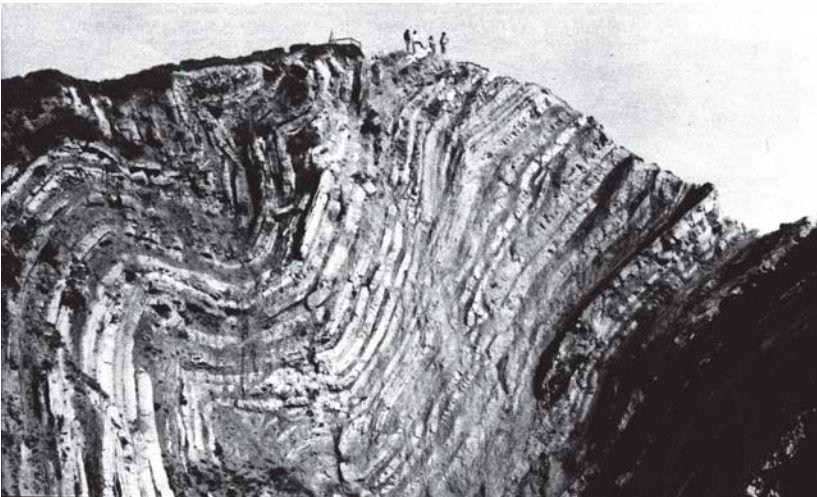
In 1855, long after he had done the work upon which his Cambrian system was established, and after his publication together with Murchison describing the Devonian System (based on the complex folded greywackes of Devon and Cornwall), Sedgwick wrote that "to begin with the fossils, before the physical groups are determined, and through them to establish the nomenclature of a system, would be to invert the whole logic of geology" (quoted in Clark & Hughes, Vol. 2, 1890:307-308).

Sedgwick's willingness to change his opinions when more information led him to question his earlier conclusions is illustrative of his candor. In a presidential address to the Geological Society (1831:313-314), he came out publicly and forcefully against his former belief that the "vast masses of diluvial gravel, scattered almost over the surface of the earth" should be attributed to the Genesis flood:



**FIGURE 4.** Folded Carboniferous strata exposed in sea cliffs at Little Haven, St. Bridges Bay on the southwest Welsh coast. The tectonic activities affecting these strata also profoundly distorted the underlying lower Paleozoic “Transition” series in Wales that were deciphered by Sedgwick and Murchison in the 1830s.

**FIGURE 5.** Exposures of folded and overturned Jurassic strata at Lulworth Cove. Part of an east-west monoclinal complex which records evidence of tectonic disturbances affecting Jurassic and Cretaceous strain in southern England.





*They do not belong to one violent and transitory period.... Our errors were, however, natural, and of the same kind which led many excellent observers of a former century to refer all the secondary formations of geology to the Noachian deluge. Having been myself a believer, and to the best of my power, a propagator of what I now regard as a philosophic heresy, and having more than once been quoted for opinions I do not now maintain, I think it right, as one of my last acts before I quit this Chair, thus publicly to read my recantation.*

In no sense, however, did this mean he denied the Flood. The mistake was in wrongly attributing the so-called “Diluvial” deposits to its actions. He continued:

*Are then the facts of our science opposed to the sacred records? and do we deny the reality of a historic deluge? I utterly reject such an inference.... And in the narrations of a great fatal catastrophe, handed down to us, not in our sacred books only, but in the traditions of all nations, there is not a word to justify us in looking to any mere physical monuments as the intelligible records of that event: such monuments, at least, have not yet been found, and it is not perhaps intended that they ever should be found.*

In 1844, in a long letter to a friend troubled by severe criticisms of geologists made by the influential William Cockburn, Dean of York, and other conservative churchmen, Sedgwick explained how he interpreted the Scriptures to avoid conflict with his interpretation of the geologic strata:

*The two first verses [of the first chapter of Genesis], are an exordium, declaring God the Creator of all material things; and I believe it means, out of nothing, at a period so immeasurably removed from man as to be utterly out of the reach of his conception. After the first verse there is a pause of vast and unknown length, and here I would place the periods of our old geological formations, not revealed because out of the scope of revelation.... The work of actual present creation now begins. The spirit of God broods over the dead matter of the world, and in six figurative days brings it into its perfect fashion, and fills it with living beings (quoted in Clark & Hughes, Vol. 2, 1890:79).*

Because of his prominence and the theological views he adopted in attempting to preserve the integrity of both Scripture and science, Sedgwick was a frequent target of conservative churchmen. In turn, Sedgwick the critic thought some scientific ideas genuinely dangerous to religion, faith and morality, the most insidious of which, in his view, was the idea of transmutation of species (organic evolution), an idea which persisted in coming up from time to time, although never from the mainstream geologists in England. In describing the changing vistas of life that seemed to be exhibited by the fossil record, even as early as 1831 he was constrained not only to interpret these changes as resulting from “creative additions,” but at the same time to disclaim “the doctrines of spontaneous generation and transmutation of species, with all their train of monstrous consequences,” a theory “no better than a phrensiad dream” (1831:305).

In 1844 when the anonymous book by Robert Chambers, *Vestiges of the Natural History of Creation*, introduced a theory of theistic organic evolution ostensibly supported by facts of geology, the whole community of geologists,

so often criticized, became the sharpest critics. The book was well written with an “agreeable style and reverential tone.” Though speculative and containing numerous technical mistakes, it was immediately popular, arousing widespread discussion. There were four editions in the first eighteen months, and eleven editions by 1860.

Such a book called for an answer. Sir Richard Owen, Hugh Miller and Adam Sedgwick prepared the most comprehensive refutations, and other leading geologists wrote shorter critical reviews. Lyell (1851:xxiii) attested to his long-time opposition to such views, endorsing the refutations prepared by these men. Those who had been criticized for “liberal” interpretations of Scripture were now the critics of still more liberal interpretations. They resisted strongly the idea of organic evolution, especially any theory that might degrade man to the level of animals.

In 1845 Sedgwick prepared an 85-page response which he added to his widely read “Discourse on Studies of the University,” and four years later, seeming to sense an ominous threat, he published a comprehensive, 442-page, technical, point-by-point refutation of the transmutation theory as presented by Chambers. Sedgwick searched for the most forceful words at his command to portray the evils that could result. Selections from personal letters to Charles Lyell and Macvey Napier in 1845 are less restrained, conveying his inmost feelings:

*The sober facts of geology shuffled, so as to play a rogue's game; ... the author perpetually shoots ahead of his facts, and leaps to a conclusion, as if the toilsome way up the hill of Truth were to be passed over with a light skip of an opera-dancer.... If the book be true, the labours of sober induction are in vain; religion is a lie; human law is a mass of folly, and a base injustice; morality is moonshine; ... and man and woman are only better beasts! ... arsenic, covered with gold leaf (quoted in Clark & Hughes, Vol. 2, 1890:83-85, 87).*

A few years later, in December 1859, responding in a personal letter to his former student and long-time friend, Charles Darwin, Sedgwick (in Clark & Hughes, Vol. 2, 1890:356) wrote concerning the *Origin of Species*, which presented organic evolution to the world in a far more scientific way, “If I did not think you a good-tempered, and truth-loving man, I should not tell you that ... I have read your book with more pain than pleasure. Parts of it I admired greatly, parts I laughed at till my sides were almost sore; other parts I read with absolute sorrow, because I think them utterly false and grievously mischievous.”

This was one of the founders of the geologic column, the Sedgwick who described and named the Cambrian and, together with Murchison, the Devonian Systems.

### **Sir Roderick Impey Murchison (1792-1881)**

The other major participant in unraveling the Lower Paleozoic Systems, the “chaos of the greywacke,” was Murchison who went to South Wales and worked from the top of the section down, while Sedgwick in the north was working from the bottom up. Murchison was by 1835 able to present to the Geological Society a carefully worked sequence of the units in the upper

Transition rock together with accurate descriptions of lithology, fossil and physical relations, although the details of its lower member, including boundary relations with still older rocks to the north, remained in doubt. His classic monograph, *The Silurian System*, appeared in 1839. The deformed and faulted strata resulting from the complex tectonic history, combined with a sparsity of fossils, made system and member divisions and boundaries difficult to recognize clearly at some levels (Figures 4-5).

Thus, when Murchison heard that comparable rocks in a nearly horizontal position were widespread in Russia, he was pleased to accept an invitation from the Czar to study the strata. There he was able to demonstrate the wide geographic extent of the Silurian and Devonian Systems. He also encountered and studied a series of strata in the province of Perm which appeared to be equivalent in position and age to the “Red Underlyer” and “Zechstein” formations of Germany and part of the “New Red Sandstone” of Britain. Since they were far more diverse lithologically and more widely exposed, he proposed in 1841 their designation as the type area for a new system — the Permian — and that they be included as the youngest system of the recently named Paleozoic succession (Zittel 1901:454). Thus Murchison was responsible for establishing three of the twelve basic systems — Silurian, Permian and, together with Sedgwick, the Devonian — a larger number than any other worker.

#### **John Phillips (1800-1874)**

John Phillips, William Smith’s nephew who was later to succeed Buckland at Oxford, developed museums in York, London, Dublin and Oxford. Consequently he had to arrange fossils from many of the systems, giving him an overview. In the field he revised and reworked with great care and detail the fossil sequence in the Devonian of Cornwall and Devon that had long presented problems (1841).

In 1841 Phillips proposed that the name Paleozoic (sometimes applied by Murchison and Sedgwick to the Silurian) should be used in a more inclusive sense for all of the systems of the Transition of Werner (Cambrian to Devonian) as well as the overlying Carboniferous and Zechstein (Permian in 1845); that Mesozoic be used for the remainder of the Secondary (Triassic, Jurassic and Cretaceous); and Cainozoic be used for the Tertiary. The suggestion met with favor, and soon became generally accepted. The geologic column was taking shape.

In the development of the geologic column some systems, such as the Jurassic and Cretaceous, were partially or essentially completely worked out before receiving their present names. “In the very beginning of the nineteenth century the fundamental features of the Jurassic succession had been so securely established” by the founder of the index fossil concept, William Smith, “that subsequent observers had little to amend” (Zittel 1901:497). Placed together under the Oolitic series, it appeared with some refinements in W. D. Conybeare and W. Phillips, *Geology of England and Wales* in 1822. Eventually the

designation “Jurassic System,” based on studies of favorable deposits exposed in the Jura Mountains of France and Switzerland, was generally adopted.

### **Sir Charles Lyell (1797-1875)**

The most esteemed position in geology in the 19th century is often accorded to Charles Lyell, not because of any geological discovery or breakthrough, although he did a fair share of original work, but rather because of the profound influence he exerted on his contemporaries and on the development of geology since that time. It has been said that “even though he had numerous forerunners,” modern geology began with him (Simpson 1975:262).

Lyell’s most famous work, *Principles of Geology*, appeared in 1830.<sup>3</sup> In it he organized the geological information of his time, deducing therefrom the far-reaching underlying principles and processes as he understood them (Figures 6-7). It was an assault both on Wernerian Neptunism and the catastrophism of Cuvier, theories which had attracted a significant following among geologists. Within a few years of its appearance it had convinced most geologists, even catastrophists, that the great majority of changes in the physical world are the result of ordinary geological processes, mostly of a gradual nature, such as may be observed in operation today.

Lyell’s support of the uniformitarianism of Hutton goes farther than many geologists are willing to go today. That the present is the key to the past, the forces and processes active in nature today — erosion, deposition, cooling, crystalization, etc. — provide clues to understanding similar processes in former times, is universally accepted. That the rates and magnitudes of geologic activity have dominantly remained at the same level has, as indicated above, faced serious challenges (e.g., see Gillispie 1951:134-135).<sup>4</sup>

Lyell’s principal contribution to the geologic column was the formalizing and naming of three subdivisions for the Tertiary — Eocene, Miocene, and Pliocene — which appeared in an early edition of *Principles*. One of his bases for considering these as valid natural divisions was the consistent decrease in the proportion of living species of marine shells in the progressively older epochs. Later in the decade, he proposed that the name Pleistocene be used for Buckland’s Diluvium, a term which by this time was recognized to be misleading and confusing (Wilson 1972:305-308, 483-485).

Although Lyell was the chief apostle of uniformitarianism, he believed in a Creator, and during the years the geologic column was being established he opposed both evolution and those popular views of progressive creations that involved an advance or trend toward higher types. Lyell (1832:271-272) deemphasized the Genesis flood as a universal geological agency, confining it to the parts of the world inhabited in the days of Noah. “On the contrary, the olive-branch brought back by the dove, seems as clear an indication to us that the vegetation was not destroyed, as it was then to Noah that the dry land was about to appear.” Some years after *Origin* appeared he accepted the theory of the origin of species by evolutionary processes.



**FIGURE 6.** Manor house on the Kinnordy estate near Kirriemuir, Scotland, where Charles Lyell was born in 1797. The estate is still held by the Lyell family. As with Darwin, family wealth supplemented by income from his books allowed Lyell to devote his full energies to the study of his chosen area of science.

**FIGURE 7.** Glen Tilt in the Grampian Highlands of Scotland where Hutton in 1785 discovered granite veins that had intruded sedimentary rock and altered the rock bordering the veins. These observations were basic both in demonstrating the igneous origins of granite and in providing evidence for “metamorphism,” the latter term introduced by Charles Lyell who adopted and expanded many of Hutton’s views. Lyell visited the classic locality with Buckland in 1824.



## **Louis Agassiz (1807-1873)**

During the early years of his career Agassiz lived in his native Switzerland, in Germany and in France, where he came under the spell of and developed a close friendship with Cuvier. The scientific studies which led to his reputation as the most respected geologist on the continent were published in his five-volume monograph of brilliant original research on fossil fishes (1833-1843), his extensive studies of glaciation, which resulted in the general acceptance of the concept of widespread continental as well as alpine glaciation (1836-1846), and his valuable studies on fossil echinoderms and molluscs. The last 27 years were spent in America, mostly at Harvard, where he founded the Museum of Comparative Zoology, and became famous for his unparalleled skill as a teacher, for his vigorous opposition to Darwinian evolution, and for his adherence to strict fixity of species.

While visiting Agassiz in 1838 in Switzerland, William Buckland was shown clear evidence of formerly much more extensive alpine glaciation. After the British Association meetings in Glasgow in 1840, Agassiz and Buckland set out to search for similar deposits which Buckland recalled having seen years before in Scotland (Figures 1-2). They soon encountered the typical moraines, glacial till, and polished, furrowed and striated surfaces so characteristic of glaciated regions. Buckland now recognized that much of what he had been calling Diluvial was, in fact, of glacial origin. Buckland immediately went to see Lyell at his home at Kinnordy, and the two men set out in search of glacial deposits. They were present on every hand. The pieces of the long-standing enigma — terminal moraines and till lacking the sorting (Figure 2) and the form to be expected in deposits of running water from floods or streams, polished and striated surfaces, erratic boulders, kettle lakes, and bogs — finally fell into place perfectly, solving a host of difficulties. Lyell was convinced.

Both men prepared papers on glaciation in Scotland which were given after a paper by Agassiz at the Geological Society meetings the following December. “The declaration of Buckland and Lyell in favor of Agassiz’s glacial theory created a sensation” (Wilson 1972:500-501). Though there was strong resistance, as is always the case with new insights and interpretations, it soon faded as others compared the evidence with that in the vicinity of existing glaciers. As a result, the events responsible for the Pleistocene series as presently understood became generally recognized.

The role of Agassiz in the development of the progression theory will be taken up in the section on the multiple creation hypotheses which follows.

### **MULTIPLE CREATION HYPOTHESES**

It has been shown that during the decades when the geologic column was being formulated, the founders had nearly all come to have certain beliefs and working hypotheses, including among others the following:

1. The history of life on the earth involved extended periods of time vastly longer than six thousand years.

2. Some organisms had a much longer history on the earth (fossil record) than others.
3. “Transmutation of species” (organic evolution) could not account for the later appearance of forms restricted to the more recent strata (belief based on both their understanding of evidence as well as their philosophical and religious views).

Although the geologists of this period were indebted to Cuvier for the theory of catastrophes, he seemed to prefer to explain the increasing proportion of extinct and unfamiliar forms he encountered in progressively older formations as a consequence of migration from distant areas, such as Australia, where a very different fauna exists, rather than from new creations. “I do not pretend that a new creation was required for calling our present races of animals into existence, I only urge that they did not anciently occupy the same places” (1812, trans. 1817:125-126). But elsewhere in the same essay he made statements that would lend support to the idea that he may have entertained the possibility of later creations of some fauna such as mammals and man. “... we are also led to conclude that the oviparous quadrupeds [reptiles] began to exist along with the fishes, and at the commencement of the period which produced the secondary formations; while the land-quadrupeds [mammals] did not appear upon the earth till long afterwards ...” (1817:107-108, translation of 1812 essay; compare p 171, 181 on recent appearance of man).

A theory of creative additions of new and different forms of life *in response to needs of a changing physical environment* was a concept that was expressed by a number of its leading exponents. Generally a view of *directional but discontinuous change* resulting in a *gradual ascent towards a higher type of being* was also expressed, hence the common designation “progressive creation.”

As early as 1808, three years before Cuvier’s theory of catastrophes was proposed, Robert Jameson, the famous Wernerian supporter in Edinburgh, postulated a succession of creations in which both animals and plants increased “in number, variety and perfection” from changing physical conditions as universal seas of Werner retreated and new habitats were formed (Gillispie 1951:99; Bowler 1976:34, 35).

Buckland (1836:107, 115) also included both the concepts of response to physical conditions and of directional change:

... *The creatures from which all these [fossils] are derived were constructed with a view to the varying conditions of the surface of the Earth, and to its gradually increasing capabilities of sustaining more complex forms of organic life, advancing through successive stages of perfection (emphasis supplied).*

But he qualified it by stating that while the “lower classes prevailed *chiefly* at the commencement of organic life, ... they did not prevail *exclusively*.” He gave numerous examples of complex forms in some of the “earliest strata.”

Sedgwick also envisions “a gradual evolution of creative power, manifested by a gradual ascent towards a higher type of being,” but he goes on to point out explicitly that:

*... The elevation of the fauna of successive periods was not made by transmutation, but by creative additions; and it is by watching these additions that we get some insight into Nature’s true historical progress, and learn that there was a time when Cephalopoda were the highest types of animal life, the primates of this world; that Fishes next took the lead, then Reptiles; and that during the secondary period they were anatomically raised far above any forms of the reptile class now living in the world. Mammals were added next, until Nature became what she now is, by the addition of Man (quoted by Lyell 1851:xxxiii, xxxiv; Bowler 1976:37).*

Elsewhere he states that “successive forms of animal life adapted to successive conditions.”

Louis Agassiz is credited with developing and articulating a second version of progressive creation that *does not relate creative advance to change in the physical world*, but rather to a *grand design in the mind of God, leading from lower vertebrates to man*, and with parallel lines from lower invertebrates to more complex types. The steps were discontinuous, resulting from a series of miraculous creations in successive epochs. “As for me, I am convinced that species have been created repeatedly and successively ... and that the changes which they have undergone during any one geologic epoch are no more than very secondary and related only to their greater or lesser fecundity and to the migrations resulting from the influences of the period” (from his monograph on fossil fish 1833-1843, quoted by Gillispie 1951:166).

Sometimes he is ridiculed for suggesting that blind fish were created blind and placed where they live in perpetually dark caves by the Creator. But viewed as part of a grand created mosaic, one can understand the basis for his belief. For Agassiz, the development of the embryo was a recapitulation of the steps existing in the fossil record. “It may therefore be considered as a general fact ... that the phases of development of all living animals correspond to the order of succession of their extinct representatives in past geologic times” (quoted by Gould 1977:67).

Several others, such as Sedgwick and Lyell, strongly opposed any scheme that linked man with lower animals, such as Agassiz’s recapitulation theory might suggest, though Agassiz would never allow an organic link. Most of the other founders of geology and the geologic column might be added to this list of those supporting one or a combination of elements from both views of progressive creation: Roderick Murchison, W. D. Conybeare, John Phillips, Sir Richard Owen, Hugh Miller, and Adolph Brongniart.

Lyell’s hypothesis embodied two basic differences: 1) *creation of new forms was not sporadic or episodic*, but a process which went on perpetually, and 2) it was *not directional with a pattern of progression* toward higher or more perfect forms. In Volume II of *Principles* (1832:124) he suggests that the



pairs from which each species is derived have “been created in succession at such time and in such places as to enable them to multiply and endure for an appointed period, and to occupy an appointed space on the globe.” In a letter to the British astronomer John Herschel, he confides that when he first “came to the notion, which I never saw expressed elsewhere, ... of a succession of extinction of species, and creation of new ones, going on perpetually now, and through an indefinite period of the past ... the idea struck me as the grandest which I had ever conceived so far as regards the attributes of the Presiding Mind” (quoted by Wilson 1972:439).

Lyell’s opposition to both transmutation of species and progressive creation is clearly articulated, but there were aspects regarding creative introductions of species on which he was not as clear. Nor was it yet resolved nineteen years later:

*By the creation of a species, I simply mean the beginning of a new series of organic phenomena, such as we usually understand by the term ‘species.’ Whether such commencements be brought about by the direct intervention of the First Cause, or by some unknown Second Cause or Law appointed by the Author of Nature, is a point upon which I will not venture to offer a conjecture (1851:lxiii).*

## **CONSERVATIVE OPPOSITION TO GEOLOGICAL THEORIES**

Virtually all of the founders of geology, including the uniformitarians Hutton and Lyell, were men with a belief in God, in a divine plan, a Presiding Mind. Many of the most prominent contributors were, in fact, trained in theology as well as geology — Conybeare, Buckland, Sedgwick and others. But as has been noted, several of the prevailing interpretations of the unfolding data of geology required a departure from traditional understanding of Scripture. For advocates of such interpretations Genesis could no longer be taken as a literal or complete account. There must be room to allow for greatly extended time periods, multiple creation events, and secondary causes.

There were reputable theologians who supported such views. Sir Robert Peel was even able to appoint Buckland to a prominent church position as Dean of Westminster, successor of Wilberforce (Gillispie 1960:152). But there were many, very many, who felt that irreparable damage to faith would result. There were countless articles, debates, and denunciations from respected theologians such as William Cockburn, Dean of York, who once debated Sedgwick. Even the most devout, the “unimpeachably pious” William Buckland, who continually sought to harmonize geological findings with Scripture, who opposed transmutation of species, who sought out evidence for the deluge, and who wrote two large volumes (1836) “on the power, wisdom, and goodness of God as manifested in the creation” for the Bridgewater Treatise series, came under repeated and sharp attack. Irrespective of “good intentions,” it was felt that these men were undermining the authority of Scripture, starting down a road that eventually would lead men to infidelity and atheism.

Not a few conservative scholars and churchmen made the study of the relation of geology and Genesis a part of their life work, reading the extensive

body of new literature in the rapidly expanding field, traveling in some instances to important rock exposures in Britain and Europe, and writing a large number of books. Lyell, in his 1851 (xxxii) president's report to the Geological Society, commented on this "voluminous class of books commonly called Scriptural Geologies," indicating that "several had been issued from the press even since the last anniversary" in a single year (1850-1851). They were of an apologetic nature, since, so far as I have been able to determine, none of these authors published field or laboratory studies that contributed to the formulation of the new science. These books, however, do provide important insights into the intellectual milieu of the time, and especially the kinds of objections being raised during those years when the geologic column was being worked out and geology was being established as a science.

Three of the more comprehensive studies written early in the period when the systems of the geologic column were being formulated have been selected for brief comment.<sup>5</sup> Common features include:

1. Lengthy exegeses of relevant Scriptures in an attempt to demonstrate that the traditional understanding of the time constraints of Scripture and the literal nature of the account must be followed.
2. Attempts to explain in hundreds of pages how much of the evidence alleged to represent extended periods may be best accounted for by the Genesis flood, and to show how it does not support "modern interpretations."
3. A deep concern for the potential impact on faith of this prevailing trend in the new science.

These books also share many features with the writings of flood geologists which appeared about a century later. In many respects their books are surprisingly similar to publications of Price, Rehwinkel, Whitcomb & Morris, and others.

### **Conservative Concern**

The profound concern for the effect on faith is well expressed by Penn (Vol. I, 1825:xix-xxii):

*If there is anything that tends more than another to perplex the thoughts of the believer in Revelation in this age of geological inquisition, it is unquestionably the objects with which he sees himself surrounded in the disordered scenery of the globe, when he is urged to contemplate them as they are adventurously expounded by persons who resist all connexion of them with the narrative of Scripture; and when, moreover, their expositions are dogmatically asserted, to be the proper dictates of philosophy. And, as the exposition of these objects has hitherto been almost exclusively adventured by persons who have systematically resisted that connexion, a reflecting mind is bewildered by the difficulty of reconciling the author of the objects which are seen, with the author of the statements which are read; and seems often driven near to the distracting doubt, whether they can be One and the Same, and*

*consequently, whether the first and introductory record of the body of Scripture can be truly of divine original: for, we are sure, that Nature is of divine original.*

In reference to those who would suggest that it is the “*professed object of Revelation to treat the history of man only,*” he warns of the danger and insecurity in attempting to determine what one may “*deem reasonable for Revelation to have imparted.*”

The pulse of many who were less involved yet genuinely concerned is echoed in verse in the writings of contemporary poets:

*Some drill and bore  
The solid earth, and from the strata there  
Extract a register, by which we learn  
That He who made it, and revealed its date  
To Moses, was mistaken in its age.*

— William Cowper, in “The Task”  
Late 18th century.

*I could get along very well if it were not for those geologists.  
I hear the clink of their hammers at the end of every Bible verse.*

— John Ruskin, 1851

## Sharp Exchanges

This section deals with a chapter in history which one could wish might not need to be included, yet which is part of the intellectual milieu that affects observation, interpretation and often selection of data. The tendency toward polarization which invariably results from accusations, charges and counter-charges almost always leads people to try to support positions taken rather than to search for truth.

Typical of the more extreme charges made by certain conservative writers are comments and phrases selected from George Fairholme, 1833, *Geology of Scripture* (x-xii, 14, 15, 70, 147):

*“It was then the fashion of science, and for a large part of the educated and inquisitive world, to rush into disbelief of all written Revelation.”*  
*“The wild character of an hypothetical philosophy.”* *“Hasty and erroneous conclusions from physical facts.”* *“Geologists (if indeed they are deserving of the name), whose great delight in this subject arises from the play of fancy under a false view.”* *“Wild and absurd.”*  
*“Wild and repulsive to our reason,”* *“unreasonable theories.”*  
*“Plunges into dark and devious mazes of hypothesis, rejects the guidance of history.”*

On the other side, “Scriptural Geologists” were sometimes alleged to be guilty of grievously misrepresenting “principal facts in the natural history of the earth,” of lacking “practical acquaintance” with the subjects on which they held positive opinions, and of arbitrary “interpretations of the ‘sacred books’” (Smith 1839:220, 30-31; cf. Ramm 1954:125-126). They are not uncommonly recipients of the epithet “lunatic fringe” (Gillispie 1951:152; Simpson 1960:144).

## The Conservative Approach

*The HISTORY OF CREATION is strictly a narrative of plain fact. The “LITERAL and popular interpretation” of that history ... is the only correct and true interpretation.*

*The SCRIPTURAL ACCOUNT of the DELUGE, will alone account for the phenomena of the fossil strata (George Bugg, Vol. 2, 1827:347).*

*I propose, in the following pages ... to account for the geological structure of the upper surface of our earth; taking in Mosaical History for my guiding star, to be kept constantly in view throughout my course” (Fairholme 1833:xi).*

## Conservative Positions on Data and Explanatory Models

It is impossible to capture or to fairly portray in the space available even the principal arguments set forth in these comprehensive studies. Perhaps a few sentences on Fairholme’s views, and brief quotations from the concluding remarks in the volumes by Penn and by Bugg, may convey something, at least, of the essence of their thinking, and may reflect the confidence and depth of feeling with which they were set forth.

Fairholme (1833:57-102 and elsewhere in his volume) attributed strata in the crust of the earth to deposits at the creation, the 1600-year-antediluvian-period, and the deluge of Genesis. There are some rudiments of the ecological zonation theory (a theory that proposes pre-flood ecological patterns as a factor in the sequence of fossil distribution) in his account, and he recognized bias in preservation as a factor, and much more.

Major theories opposed are cited:

*Exclusive and peculiar fossils are wholly without evidence, — numerous successions and revolutions are unsupported and impracticable, — while the new creations they would involve, are miraculous and destructive to the Theory, and even to the Scriptures...(Bugg, Vol. 2, 1827:346).*

The Genesis flood is central to suggested explanatory models.

*The DELUGE affords an EPOCH among ANIMALS, by which the inexplicable phenomena found by Geologists, are easily explained; as far at least, as they are in our present state of ignorance intelligible to us. The shells of 16 centuries, elevated by the breaking up of the bottom of the sea, partly, perhaps in a consolidated state, partly in a slimy mud, and partially in a loose state, account for all the shells in the rocky strata, and (in connexion with those deposited during the Deluge) for shells scattered through the globe...(Bugg, Vol. 2, 1827:347).*

Penn’s model (Vol. 2, 1825:387) similarly utilizes the deposits, including the biomass, of antediluvian centuries for redistribution during the year of the flood.

*But, when we can be certified by competent testimony, that the body of the ocean acted both mechanically and chemically upon the present surface of the earth for sixteen hundred years and upwards, during which long period a vast proportion of its soils, now fixed and indurated, were soft and moveable; that, during the twelve months of its gradual departure, during which it was “sweeping over the whole globe,” it*

*was continually propelling over every part of that surface its various moveable soils, together with the animal and other contents of its basin; that, its propulsions were not uniform but irregular; and alternating according to its successive advances and refluxes...*

### **Conservative Conclusion**

But as to the modern “Theory” of Geology, in all its essential properties ... [it] is not more contradictory to the plain meaning of Scripture, than it is to every known operation of nature, and every dictate of rational understanding (Bugg, Vol. 1, 1826:xv-xvi).

“ — BIBLE THEREFORE STANDS PERFECTLY UNAFFECTED.

“ — AND GEOLOGY FALLS TO THE GROUND” (Bugg, Vol. 2, 1827:348).

### **CONCLUSION**

It has been demonstrated that the basic framework of the geologic column was founded by men with respect for Scripture, who, although not holding to conservative interpretations, opposed organic evolution. Anyone who reads the original literature will soon recognize that there was no conscious conspiracy on the part of these scientists to undermine the moral and religious authority of Scripture as sometimes has been charged. Completely apart from any merits or weaknesses, the geologic column is the result of an attempt by conscientious scientists to construct to the best of their ability a classification of rock strata that would account for the phenomena encountered in the crust of the earth.

### **ENDNOTES**

1. Although not yet introduced by Darwin and Wallace, transmutation of species was the topic of frequent discussion, especially in the years following 1844 when it was introduced to the public in the widely read book, *Vestiges of the Natural History of Creation*, by an anonymous author (Robert Chambers).
2. Those among the founders of geology who were flood geologists generally followed Cuvier and Buckland in assigning to the flood only the superficial Pleistocene deposits. The great thickness of older strata was assigned to earlier episodes in earth history. The “Scriptural geologists” and flood geologists of recent decades (e.g., Price 1923; Whitcomb & Morris 1961; Rehwinkel 1951; Coffin 1969; Clark 1946) generally assign almost all of the earlier deposits to the flood and the Pleistocene (Buckland’s Diluvial) to either the flood or to postflood times.
3. One sometimes gets the impression that Lyell’s work was the first manual or textbook of geology. This is not correct. Several texts and manuals appeared in Britain before or about that time, some going through a number of editions and being printed in the U.S. and on the continent of Europe as well (Greenough, 1819, *First Principles of Geology*, London, 336 p.; de la Beche, 1833, *Manual of Geology*, 3rd ed., London, 622 p.; Conybeare & Phillips, 1822, *Geology of England and Wales*, London, 470 p.; Bakewell, 1829, *Introduction to Geology*, 3rd ed., London, 429 p.). Lyell’s volumes differed in being not only a review of what was known, but also a creative synthesis which challenged much current theory.
4. A number of recent books and articles illustrate the trend. The delightful book by Derek V. Ager, 1973, *The Nature of the Stratigraphical Record*, John Wiley & Sons, New York, is one of the most perceptive and refreshing approaches,

comparing earth history to the life of a soldier — “long periods of boredom and short periods of terror.”

5. (a) Granville Penn, 1825. *A Comparative Estimate of the Mineral and Mosaic Geologies*, 2nd ed. in two vols. London. 866 pages. (b) George Bugg, 1826, 1827. *Scriptural Geology; or Geological Phenomena Consistent only with the Literal Interpretation of the Sacred Scriptures, upon the Subjects of the Creation and the Deluge; In Answer to an “Essay on the Theory of the Earth” by M. Cuvier, ... and Buckland’s Theory ... as Delineated in his “Reliquiae Diluvianae”* (especially on the fossil vertebrates and deposits interpreted by Buckland to have resulted from the Deluge). In two volumes. London. 735 pages. (c) George Fairholme, 1833. *General View of the Geology of Scripture, in which the Unerring Faith of the Inspired Narrative of the Early Events of the World is Exhibited, and Distinctly Proved by the Comparative Testimony of Physical Facts, on every Part of the Earth’s Surface*. Philadelphia. 293 pages.

### REFERENCES CITED

- Ager DV. 1973. The nature of the stratigraphical record. NY: John Wiley.
- Bowler PJ. 1976. Fossils and progress. NY: Science History Publication.
- Buckland W. 1820 (1819). *Vindiciae Geologicae or the connexion of geology with religion explained*. Oxford: University Press.
- Buckland W. 1823. *Reliquiae diluvianae*. London: John Murray. Reprinted 1978 by Arno Press (NY).
- Buckland W. 1836. Geology and mineralogy considered with reference to natural theology. Vols. I, II. (In Bridgewater Treatise Series). London: William Pickering.
- Bugg G. 1826, 1827. *Scriptural geology*. Vols. I, II. London: Hatchard & Son.
- Chambers R. 1844. *Vestiges of the natural history of creation*. London: J. Churchill.
- Clark HW. 1946. *The new diluvialism*. Angwin, CA: Science Publications.
- Clark JW, Hughes TM. 1890. *The life and letters of the Reverend Adam Sedgwick*. Vols. I, II. Cambridge: University Press.
- Coffin HG. 1969. *Creation — accident or design?* Washington DC: Review & Herald Publishing Association.
- Conybeare WD, Phillips W. 1822. *Outlines of the geology of England and Wales*. London: W. Phillips. Reprinted 1978 by Arno Press (NY).
- Cuvier M. 1817. *Essay on the theory of the earth*. Edinburgh. Reprinted 1978 by Arno Press (NY); translated from 1812 book.
- de la Beche H. 1833. *Manual of geology*. 3rd ed. London.
- Fairholme G. 1833. *General view of the geology of Scripture*. Vols. I, II. Philadelphia.
- Gillispie CC. 1951. *Genesis and geology*. Cambridge, MA: Harvard University Press.
- Gillispie CC. 1960. *The edge of objectivity*. Princeton, NJ: Princeton University Press.
- Gould SJ. 1977. *Ontogeny and phylogeny*. Cambridge, MA: Harvard University Press.
- Hitchcock E. 1860. *Elementary geology*. NY.
- Lyell C. 1830-1833. *Principles of geology*. Vols. I-III. London: John Murray.
- Lyell C. 1841. *Elements of geology*. Vols. 1 and 2, 2nd ed. London: John Murray.
- Lyell C. 1851. Anniversary address of the president. *Quarterly Journal of the Geological Society* 7(1):XXXII-LXXXV.
- Millhauser M. 1959. *Just before Darwin*. Middletown, CT: Wesleyan University Press.
- Penn G. 1825. *A comparative estimate of the mineral and Mosaic geologies*. Vols. I, II. 2nd ed. London: James Duncan.
- Price GM. 1923. *The new geology*. Mountain View, CA: Pacific Press Publishing Association.

- Ramm B. 1954. *The Christian view of science and Scripture*. Grand Rapids, MI: Wm. B. Eerdmans.
- Rehwinkel AM. 1951. *The flood*. St. Louis: Concordia Publishing House.
- Sedgwick A. 1831. Presidential address to the Geological Society. *Proceedings of the Geological Society of London* 1(20):281-332.
- Simpson GG. 1960. The history of life. In: Tax S, editor. *The Evolution of Life*. Chicago: University of Chicago Press, p 117-180.
- Simpson GG. 1975. Uniformitarianism, an inquiry into principle, theory, and method in geohistory and biohistory. In: Albritton, Jr., CC, editor. *Philosophy of Geohistory:1785-1970*. Stroudsburg, PA: Dowden, Hutchinson & Ross.
- Smith JP. 1839. *On the relation between the Holy Scriptures and some parts of geological science*. London: Jackson & Walford.
- Smith JP. 1854. *The relation between the Holy Scriptures and some parts of geological science*. London: Henry G. Bohn.
- Whitcomb JC, Morris HM. 1961. *The Genesis flood*. Philadelphia: Presbyterian and Reformed Publishing Company.
- Wilson LG. 1972. *Charles Lyell. The years to 1841: the revolution in geology*. New Haven, CT: Yale University Press.
- Zittel K von. 1901. *History of geology and palaeontology*. London: Walter Scott.