Introduction

This contribution is taken from a long chapter in *Unravelling Genesis*, a book that will be released in late 1990. Its main contention is that our planet is not an untouched body, but undergoes sudden massive physical and organic changes as it circles its galaxy. From these habitual encounters, it is argued, evolution proceeds. As the earth makes repetitive passages through a massive sun-circling meteoric shower, it acquires foreign earth-girdling layers of crust. The large amounts of debris are chemically indigestible to the biosphere and immediate genetic change takes place, triggered electrically by the encounter itself.

The research for the following article did not come from any original discomfort with modern geological theory, but from a persistent ancient sacred tradition that the earth was originally brought down from the sky. These puzzling yet widespread notions of heaven-borne, life-giving and continent-generating soil led me to re-examine the doctrine that the earth's crust is formed solely by internal processes.

Developed in the late eighteenth century, this long-standing model of crustal development, known as the Rock Cycle, perceives the earth as a huge heat machine slowly building up and pushing around continents for the purpose of recycling them as material for new crustal uplift. Modern geologists, whether speaking of isostacy, continental drift, or plate tectonics, still unquestioningly hold to the governing tenet of internally generated crustal development. The doctrine is challenged, at the conclusion of this article, on a single issue - the solution to a widespread but little understood phenomenon commonly called a cyclothem. First described in the coal-bearing formations of the American mid-west, it is, as the name suggests, a repetition or "cycle" of multi-layered minerals, each cycle repeating itself, in the same order, as much as one hundred times or more. The proposed solution to the origin of cyclothems, based on conventional geological methodology, is that they are annual glacial outwash, that is to say, the yearly residue of extremely dirty retreating continental ice sheets.

The process of building a cyclothem, in my hypothesis, begins with the earth's passage through a large stream of space debris. Much of these earth-girdling depositions stayed where they fell, forming great sandy deserts and fertile plains. Some of these materials were cemented into place by chemical reactions and formed rock; some washed down to the sea, coating river valleys with mud and filling estuaries with kilometre-deep deposits of sediment. In the higher latitudes, large accumulations of minerals, hydrocarbons and water were frozen into continent-sized icy formations. These great dirty ice sheets formed cyclothems as they retreated, filling the adjacent water-filled basins with an annual deposit of minerals graded according to their ability to precipitate and settle in these quickly filling lakes.

The claim that geological eras are quickly deposited space debris not only violates the current model of crustal formation, but also undermines the rock cycle; which dictates an organic origin for limestone and coal, presently considered the products of decaying animals and forests respectively.

The radical nature of this idea, if it is to be considered by those unfamiliar with the details of petrology, sedimentology and the history of structural geology, requires some background which is provided in the following pages.

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THE CONTINENTS

The Surface of Things

Sediment is the geological term for the particulate matter which, in loose and solid form, comprises most of the earth's crust. The word sediment comes from the Latin sedimentum, meaning that which is settled. The sediment itself, according to the accepted scientific explanation, comes from the water-borne deposition of distinctive layers of chemically eroded particles, which eventually convert to rock.

All sediment is considered to be the product of weathering, the slow breakdown of sedimentary and igneous rock, principally by chemical erosion. This process, presently observed in such diverse phenomena as the leaching of Hawaiian lavas by lichens, the hollowing of limestone caves by organic acids, and the erosion of Egyptian monuments by damp desert sands, may be seen in general physical terms as the destabilizaton of the earth's surface.

Geological theories, such as those explaining the accumulation of sediment, include only those forces that operate within earth's biosphere. Though geologists recognize that earth travels through the universe like other members of the galaxy, they see the earth as essentially isolated from its cosmic environment. Geology assumes the contribution from the cosmic environment on earth's geological processes is negligible.

The accepted earth-bound model for the continuous growth and shedding of the earth's outer crust is called the rock cycle, a theory with its roots in the seventeenth century.

Inspired by observations of erupting volcanoes and vast tracts of frozen magma exposed at the earth's surface, nineteenth century natural philosophers evolved the vision of the earth as a benign heat machine, building the earth's surface from below. Originally the power source was conceived of as vast underground burning caverns, which ejected lava and pushed the crust upwards to provide the prominences which in the course of geological time would crumble and flow down to the seas. There the rocks would form and, through some sort of process, be levitated and recycled. New theories have now evolved to explain the growth of continents, such as plate tectonics and sea floor spreading. But these new theories have done nothing to alter the basic premise of the rock cycle. The earth is still, in the minds of geologists, an isolated body, continuously recycling its crust through the ages.

Scale of Deposits

Unlike the ancient mythographers, modern lyricists have never waxed eloquent over sediment - perhaps it is hard to get excited over a material that civilized people consider a contaminant. Yet the sheer quantity of the stuff, particularly when its subtle production techniques are considered, is overwhelming. The prodigious deposits of sand, silt, gravel, clay, and collections of larger rocky rubble that blanket the globe are routinely computed, in their many categories, in thousands of cubic kilometers.

Loess, for instance, a silt-like material that covers the globe with its fertile blanket, lies in northern China in hundred meter thick deposits and forms the banks of such great

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rivers as the Rhine and Mississippi. Kansas alone has approximately 236 cubic kilometers of loess, left behind by retreating ice sheets of the last glacial period. Sand, another category of sediment, is not only the chief constituent of deserts, but lies in kilometre deep heaps at continental margins and underlies a substantial portion of agricultural land. The Navaho sand formation in the Grand Canyon area covers 40,000 square miles and averages 12,000 feet in depth. It is considered to be the product of the relentless erosion of colossal pre-historic mountains of sandstone, which towered over the plains in heights twice the average depth of the present sand formation.

The Rock

Under the vast accumulations of disaggregated materials are their progeny, the rocks. When sediment and sea are removed, over two thirds of the crust consists of sedimentary rock. The individual thickness of each stratum varies, and each layer is considered to represent a different ecological regime and earth age, its history and duration essentially determined by the time it would have taken to deposit the rocks of which it consists.

However, the thickness of a particular stratum can vary considerably. For instance, the Jurassic limestones of the Paleozoic era range from one hundred feet thick in England to seventeen thousand feet in western Ireland.[1]

These variations are unexpected under the conditions of uniformitarianism, which states that geological processes of the past were uniform.

THE BEGINNINGS OF GEOLOGY

The Neptunists' Early History of Sediment

The role of sediment in the history of geology is rather a peculiar one. Western science at its inception was inextricably bound to religious dogma, and it was impossible to speculate on any matter concerning the earth sciences without reference to the canons of the church. No one seemed to be immune. Aristocratic philosophers could not calculate the age of the earth without their ears cocked for the protests of the church. Even the august Compte de Buffon had to placate the theologians at the Sorbonne, who did not take lightly the millennia he posited for the cooling of a molten earth.

As geology matured, later developments, such as structural geology, inherited these Biblical views. Early geologists viewed the differently textured layers of the earth revealed by outcrops and canal excavations as the direct result of Noah's great flood. These peculiar strata were presumed to have been either settled or precipitated from the product of the Lord's watery wrath, an ocean that completely encompassed the globe.

Theories to explain the emergence of the post-deluvian world, complete with continental land masses, varied since getting rid of so much water was difficult. Some suggested the oceans drained into great subterranean caverns opened by the deluvian

[1]Corliss.

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upheaval and one scholar went so far as to suggest that a passing comet was responsible for scooping up the surplus water.

The Neptunists

In the 1700s, science and religion began to separate and attempts were made to drop some of the more dogmatic Christian elements from the nascent discipline of geology. A movement began, taking its cue from the stories of a global deluge, that acknowledged the importance of alluvial processes. But its followers concentrated on the importance of categorizing the earth's riches. These scholars were dubbed the Neptunists. They were the early eighteenth century proteges of Gotlieb Werner. A scholar and bureaucrat, head of the Bureau of Mines in Saxony, his knowledge of geology came from an intimate connection to the minerals the miners of his kingdom extracted from the bowels of the earth. Though Werner never published a theory of his own, his students developed the first widely accepted stratigraphy based on his teaching. The doctrine was based on a global flooding and recognized three distinct crustal regions: the primary, secondary and tertiary. The primary layer was a crystalline core, which supported the global ocean. The sediment that settled out of this ocean formed the secondary layer, and the tertiary layer represented the later erosion of the continents: "At bottom the primordial (original rocks), succeeded by the sedimentary beds and the final alluvial layer."[2]

The Plutonists

Neptunist thought dominated continental European geology in its early years, but was eventually opposed by a band of English contrarians. The official opposition to the Neptunists became known as the Plutonists or Vulcanists. They took their theoretical lead from an English gentleman named James Hutton who conceived of the earth as a ponderous but benign heat machine. The essential mode of sediment production was water and erosion. "Streams wear down the continents and deposit their waste in the sea. Subterranean heat causes the outer part of the earth to expand in places, lifting the compacted marine sediments to form new continents. The history of the earth is the repetition of these cycles of denudation and rejuvenation of the lands."[3]

While neptunists and plutonists waged fierce battles over their particular theories of crustal formation, they overlooked a broader area of agreement. Both groups not only agreed, but assumed unquestioningly, that the earth's own crust provided the grist for the earth's sedimentary mill. Werner never claimed that precipitation was the only factor in

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[2]Mott T. Greene, *Geology in the Nineteenth Century: Changing Viewa of a Changing World*, (Ithaca: Cornell University Press, 1982), p. 41[?]. Later another layer, called the transitional, was intercalated into the scheme between the primary and the secondary. Note that "Werner never published his own version of a Neptunist theory ... 'the onion skin myth' of an earth created entirely by successive universal precipitations of rocks from chemical solutions or suspensions, as Ospovat has noted, is utter invention, when applied to Werner."

[3]Britannica/86, "Geochronology," p. 577[?].

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the manufacture of rock, but once the battle lines were drawn neither party was looking for compromise. The neptunists became totally dedicated to a wholly precipitated earth mantle. All the rocks which formed the dry land, the neptunists decreed, were laid down under water. Even streams of lava which were seen to flow from an active crater were regarded only as portions of sedimentary rocks which had been melted by "the fervent heat of the burning inflammable materials that have been kindled underground."

This intellectual monomania prevailed until Werner's most influential protege, Leopold von Buch, took a field trip to Norway. There he found to his astonishment that granite, which he had been taught to regard as the oldest chemical precipitate from the universal ocean, was laid out before him as frozen streams of volcanic magma. Neptunist doctorine became too big a pill for Buch to swallow, and he defected.

Mott Greene, the historian of this period, reports that this blow was final: "his faith in Werner's order of the succession of the rocks in the earth's crust received a further momentous shock. After his defection, Plutonism came to the front where it has ever since remained."[4] The recent theory of plate tectonics, which posits the driving force of hypothetical rivers of magma, is simply a reconfiguration of Hutton's ponderous heat machine.

Essence of the Debate

Despite the debate's focus on the nature of granite, the issue of whether it is magmatic or sedimentary has never been satisfactorily resolved and still resurfaces to plague geologists. The battle, however, was not fought over granite, but for the defeat of one's enemies and the privilege of defining the nature of the universe.

The role of sediment in science has never been better exemplified than in geological theory. From the very beginning the masks of comedy and tragedy hung over the proposed narratives of the earth's evolution. The Biblical epic of the deluge was the inspiration of a number of secular earth forming narratives that were either sad or happy. Until the advent of Lyell and Darwin and their enforcement of the doctorine of infinite geological time, scholars were not reluctant to see the marks of catastrophe in the development of the

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[4]Greene reports that as early as 1814, the unreconcilable differences existed between the two camps, as stated in the lament of Giovanni Brocchi:

> When one shows them [the Vulcanists] that the rocks they call lavas alternate at Aix, 15 or 20 times with calcarious strata, when one shows them several places they are full of marine shells, which are found in the most perfect state of preservation, when one points to basalts emplaced upon a substance as combustible as coal, [carbon fossil] as had been verified on Mount Meissner in Hesse, and when one finally considers that these striking facts have not made the least impression upon them and that they follow their own course with indifference, one is forced to conclude, that such changes of mind are extremely difficult; so difficult that one despairs of them. [Greene p. 58; quoted from Stanislov Meunier, 1911 L'evolution de theories geologique]

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earth's crust; it was still subject to dramatic protocols.

The neptunists, in their acceptance of the deluge and the Lord's rainbow promise, saw the process of earth building as essentially finished. The plutonists, armed with Hutton's perpetual heat machine, perceived crustal development as a cycle of constant rebirth.

The plutonist victory over the neptunists permanently embedded the rock cycle into the structure of geological theory,
diverting attention from issues of chemistry and erosion to questions of structure and crustal dynamics. Now, in the closing decades of the twentieth century, as new theories challenge the dominant plutonists, we see just how firmly their hold is on the geological mind. This group saw internal heat as the machinery of earth making, and preferred to see rock as a product of cooling magma. (The ruling neptunists thought lava was formed by the burning of coal deposits underground.) Lava and other molten rocks were therefore a superficial and young formation, unable to supply the raw materials for large scale sediment production.[5]

IGNATIUS DONNELLY

Atlantis

One of the best sellers in the United States in 1882 was *Atlantis, The Antediluvian World*. Its author, Ignatius Donnelly, a well-known western radical and four-term congressman from Minnesota, presented a new approach to the legendary lost continent.[6]

Donnelly judged his market well, for the subject seems to have an inexhaustible charm for the public. The phantom continent was usually marked on medieval maps, and in the 18th century the historicity of this legend was seriously debated by such savants as Montaigne, Buffon and Voltaire.[7]
Donnelly's Atlantian theory was quite ambitious, for he not only saw the lost continent as geographical fact, but also as the region where man first rose from the state of barbarism into civilization. Moreover, he believed that the destruction of Atlantis was preserved in the myths and legends of the few individuals who escaped the cataclysm, and that a close reading of these stories could lead to its discovery.

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[5]Greene, p. 47[?].

[6]Born in 1831, he published his first book after a career as promoter, publisher, prairie radical, and three-term congressman from Minnesota. When Donnelly's plans for Nininger City, a western Utopia, failed in one of the many financial panics of the nineteenth century, he turned to politics and became the lieutenant-governor of Minnesota at the age of 28.

Donnelly went on to publish novels on radical anti-capitalist themes and became the leading proponent and publisher of Bacon-mania, the theory that Francis Bacon was not only the author of all William Shakespeare's works, but those of Marlowe and Montaigne as well.

[7]Britannica/86, "Geochronology," p. 858[?].

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Ragnarok

Encouraged by the critical and financial success of his first literary effort, Donnelly wrote a sequel examining the cause of the island's destruction and proclaiming its present location. *The Destruction of Atlantis, Ragnarok: The Age of Fire and Gravel*, claimed that the instrument of catastrophe was no mundane phenomenon, such as earthquake or invasion, but the earth's encounter with the tail of a great comet which, in the course of destroying Atlantis, covered most of the globe with its debris.

The Drift

Donnelly identified much of the fallout as what we now call sediment and was then called drift. This term was used by contemporary geologists, and was derived from disappearing beliefs that the huge collection of fossiliferous and mineral detritus blanketing the earth was the residue of Noah's deluge.

He described this material in his effective folksy prose:

> Upon the top of the last of this series of stratified rocks we find the drift. What is it? Go out with me where yonder men are digging a well. Let us observe the material they are casting out. First, they penetrate through a few inches or a foot or two of soil. Then they enter a vast deposit of sand, gravel and clay. It may be 50, 100, 500, 800 feet before they reach the stratified rocks on which this drift rests. It covers entire continents. It is our earth. It makes the basis of our soils, the railroads cut their way through it, our carriages drive over it, our cities are built upon it, our crops are derived from it. The water we drink percolates through it. On it we live, love, marry, raise children, think, dream and die, and in the bosom of it we will be buried.[8]

Donnelly had access to essentially two theories to account for the drift: the Neptunist's deluge and glaciation. He found them both wanting. The glacial hypothesis, inspired by observations of the ability of the great Alpine glaciers to convey large amounts of debris for many kilometers was adopted by geologists with unabiding distaste for biblically inspired geology, and won a questionable place for ice as an important contributor to the mechanical production of sediment, a position it has not yet conceded fully to the new chemical weathering school.

Donnelly carefully analyzed both approaches to the problem of sediment production and rejected them as incomplete. Neither flood nor ice could lift the boulders and other elements of the drift to the tops of the highest mountains. Neither could these agents account for their reduction, order and distribution. He concluded that water and ice would be associated with the distribution of sediment but not with its production.[9]

The Cosmic Grinder

Donnelly's principal insight was that the world's extensive deposits of rocky debris, sand

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[8] *Ragnarok*, p. 2[?].

[9] Geikie[?].

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and clay, which became known as till, were the products of a unique magnetic grinding machine found in the wake of a comet's head. Most drift, particularly the rocky tills strewn around the landscapes of many countries was in Donnelly's day considered to be principally the product of glacial grinding. Contemporary geologists, however, had already noted some inconsistencies relating to the theory. "There is something very peculiar about the shape of the stones," said the highly respected Geiky. "They are neither round or oval like the pebbles in river gravels or the shingle of the seashore, nor are they sharply angular like newly fallen debris at the base of a cliff, although they more closely resemble the latter than the former. They are indeed angular in shape but the sharp corners and edges have invariably been smoothed away. ...Their shape, as will be seen, is by no means their most striking peculiarity. Each is smoothed, polished and covered with stria or scratches, some of which are delicate as the lines traced by an etching needle, others deep and harsh as the scores made by the plough upon a rock. And what is worthy of note, most of the scratches, coarse and fine together, seem to run parallel to the longer diameter of the stones which, however, are scratched in many other directions as well."[10]

Geiky also noted the difficulty of tracing the till to existing glacial formations: "...No till or drift is now being formed by, or under, the glaciers of Switzerland. Nevertheless, till is found in that country disassociated from the mountains ..."

Donnelly not only rejected ice as the creator of till, he attacked the essential mechanism of erosion as the producer of sediments. He pointed out that the tail of a large comet was not only suited for marking the larger fragments of till but also segregating particles into the anomalously segregated clay deposits.

In the author's words, comet:

> debris arranges itself in a regular order, the largest fragments are nearest the head, the smaller are farther away, diminishing in regular gradation until the farthest extremity. The tail consists of sand, dust and gasses. Through the continual movement of the particles of the tail, operated on by the attraction and repulsion of the sun, the fragments collide and crash against each other. By natural law each stone places itself so that its longest diameter coincides with the motion of the comet. Hence, as they scrape together they mark each other with lines or stria lengthwise of their longest diameter. The fine dust ground out by these perpetual collisions does not go off into space but pack around the stones. But still governed by the attraction of the head, it falls to the rear and takes its place like the small men of a regiment in the farther part of the tail.[11]

Donnelly's mechanical/gravitational hypothesis for explaining till striations and particle separation of sediments, is open to criticism. The gravitational relationships of such a heterogeneous mass of debris are still unpredictable. His observations concerning the magnetic properties of clays, however, are another matter.

Clay, which is a wide classification, covering all heterogeneous finely ground up rock

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[10]*Ragnarok*, p. 72[?].

[11]*Ragnarok*, p. 73.

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is inexplicably organized into iron rich and iron poor beds. It was already known in the author's day that the colour of clays was due to this peculiarity. Mica and hornblende contain considerable iron oxide, whereas feldspar yields only a trace, or none; therefore, clays that derived from feldspar are light coloured or white, while those partially made up of decomposed mica or hornblende are dark, either bluish or red. Donnelly observed: "The particles ground out of feldspar are finer than those derived from mica and hornblende, and we can readily understand how the great forces of gravity might separate one from the other, or how magnetic waves passing through the comet might arrange all the particles containing iron by themselves and thus produce their marvelous separation of the constituents of the granites which we have found to exist in the drift clays."

Donnelly's Contributions

Donnelly did not explain how the larger grinding stones of this extra-terrestrial mill originally broke off the comet's nucleus. Moreover, the nature of the cosmic debris following a comet's tail is still not well known. We have not yet, for instance, found any remains of the most intense meteoric showers, which appear to be completely consumed in their passage through the earth's atmosphere. He did, however, suggest plausible explanations for some contemporary geological enigmas:

1. the uniquely generated and oriented striated till.
2. the strangely unfossillized nature of many large unstratified beds of sediment.
3. the occurrence of clay beds organized according to particle size and iron content.

DONNELLY'S COMET

The Giant

Ragnarok's comet has been contemplated more by catastrophist literature and cinema than by modern astronomy, and most astronomers would argue that we have no evidence that comets grow to that size. Nonetheless, comets, as astronomical phenomena, have always been in a class of their own, their appearance prior to the age of Newton, a bad omen. Donnelly's contention that a single comet could cover the entire earth with its debris was, in any era, an unsettling idea.

Donnelly painted a bleak picture of its destructive power, which ended the "Golden Age" at some indeterminate era. The drift, he wrote, "marks probably the most awful convulsion and catastrophe that has ever fallen upon the globe." Accompanying these deposits of "continental masses of clay sand and gravel" were convulsions which produced "cracks and fissures which reached down through many miles of the earth's crust to the central fires and released the boiling rocks imprisoned in its bosom." He cited the Grand Canyon and Scandinavian fjords as examples of formations wedged apart by the action of cooling magma in gaping tears in the earth's crust.

The Atlantian disaster, according to Donnelly, was not the only encounter the earth

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had with comets. "We find that all through the rocky record of our globe, the same phenomena which we have learned to recognize as being peculiar to the Drift Age are, at distant intervals, repeated. The long ages of the Paleozoic time passed with few or no disturbances, the movements of the earth's crust oscillated at a rate not to exceed one foot in a century. It was an age of great peace. Then came a tremendous convulsion."

Drawing on the mythological and physical record, Donnelly posed a question only now being asked by today's astronomers. "Can it be that there wander through immeasurable space upon an orbit of such (great length) that millions of years are required to complete it, some monstrous luminary so vast that (its tail)
showers down upon us deluges of debris while it fills the world with flame?"

Donnelly was confident that analysis of comet debris would be a key factor in identifying the errant giant comets of the past but was somewhat naive concerning the interest of future scientists in this question, feeling that no secret could escape discovery when "the world's intelligence is brought to bear upon it." In expressing this pious notion, Donnelly displayed a poor understanding of the degree of scientific interest in earth history.

1833

Ancestral fears of comet-borne cataclysms are well documented by today's science writers, particularly when the return of Halley's comet is imminent. What is less apparent was the collective concern of earlier astronomers regarding their unpredictable nature. The leading figures of the early Royal Society of England, for instance, were obsessed with the question.

Until very recently the protection of the earth from external forces seems to have been an unstated responsibility of astronomy, and it has never been better demonstrated than in Edmund Halley's idolatrous ode to Isaac Newton's Principia Mathematica, a publication which Halley patiently extracted from Newton's reluctant hands. This document, now some two and one half centuries old, organized the physical laws which, despite the theories of Einstein, still rule the pragmatic aspects of the physical sciences. In case anyone still harbours any illusions concerning the quest by early natural philosophers for order in the universe, Edmund Halley's ode should lay the controversy to rest:

. . .The sun
Exalted on his throne bids all things tend
Toward him by inclination and descent,
Nor suffers that the courses of the stars
Be straight, as through the boundless void they move,
But with himself as centre speeds them on
In motionless ellipses. Now we know
The sharply veering ways of comets, once
A source of dread, nor longer do we quail

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Beneath appearances of bearded stars.[12]

Contemporary Views

The trouble caused by the predictions of comet-borne catastrophes in Donnelly's day continued, despite the work of Halley and Newton, into the succeeding century.

The panic that followed the extraordinary leonid meteoric showers of 1833, exaggerated by ancient fears of global upheavals, occurred in Europe and North America among primitive and civilized societies alike. During these displays, the Pawnedd priests in Nebraska calmed the tribe by pointing out that the north star's unwavering position guaranteed that the end of the world had not yet come.

Europe and America were no less concerned that year with potential comet-bourne calamity. Biala's comet was due to cross the earth's orbit during its next return in 1841, though nowhere near the earth itself. Nonetheless, the nervous populace had to be reassured by Herschel, the Astronomer Royal.

Potential cometary impact was, therefore, not a novel idea in Donnelly's time. What made his thesis so radical were the extraordinary claims that he made for the scale of these comet-borne materials. His arguments, however, are as cogent and unanswered today as they were over a century ago.

THE REJECTION OF RAGNAROK

Publisher's Rejection

Despite the great success of *Atlantis*, Harper and Bros. passed up *Ragnarok* on the grounds that it would offend the scientific community.[13] Scribners, Donnelly's second choice, also rejected the book. They sent the manuscript to a New Haven scientist, who reported the theory to be absurd. "Well written, but ridiculous. ...Worthy of Jules Verne." But Donnelly refused to concede defeat. "I believe that I am right, and if not right, plausible, and that the book will be a success." Although he lacked confidence in New York publishers, having been rebuffed twice, and convinced that they would submit the text to a scientist "who would get mad at the idea of an extraterrestrial origin of anything found on earth from the soul of man to a paving stone," Donnelly finally found a publisher for *Ragnarok*.

While not rivalling the public success of *Atlantis*, the sequel developed the argument of meteoric impact cogently. The second part, burdened with his relentless desire to prove the reality of Atlantis, however, was less convincing. The manuscript's editor, who enjoyed the book, agreed, wondering how distinguished scholars would react to this type of speculation. The editor need not have fretted, for there is little evidence that the academic

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[12]Edmund Halley in Newton, Sir Isaac. *Newton's Principia*. Vol. 1 (ed. Florian Cajori) University of California Press: 1934. pp. xiii-xiv.

[13]M. Ridge, *Ignatius Donnelly, The Portrait of a Politician*, pp. 206-09.

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community made a serious attempt to criticize any part of *Ragnarok*. Donnelly, desperate for peer recognition, pressured his publishers, who owned the successful *Popular Science Monthly*, to review the book. The editor's written rejection included the following gratuitous comment: "There has not been any extended attempt to refute the position of the author of *Ragnarok*, nor is it probable that there will be, because the minds that have been taken with that work are in a very unpromising condition to reason with, the book being absurd."

Although *Ragnarok* went into nineteen editions, Donnelly became resigned to the limited intellectual concerns of his countrymen. Their genius, he concluded, "was practical rather than speculative or philosophical."

Academic Rejection

Donnelly was not an obsessive catastrophist; he was more interested in reconstructing the legendary Atlantis than in destroying it and may have failed to recognize other reasons for the rejection of his ideas, for he was ignored by neither the public nor the popular press.

The only resistance he met with was from the scientific community, which was only giving *Ragnarok* the traditional greeting it gave to all bad cosmic news. Even if the book had been written in a traditional scholarly style, it is unlikely it would have received much scientific recognition. Donnelly was not only without formal credentials in an age which was becoming more professional, he was making pronouncements on the state of the universe, which was a great provocation to astronomers. Donnelly, on a relatively intellectual plane, was, perhaps unknowingly, fighting a rearguard action in an academic controversy that had been going on for centuries. Not only was he putting forth a psychologically abhorrent argument, he was advancing evidence which could not be integrated with the current models which had already been fashioned for the earth sciences.

It is difficult to believe Donnelly's naivete in expecting a fair hearing from a professional group notorious for its own internecine intrigues, for he was a battle-scarred politician. Despite the popularity of his books and his image as a sage, he had to join the long line of amateurs, innocently venturing into the professional scholar's only to be reviled or ignored by traditional science.

UNIFORMITARIANISM

The battle lines over geological and evolutionary theory had long been drawn by the time *Ragnarok* had been published.

Despite the attempted interference of the church, geological thought was not essentially influenced by religious dogma. Nineteenth century geologists, whatever their private thoughts, usually admitted the workings of a benign divine Christian hand, whether addressing university, church or the public, but once the threat of excommunication receded, the power of the established dogmas and the collective respect for cosmic quiet became apparent.

Professional science, in retrospect, was on the road to an ordered, peaceful universe,

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and those who sought to challenge this view had a hard row to hoe.

Competition

The controversies of the eighteenth century had receded, and memories of the conflict between igneous or sedimentary origins of rock had been replaced by a contest over the mechanics of earth formation, the bitterness of this conflict fuelled by personal, group, and nationalistic rivalries.

Sediment, nonetheless, required some form of production machinery, and this constraint was never too far from the minds of nineteenth century geologists. Erosion, whether mechanical or chemical, required progressive crustal uplift, and competition began to uncover the best hypothesis.

In England the ruling plutonists offered the body of work drawn from Hutton's vision of "a perfect machine working with no hint of senescence until God" chooses to ordain an end.[14]

Hutton saw the huge intrusive formations of igneous rock separating ancient strata as ample evidence of the driving force of his "ponderous heat machine, throwing up oozing magma that formed mountains that slowly and cyclicly wear down."[15]

Hutton could not compute the time sequences of this machine, but stated "Time is to Nature, endless and as nothing." With all these vast resources of time of course, the formation of mountains was no problem at all, and the same forces that produced erosion produced uplift. Hutton's approach had a diplomatic element to it for, as Greene noted, it appealed to both structuralist camps: "The theory had the theological advantage that it seemed to accord with the accounts of the Biblical flood, while its geological rationality stemmed from the evident fact, also present in Huttonian theory, that sedimentary beds were created and cemented at the bottom of the sea."[16]

As well as representing a fusion between the warring structuralists, Hutton's theory was cyclical and therefore eternal. Moreover, it offered geological time, a tool which would be grasped with even greater fervour than he could have guessed.

Prior to 1830, the catastrophists were still respectable, especially when it came to explaining the great concentrations of sediment. One historian notes: ".... The idea of a great flood or many such floods was particularly useful in explaining the distribution of enormous amounts of sand, gravel, rock debris and erratic boulders over much of the surface of Great Britain and Europe. The erosion cycle was not useful as an explanation for those materials, often consisting of rock with no petrological relationship, either

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[14]Hutton's *Theory of the Earth* was published first as an essay in 1788 and later expanded to a two volume work in 1795. John Playfair, a professor of Natural Philosophy in the University of Edinborough, defended Hutton against the counter attacks of the neptunists and his illustrations of the plutonium theory (1802) is the clearest contemporary account of the plutonist theory. (Brit/86, "Geochronology," p. 752)

[15]Britannica/86, "Geochronology," page unknown.

[16]Greene, page unknown.

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chemical or structural, to the country rock over which they were strewn, nor did they appear to be the result of local upheaval. Certain geomorphic phenomena (deep ravines, gaps in mountains, isolated buttes) also seem to be best explained by intense forces, especially flooding acting over a short time...."[17]

Greene gives the prevailing nineteeth century attitudes to catastrophism: "Most geologists in the 1820s believed that the earth had been subject periodically to episodes of great violence in which normal igneous and aqueous agencies were swollen to catastrophic proportions: great volcanic eruptions, huge floods and deluges. However, by that time, the invocation of these cataclysmic irruptions [sic] had little to do with biblical conformity, especially outside Great Britain. Cuvier employed them as an explanation for the periodic extinctions of whole classes of life forms revealed in his paleontological work, and many others followed suit."[18]

Buch was able to show that many of the huge erratic boulders (large rocks found far from their suspected origins) on the north German plains had originated in Scandinavia, and he explained their transport by means of a catastrophic flood. Against this theory, other British geologists proposed a 'drift theory', in which the materials were transported by drifting icebergs during periods when the land, sea and climate allowed such a thing to happen. Eventually a more complete theory of continental glaciation would be brought in to explain the drift, but in the meantime, as Greene relates, in the 1820's and 1830's field evidence required geological action of an intensity far beyond explanations given by the geologists preferring a serene tectonic past.

The real threat to a growing anti-catastrophist consensus was to be found in Europe, where Georges Cuvier was making discoveries in the Paris basin which alarmed the seekers of benign processes in nature. In his study of Cenozoic vertebrates, Cuvier was in the process of developing a system of classifying world ages, using fossils as the critical marker. He found that each distinct stratigraphic layer had its own suite of fossils. He came to the conclusion that these ancient life forms expired in a series of great calamities. What concerned the opponents of Catastrophism were the "brief, convulsive and lethal episodes...." that Cuvier claimed created these strata.

Catastrophists now made the ominous claim that "beds in which the fossilized remains of marine animals and terrestrial plants were mingled seemed to attest the destructiveness and confusion of paroxysmal events." They saw mountains of igneous rock and concluded that "the magma that formed these masses must have burst through the Earth's crust."[19]

In light of these harrowing visions, the geologists of the mid-nineteenth century were looking for a man on horseback, and he turned out to be Charles Lyell, the father of uniformitarianism.

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[17]Richard Foster Flint, *Glacial and Pleistocene Geology*, (New York: John Wiley), p. 148[?].

[18]Greene, pp. 72-3.

[19]Britannica/86, "Geochronology," p. 751-2.

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Charles Lyell

Charles Lyell, who was to be the commanding figure of nineteenth century geology, made no bones about what his scholarly mission would be. He prepared data for his monumental *Principles of Geology* with the express purpose of proving that "the earth had been shaped from the beginning by uniform forces still at work, erosion by running water, accumulation of sediment, earthquakes and volcanoes." Since he felt that such forces, through millennia, had made the earth what it was, there was no need to imagine catastrophes.

Lyell saw the true plutonist legacy not so much as the rock/sediment cycle, but as Hutton's concept of limitless geological time. Lyell had read Hutton's concession that the creation of huge granitic formations would require ages to achieve. Hutton, contemplating the rock formations in his country estate, however, found "no vestige of a beginning, no prospect of an end."[20] It was this element of Hutton's argument that Lyell took to his bosom, and the fate of modern geology was set.

Lyell made no secret of his ambition to "free science from Moses." Stephen J. Gould reports a letter Lyell wrote to a colleague in 1829 stating, "My work will endeavour to establish the principle of reasoning in the science that no causes whatsoever from the earliest beginning to which we can look back to the present ever acted but those now acting and that they never acted with different degrees of energy from that which they now exert."[21]

John McPhee, in his excellent *Basin and Range*, has the following to say of the man's character and influence:

> Charles Lyell ... gave Hutton's theory and his sense of deep time their largest advance toward universality. In three volumes, he published a work whose full title was *Principles of Geology, Being an Attempt to Explain the Former Changes of the Earth's Surface, by Reference to Causes Now in Operation.* Lyell was so anti-neptunist, so anti-catastrophist, that he out-Huttoned Hutton both in manner and in form. He not only subscribed to uniformitarian process - the topographical earth building and destroying and rebuilding itself through time - but was finicky in insisting that all processes had been going on at exactly the same rate through all ages.[22]

The revision of Hutton's catastrophic ideas was not onerous, for Playfair, Hutton's editor, had already expunged such passages from *Theory of the Earth*, as "The theory of the world that I would here illustrate is founded on the greatest catastrophes which can happen to the earth. That is (continents) being raised from the bottom of the sea and sunk again."

In banishing "extraordinary causes," Lyell substituted as prime mover the earth's vast resources of internal heat "which caused earthquakes and volcanic eruptions, which in turn forced the earth up." He assumed that at some distance below the surface the earth was molten and under great pressure, and therefore capable of moving enormous masses of

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[20]*Mysteries*, p. 215.

[21]Stephen J. Gould, *The Panda's Thumb*, page unknown.

[22]John McPhee, *Basin and Range*, (New York: Farrar, Straus, Giroux, 1980), p. 142.

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land. Lyell had volcanic exhalations as a kind of safety valve preventing just the paroxysms Hutton spoke of. For him the earth was "steady, stable, self-perpetuating."[23]

Lyell effectively brought together application of the sciences of chemistry, natural philosophy, mineralogy, zoology, comparative anatomy and botany to elucidate the history of the earth.[24]

Lyell's Influence on Darwin

Principles of Geology became the most enduring and effective geological text ever published, and it even influenced Darwin's famous theories. Darwin took Lyell's three volume work on the *Beagle*, and he found Lyell's prescription of deep time relevant to his search for a theory of organic evolution. McPhee relates:

> When Darwin had first studied geology, he had heard lectures in Wernerian neptunism at Edinburgh, and they had very nearly put him to sleep. Now he was voyaging on the Beagle and developing his own sense of the slow and repetitive cycles of the earth and the giddying depths of time, with Lyell's book in his hand and Hutton's theory in his head. In six thousand years, you could never grow wings on a reptile. With sixty million, however, you could have feathers, too.[25]

Profoundly deep and boundless time, the philosopher's stone of the sciences of the earth and genetics, had been found. It only remained for the English philosopher William Hewells to name the movement Uniformitarianism.[26]

In recapitulating the battles that brought the doctrine of uniformitarianism to the forefront of earth sciences, Greene sees our legacy in this light: "the heroic juxtaposition of new and old ignores the complexities of the very period that gave geology its modern form and aims, and it hides the emerging fundamental tensions in geological thought that are pertinent even now."[27]

DONNELLY RECONSIDERED

Bonds of the Past

More than a century has elapsed since the publication of *Ragnarok*, and there has been in recent years a resurgent interest in the role comets play in extinguishing life in the remote past. Although little catastrophic research is done on the much more recent age of man.

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[23]Greene, page unknown.

[24]Flint, *Glacial and Pleistocene Geology*, page unknown.

[25]McPhee, p. 143.

[26]Britannica/86, "Geochronolgy," p. 751[?].

[27]Greene, page unknown.

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the more ancient soils and stones of the age of the dinosaur have proven fertile ground for catastrophic research.

If Donnelly's observations were valid a hundred years ago, then the data acquired since, pro or con, should be that much better. And so they are. We can not only scrutinize Donnelly's assumptions concerning till, sands, and clays, but also the world of sedimentary rocks which he overlooked.

Towards a Cometary Hypothesis

Donnelly's premise may be simply stated: The tail of a giant comet will disperse its materials over the earth's surface in a manner substantially different from the processes of ice, wind or water. If the earth's sediments came from the tail of a comet, the particulate matter will act in a manner consistent with materials moving through a magnetic vacuum, the tail shedding its debris through the earth's atmosphere in a manner consistent with the properties of that unique extraterrestrial environment.

The following analysis of most of the earth's major sedimentary deposits and structures will show that they have little or no direct chemical relationship to their alleged sources. More to the point, important categories of particulate matter such as muds and limestones, in their broken, scattered, compacted and lithified form, will be shown to have a direct structural and chemical relationship to meteoric debris.

But before re-examining Donnelly's theories in the light of modern geological theory, we should make a preliminary examination of the use of sediments in analyzing the past.

It is difficult to overemphasize the importance of sediment in evaluating the earth's history. The Britannica states "the proper sequence of the layers exposed in any particular outcrop - be it as extensive as the Grand Canyon or as limited as a small road cut - can be determined. ... As the only tangible record of a certain past interval at a certain place, every sedimentary outcrop is essentially the sole source of whatever is to be learned about that interval in that place."[28]

But care must be taken with these records, and *The Britannica* points out one of their serious deficiencies: "Unfortunately, when the geologist finishes interpreting a single sedimentary outcrop, he has only the story of an unknown time interval from somewhere in the vastness of the past."[29]

Gaps

The cautionary attitude of this standard reference work comes from its understanding of the disconnected nature of the geological column. Even the most conservative geologist concedes that, within a particular era, sedimentation proceeded at markedly different rates at different places on the globe.

Nonetheless, these equivocations only mask the fact that entire eras with complex stratigraphical sequences are entirely missing from substantial expanses of the world's

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[28]Britannica/86, "Geochronology," p. 778.

[29]Britannica/86, "Geochronology," p. 779.

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surface.

Compounding this problem are the present gaps in radiometric dating techniques, leaving us without a continuous or precise time record further back than forty thousand years.

Moreover, if Donnelly's theory is right, attempts to objectively date the earth's rocks radiometrically can give us, in most instances, only the age of the meteoric debris that concluded and began evolutionary epochs.

The Alien Crust

A recent survey of the earth's rocks published by the *American Scientist* seems to confirm both the anomalous nature of the earth's rocks and the marginal use they may be in determining its past. "Crustal rocks appear literally to be a penultimate silicate froth of the most uncommon terrestrial elements..."[30] The writer concludes: "Because the earth and oceans and air are extreme distillates and fractionates of the average original earth and very unlike it in composition and origin, it is obviously risky, if not misleading, to infer that superficial studies tell much of what we must know of time in the earth."[31]

Bones

So little do sediments and rocks by themselves tell us of the earth's chronology, that for some time geologists have depended on the remains of extinguished life forms to achieve coherent dating systems.

We shall not challenge the paleontological approach to dating earth history, for it is a valid technique and can be used along with carbon 14 and other radiometric techniques for sampling the most critical physical element of our inquiry, the environment in which the fossil remains of our neanderthal and Cro-Magnon ancestors were found. They preserved the final organic development of a world age and described clearly the division between the chemical regimes of the past and the succeeding epoch. If the materials of each era were brought to earth in elongated sub-continental sized depositions, then it is natural that the world's sediments should be discontinuous both geographically and stratigraphically. This is only one of many important distinctions which separate cosmically derived and earth born sediments.

Different Strokes

The following pages will further develop the argument by examining the earth's major sediments, rocks, and minerals and demonstrate their relationship to extraterrestrial provenance. Should these arguments be persuasive, they will demonstrate the interdependence of the earth's sediments and its biosphere.

This planet's life and the environment on which it feeds and replicates represents a co-evolutionary phenomenon. The food chain is a cycle that has vital links to the chemical

[30]Greene, p. 27[?].

[31]Greene, p. 27[?].

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composition of the local environment. If this environment changes radically, and the genetic data bank of a species does not have the resources to adapt, that species will expire. The paleontological record obviously suggests this. If, on the other hand, life forms, particularily the specialized cropping types, can adapt to radically altered circumstances then they should thrive and radiate throughout the new physical environment.

The stones and bones of the geological column are not merely a calendar of timeless imperceptible changes in the life of the earth, but an invaluable record, frozen in time, of vast, rapid and interdependent geological and biological changes.

THE REGOLITH

The Grand Canyon

Before looking into the make-up of the individual layers of the earth's strata, some philosophical reflection on the strata as a whole is warranted, for the whole idea of stratification seems to present an innate contradiction to the doctrine of uniformitarianism.

When the tourist looks into the abyss of the Grand Canyon, he is asked to believe that the kilometre-deep strata, principally made up of sedimentary rock, are the product of gradual erosion. But is not the essence of stratification differentiation? If uniformitarianism implies repetition, what do these substantial layers of metals, limestones, coal beds and multicoloured silicates represent, if not distinct geological regimes?

Geologists provide sophisticated concepts such as foliation and metamorphosis to explain what they consider to be slow transitions, principally caused by chemical rediffusion and relentless pressure. The problems with these theories, which we will deal with later, are that they do not get around a basic contradiction. The existence of distinctive strata, some thousands of metres thick, each member supposed to represent some unique set of unreplicable events, directly contradicts the doctrine of uniformitarianism.

The Uniformitarian World

In the uniformitarian world of geology, the processes we are instructed to observe in the interpretation of the formation of strata are of a seasonal nature. These yearly sedimentary depositions are recorded in the settling clay and silt of rivers and other catch basins, as is the yearly snowfall that accumulates and compresses into measurable layers of ice in the alpine and arctic regions. These relatively thin pages of the geological record, however, are not the stuff of the Grand Canyon, with their hundred metre deposits of cemented silica and carbonate debris. The uniformitarianist time unit is ideally an eternal cycle of the unchanging seasons, and if we accept this premise we should be gazing into a canyon consisting of a monochromatic wall of millions of thin, uniform, annual layers. Obviously other processes are at work here, for what we see is a bewildering array of multicoloured layers and boundaries.

Missing History

The sequence of rocks in the Grand Canyon's walls is clearly organized in distinct steps and

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not uniform layers. What is not immediately clear is that this sequence lacks long segments of earth history. The tourist passing by an outcrop in the canyon wall is advised by a brass plaque that the Ordovician and Silurian periods of the Paleozoic era are missing from the Grand Canyon sequence, a lacuna, by accepted chronology, of 100 million years.[32]

These gaps are called uncomformities, and are so common in the geological column that they are regarded as stratigraphical signposts rather than geological anomalies. Geologists claim that erosion has removed the missing layers, but the cleanliness of the gap belies this explanation. To some geologists, the existing layers appear to have been deposited successively.

Certain similarities have also been noted by geologists.
"An unconformity separating the oldest Pre-Cambrian from the latest Pleistocene may have the same physical appearance as one between the latest Pleistocene and the middle Pleistocene...The fossils of the strata bounding an unconformity are the only indicators of time value..."[33]

George McReady Price stated "Nature must have served an injunction on the action of the elements and they had to continue in the status quo for millions of years, the water neither wearing away nor building up over any part of this taboo ground during all this time."[34]

THE BEDDING PLANE

The Most Commmon Feature

What may be an even greater problem than the unconformities are the beds that separate them. Continental in breadth and hundreds of metres in depth, they strain uniformitarianistic beliefs and imagination.

The author of the sedimentary section of a standard petrology text had the following to say of the most common phenomenon of sedimentary rock formation:

> Bedding surfaces commonly are generated by contrasting textures ...; for example, the contrast between the very coarse texture of the conglomerate and the finer texture of an overlying sandstone. What mechanism produced the boundary between the coarser- and finer-grained layers? Was it a rapid decrease in stream current velocity; or a lateral shift in channel position; or the transgression of an offshore marine sand bar over a gravel beach? The causes of bedding surfaces are many, and often they are not understood. Their existence, however, means that *something* must have changed during the interval of time represented by the infinitely thin surface; perhaps a change in water chemistry caused incipient cementation of the earlier sediment; or perhaps there was a change in water temperature resulting from a

[32]From the creationist text *Earth's Most Challenging Mysteries*, page unknown.

[33]*Earth's Most Challenging Mysteries*, page unknown.

[34]*Earth's Most Challenging Mysteries*, p. 215[?].

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> change in solar radiation; or perhaps a change in stream current velocity occurred as a result of a spring flood on April 7th of the early Middle Devonian. It is worth remembering that most of the time since the earth was formed is represented in the geologic record by bedding surfaces, not by rocks. Hence, the bedding surfaces we see in outcrops deserve careful examination. Their commonness should not make them less noteworthy.[35]

We will begin a close examination of these bedding planes with historical perspective on their explanation.

THE PENNAPLAIN

Oscillations

The explanation of the origins of sediment, although established for purposes of teaching, are only partially accepted by the profession itself. We will, nonetheless, review the history of thought regarding sedimentary formation, as it illustrates the motives for modern theory.

Since both major nineteenth century factions in geology believed that sediments were both produced and transported by alluvial processes, it was natural for them to attempt to understand the processes that deposited thousands of kilometers of thick bedded silts and sands and their lithified progeny.

The first explanation to be proffered was that from time to time oceans gently and gradually crept over the continents, their currents depositing gravels and sands as they advanced and retreated. To accomplish this, however, it was necessary to make the continents rise and fall and the ocean floor to do likewise. The manner in which these alternating elevations and submergings of the earth's crust occurred led to extensive deliberations, and engaged the minds of the greatest virtuosi of the nineteenth century.

An idea developed that continents were joined in some way, and then the oceans enlarged. From this emerged the concept of oscillation, or the impermanence of oceans. Greene considers this idea to be "one of the great generalizations of late-nineteenth-century European geology."[36]

Isostacy

The principle behind this particular form of earth movement was named isostacy, and though modified somewhat by the introduction of continental ice sheets as the source of sedimentary deposition, it has never been completely superseded by new tectonic theory as a motive force in sedimentary production.

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[35]Ernest G. Ehlers and Harvey Blatt, *Petrology: Igneous, Sedimentary, and Metamorphic*, (San Francisco: W.H. Freeman and Company, 1982), pp. 336-9.

[36]Greene, p. 234.

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The Davisians

In the United States the chief proponent of isostacy was William Davis. The Britannica states, "The principal development of evolution by means of erosion was developed by William Morris Davis and his students between 1884 and 1934." The man published more than 500 papers on the subject. These papers form the basis of present geological dogma. They followed Hutton's idea that the earth had an organic soul and went through a life cycle. Davis developed the idea that there was a youthful stage where a mass emerges, probably from the sea, and then alluvial processes wore the pennaplain down. Finally, in old age the land was entirely levelled.

The Britannica, however, does not fully endorse the Davisian scheme and is critical of the school, finding that Davis and his colleagues, while paying a lot of attention to form and stage, paid little or no attention to the structure (rock type) and process.[37]

What the Britannica's writer had in mind are such structures as the so-called pennaplain of Basutoland in South Africa, "large portions of which still stand at an elevation of 10 thousand feet, almost untouched by erosion."[38] This idea, though never wholly accepted even during Davis' lifetime, is nonetheless the basis of most high school texts.

THE ROCK CYCLE
"Back to the Bowels of the Earth"

Modern Tectonics

Since experts still contend that erosion plays a minor role in the production of rocks, and some standard reference works still imply a larger role for the process, a review of present dynamic theory is necessary.

Insofar as rocks are considered to be formed by erosion, heat, and pressure, they require transportation to the earth's basins. Transportation requires elevation, and elevation brings us to structural geology, one of the most active theoretical fields in geology.

The Rock Cycle

Sediments are produced, according to geological doctrine, by a rock cycle. The Britannica defines this process as "The idealized path traversed by molten material through various rock types and, ultimately, back to the bowels of the earth." The latest model for global techtonics is somewhat different from the formulation developed by Hutton and the plutonists, but there are points of commonality.

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[37]Britannica/86, "Geochronology," p. 750[?].

[38]*Earth's Most Challenging Mysteries*, page unknown.

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Sediment as Fuel

Originally sediment was seen, particularly by the plutonists, as some sort of driving mechanism, for it had to cycle itself back "into the bowels of the earth" before making its way to the surface again. It was the weight of these sediments pressing on the bottom of the ocean that moved the magma under the continents and up again. This idea has since been superseded by the plate tectonic theory, but its shadow is still to be seen in today's ideas of the production of the earth's sediments.

The pressure of the earth's rising accumulation of detritus, presumably accumulating under the seas, is still considered to form the great accumulations of mud rocks that represent the majority of the earth's brittle rocks.

Plate Tectonics

The current tectonic model proposes the earth's own heat as the magma propelling mechanism, cycling such tremendous amounts of molten and slowly hardening rock that the earth's continents appear like mere cow chips on a stagnant pond. Under these circumstances the earth does not need sediment to fuel the old plutonist model of a rebuilding, revitalizing earth.

Theory and Application

It is hard to determine what purpose both the rock cycle and plate tectonics now serve in explaining sedimentary production. At one time it was important to establish uplift in order to explain sediment, for both the transportation and production of sediment were principally attributed to mechanical erosion.

Weathering, the erosion of the earth's crust by water-borne particles, glaciers and ice wedging, is now considered to play a minor part in sediment production. Much of the earth's sediment is now thought to come from chemical action, principally on igneous rocks. This makes the problems of mountain building somewhat irrelevant in determining the source of sediments. But the theory, difficult as it is to comprehend and justify, still remains in university texts.

Even the most conservative academics such as Flint, the late dean of American geologists, admits "the circuit of the rock cycle that includes the mantle involves mysterious and little-understood processes."[39]

The so-called rock cycle requires some critical analysis, for it seems to confer credibility to erosion as the sole cause of the production of sediment, a premise which this work attacks. We are still uncertain of the composition of the earth's interior, let alone how continents are formed, and this is relevant to an hypothesis that advances the idea that strata are pushed into the crust by the weight of overburden.

[39]Flint, Richard Foster and Brian J. Skinner. *Physical Geology* 2ed. (New York: John Wiley & Sons, 1974), 75.

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Up or Down?

Compounding the confusion is the recent theory put forward by the plate tectonists which proposes that sediments are being shoved under the continents by the crust's spreading plates.

Some petrologists, however, believe that continents are growing. Does this mean that the crust is growing from the bottom up? This contradicts the principle of superposition - the premise that sedimentary rocks form on the surface and then are submerged. Do some rocks come up and some go down?

Fortunately, current doctrines of weathering have nothing to do with cycles of any sort, be they plates or sub-crustal magmatic currents. If, as argued by Donnelly, sediments originated exogenously, it would do little to invalidate plate tectonics or the rock cycle, both of whose basic movements theoretically should progress quite independently of one another. Simply put, the weathering of rock cannot logically contribute to the movement of continents. Sediment may be a byproduct of that movement, but it does not contribute to that movement.

Metamorphism

Before moving to the critical topic of weathering, the process which presumably accounts for the world's production of sediments, we must address ourselves to some further obsolescent notions on lithification, the process whereby loose and compacted grains of sediment are finally converted to rocks of all types.The Britannica states that "...in the development of new minerals, under the high pressure and temperature of the metamorphic environment, changes of different sorts occur: the development of new minerals, enlargement of pre-existing crystals, and the re-arrangement of crystals into more orderly patterns."

Although the Britannica allows that these processes are inferred rather than observed, and this work does not take exception to this generalization, we can be easily misled into assuming that "true rock" (limestones, sandstones, aragonites, etc.) is finally formed or lithified by this process.

The next section will deal with the true source of sediment.

WEATHERING

Early Reservations

Though the concept of sediment production by the erosion of continents is still the dominant academic theory, it attracted the skeptical geological mind even as early as the late nineteenth century. Greene reports that "Buch ... declined to accept erosion as a major factor in creating relief - for Buch, everything was a consequence of plutonic upheaval in some form. An inheritance of this conviction was the theory, still defended in the 1870s, that the deep Alpine valleys were fissures in the crust and certainly not the

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product of the puny streams barely visible from the peaks they had supposedly created."[40]

Accounting for the enormous amounts of the world's sediments in the past has required the combination of geological time and alluvial erosion. The minor role of riverine erosion and the probable tectonic origin of such large depressions as the Grand Canyon, however, is a smaller problem than the one of disposal. Sediments, heaped in kilometre deep deposits around the continental estuaries, present a geological problem that has required the reintroduction of isostatic-like concepts.

Deep Drilling

Brian J. Skinner, in evaluating the results of the Glomar Challenger's deep sea drilling program, stated the problem. "Geologists are able to make very good estimates of deposition of erosional sediments into the world's oceans. The rate is such that the basins would be filled in tens of millions of years. Even allowing for adjustments of isostacy ... this was far shy of the number of the several billion years generally accepted as the age of the earth."[41]

This "gross inconsistency" lasted for many years until plate tectonics came to the rescue, by reintroducing Herschell's nineteenth century theory of isostacy, with one embellishment. Instead of the pressure of sediment supplying the continents with elevation for creating and transporting sediments, plate tectonics would act as a global broom, sweeping the surplus sediment under the continental carpet. Skinner reports the insight. "...The accumulation of sediments near the continents no longer presents a problem. The sediments are continually scraped from the plate as it takes its downward plunge at the continental margin. The accumulation is presumably impacted into the continent and rebuilds and maintains it in some crude isostatic equilibrium."[42]

It has apparently never entered the minds of geologists, that the apparent overabundance of the earth's sediments is due to the simple fact that the earth did not produce it.

The development of ad hoc theories of sedimentary production through the centuries has led geologists to accept weathering as the self evident source of virtually all sediment.

The Great Housekeeper

The process has an almost idyllic quality when described by a talented academic hand.

Weathering is seen by Flint as some modern day goddess - a perpetually restless housekeeper, "...ceaselessly sweeping regolith (the layer of disintegrated and decomposed rock fragments, including soil, just above the solid rock of the earth's crust) off the non-

[40]Greene, p. 197.

[41]Brian J. Skinner (ed.), *Earth's History, Structure and Materials - Readings for American Scientist*, "The Deep See Drilling Project, After Ten Years," p. 76[?].

[42] Greene, p. 58. (Quoted from Stanislov Meunier, 1911 *L'evolution de theories geologique.*)

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weathered rock below, ..and depositing it as sediment in river valleys, lakes, seas and innumerable basins."[43]

This geologist sees sediment being transported "by every trickle of water after a rainfall and by every wind that carries dust. The mud on the lake bottom, sand on the beach and even dust on the window sill is sediment....When a thick pile of sediment accumulates, particles near the base of the formation become compacted. Eventually they become cemented together to form a solid aggregate rock."[44]

The last line of this poetical description, almost an afterthought, reveals one of the most curious facts in geology, that most of the world's rocks are essentially cement, and thus require neither heat nor pressure to form. With the source, production and disposal of the earth's sediments still presenting problems, Donnelly's idea of an external origin for the earth's sediments does not seem wildly out of order in this century.

RETURN TO THE DRIFT

One Hundred Years

There is little more that modern geology can tell us of the crustal origin of drift a century after the publication of *Ragnarok*. Drift and stratified till are gathered under one category called glacial drift, which "embraces all rock material in transport by glacier ice, all deposits made by glacier ice, and all deposits dominantly of glacial origin made in the sea or in bodies of glacial melt water, whether rafted in icebergs or transported in the water itself."[45] Though this definition embraces the transportation of the materials that preoccupied most nineteenth century geologists, it mentions nothing of the contribution made by advancing and retreating glaciers.

It is still conceded that neither glaciers nor ice sheets are presently seen manufacturing this material. Present texts admit that it is not found where it should be, absent from glacial areas and filling valleys to the brim in tropical climes. Current texts repeat Donnelly's assertion that the materials lack fossils and that water seems to perform a minimal role in its production. Flint, in a somewhat bewildering statement admits that the regolith (the earth's cover of unlithified sediment) did not contribute much to the formation of glacial drift. One assumes that he means that this class of sediment does not seem to be the product of observable mechanical or chemical breakdown of larger rock fragments. One can only assume that the rocky fragments created by the expansion and contraction of freezing water soaked in upland rock formations, the principal source of mechanically produced sediments, do not produce the peculiar geometry and markings found in tills.

We are therefore still lacking an explanation of the origin of a class of material which

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[43]Source unknown.

[44]Source unknown.

[45]Fint, *Glacial and Pleistocene Geology*, p. 108.

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makes up a significant portion of the world's sediments.

Jumbled Till

Flint does make one striking point concerning the formation of till: one type can be distinguished from another. This is somewhat contrary to the glacial hypothesis which holds that the tills are gathered up and presumably jumbled together as the ice sheet bulldozes them.

Transport: Alluvial and Airborne

There would be no contradiction in this finding if the source of these materials were coherent streams of exogenous debris, laying themselves across the earth in continuous, discrete, graded paths. This grading effect has always been an important point of departure for geologists. All large accumulations of particulate matter passing through a resisting medium will be graded, in this case the earth being graded as it passes through the atmosphere.

Wind-blown and river-borne particles, however, will vary greatly, for the density and chemistry of each medium is quite different. Gravels, being the most heavy sediments normally transported by alluvial processes, usually travel, at most a few hundred meters from the formations from which they are dislodged. However, eskers, a geological phenomenon which will be discussed in greater detail below, extend for hundreds of kilometres. This anomalous grading is relatively less dramatic than the propensities of clays to separate into iron rich and iron deficient clays.

Magnetic Properties Revisited

This grading effect, ingeniously explained by Donnelly's magnetic tail separator, can be further supported by other magnetically sensitive categories of earthy materials.[46]

One writer comments on the high ferrous content of some loams, which cannot be accounted for by the conventional wind-blown or aeolian hypothesis alone: "Weathering of minerals, loss of silica, relative accumulation of iron, does not satisfactorily explain this anomaly."[47]

Even more unusual is the location of some of these ferrous deposits. The bauxites found on Hawaiian volcanoes are rich sources of iron compounds. Once believed to be the product of the volcano itself, these deposits are now suspected to be of wind blown origin, dated to the period of a major geomagnetic event called the Gothenberg Flip just prior to the last major retreat of the great ice sheets. Volcanoes, which are known to be geomagnetic hot spots, particularly during eruption, could have served as an excellent "lightning rod" for a descending element of a great comet's tail.

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[46] *Catastrophist Geology*, 1970 and 75[?].

[47] Source Unknown.

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THE ESKER

Recent Arrival

Donnelly was unaware of the esker, which was not well described until the end of the 19th century. There is little doubt, however, what his opinion would have been of this geological peculiarity.

Eskers are elongated narrow sand and gravel ridges. Some of these formations are over 500 kilometres long and from 3 to 200 metres in width. The sides are generally steep and sometimes slicked with layers of clay. The geological consensus is that they are glacial in origin, and there is good reason to believe this, for they are found in regions evacuated by the great ice sheets and trend, in broad outline, parallel to the direction of flow of the latest of the former glaciers.

Current Theory

Though there is little debate over their connection to the retreating ice-sheets, the actual formation of eskers presents some difficulties. The geological consensus is that eskers are probably deposits made by streams flowing in ice tunnels at the bottom of ice sheets. Flint suggests that this would only work, though, if the ice sheets were motionless. "During this obviously warm wet period ... melt waters flowing from the surface of the glacier sought the lowest channels and thus topography influenced the course of the esker"[48]

Topography is, however, the most important sticking point for Flint's hypothesis, for these sinuous formations, in the words of the author himself, "may climb up a valley, pass over a low divide, and descend the far slope."[49] In addition to hills and valleys, eskers cross rivers as well, straining the credibility of arguments that they follow present topography.

We do not know what arguments may be put to deny their extraterrestrial origin, for this possibility is not mentioned by any conventional authority, yet Donnelly would apply the same criteria to analyzing the esker as he did to the drift.

Where do these strange gravel and sand deposits come from? For, as Flint and others agree, alluvial and glacial processes have little to do with their formation. If they are the result of alluvial processes, why are there no marine deposits found in and amongst their non-fossiliferous stones? Why, if they are the product of a stream, do many eskers taper off into nothingness, instead of ending at a terminal moraine of unconsolidated rubble?

If these eskers formed in ice tunnels, at the bottom of ice sheets, then bringing the gravel over the top of hills would have required such unpromising arguments as proposing that the "ice squeezes the stones uphill on both sides" (see Corliss reprints). And why, finally, do they not resemble the product of ordinary alluvial processes, which do not normally transport gravels for more than tens of metres, let alone hundreds of kilometres?

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[48]Flint. *Glacial and Pleistocene Geology*, p. 157. [paraphrase]

[49]Flint. *Glacial and Pleistocene Geology*, p. 155.

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The Cosmic Serpent

It is unlikely that Donnelly would have overlooked this formation. He would have identified it as a perfectly preserved meteoric shower representing the tail of a comet, gently let down by the surface snows of an extinguished ice sheet. Each element of his hypothesis would substantiate the identification - the unfossiliferous nature of the gravel, the graded size of the gravels, the orientation of the till, their longest diameters parallel to the axis of the esker, the whole train of material a textbook illustration of his vacuum grinding machine. He would have seen the meandering hundred kilometre long beds, slicked by coverings of clay, draped over hill and dale, as the skeletons of the vanquished serpent he described in his retelling of ancient cosmogonies.

LOESS

Flesh of the Serpent

Having found the skeleton of our cosmic serpents,[50] where are the remains of their flesh? This point at least is not particularly controversial. Most of the great river valleys of Europe and North America are covered with a loamlike material called loess. Multi-layered and fossil-free, it has been identified as the outwash of the great ice sheets of the last ten to fifteen thousand years. The loess, we are told, was supplied by great winds of this era which deposited thousands of cubic kilometers of the silt-like materials on the retreating ice. These winds are conceded to have a velocity and direction that has no relationship to present day weather patterns.

Chemistry

Microscopically, loess, when not worn by alluvial processes, has an angular sharp-edged shape, which makes its unstratified deposits quite porous; in most cases at least 50% air. Chemically, it is complex and heterogeneous, made up mainly of quartz and with some clay minerals, micas, hornblende, and pyroxene added into the mix. By weight, up to 40% of the sediment may be carbonates. The composition of loess "is so elastic that it tells us little about the rocks in which the minerals originated."[51]

Domain

Loess underlies an enormous aggregate area of at least 10 million square kilometers in North America and more than 1.8 million square kilometers in Europe. So vast are the deposits that Flint states that a large proportion of the buried Quaternary soils now known are developed in loess.[52]

[50]Apologies to Klube and Napier, authors of *The Cosmic Serpent*, the first academics since William Whiston to seriously examine the actions of comets in earth history.

[51]Flint. *Glacial and Pleistocene Geology*, p. 181.

[52]Flint, *Glacial and Pliestocene Geology*, p. 186[?].

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Provenance

In researching the source of these materials, geologists are generally content to indicate the geographical sources of the wind-borne particles and not the actual method of their production. Flint cites deserts, outwash, and recently exposed till, adding some perplexity to the problem by admitting that once covered, the loess deposits are not easily airborne. Some effort is expended in developing a method for these particles to lift off the ground, and we are led to believe that sand particles help the take-off by kicking the lazy silt into the air.[53]

These hypotheses only obscure the fact that outwash, deserts and till deposits are only secondary sources of loess and, even if perfectly able to rise freely and circulate to northern latitudes, could not account for the thousands of cubic kilometres that are found in some North American deposits.

The current attitude towards the source of loess deposits is to point to the inferred origin of the prevailing winds. Unfortunately this sometimes suffers from a nationalistic bias.

Geologists never seem to own up to a local source for loess. Each nation disclaims the intrusion, as if the loess were some old version of acid rain. Since much of the Pleistocene loess shows a westerly directionality, we have the geologists, from a bird's eye view, pointing perpetually eastward, quite naturally outside of their own territories.

Another difficulty in explaining the origin of loess is that a good part of the loess found on the earth's surface does not seem to be the product of alluvial processes, a primary condition of their eventual transport and deposition by air.

Northern China

The greatest deposits of loess not located adjacent to Pleistocene glaciation occur in Manchuria, where they are found in unstratified conglomerations as deep as one hundred metres. First described in the late nineteenth century, these reports were not available to Donnelly. The writer of the Chinese report registered his frank disbelief that these deposits could have been alluvial in origin. He noted that loess was found in formations as high as seven thousand five hundred feet and "the uniform composition of this material over extended areas, coupled with the absence of stratification and of marine or fresh water organic remains, renders impossible the hypothesis that it is a water deposit."[54] The writer especially noted the use the Chinese peasants made of the loess, for the soil yielded up to three crops per year and required no manuring. "Wherever this deposit extends, there the husbandman has an assured harvest, two or even three times a year. It is easily worked, exceedingly fertile, and submits to constant tillage, with no other manure than a sprinkling of its own loam dug from the nearest bank."[55] The material not only provided homes which were dug out of the side of its cliffs, but also partition walls, cement, beds, and

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[53]Flint. *Glacial and Pleistocene Geology*, p. 257[?].

[54]Corliss, page unknown.

[55]Corliss, page unknown.

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furniture were made of this remarkable material. "Whole villages cluster together in a series of adjoining or superimposed chambers, some of which pierce the soil to a depth of more than 200 feet."[56]

The reason for the extraordinary qualities of this material is that it is 'nailed' together by tiny limestone capillaries, creating a lightweight masonry composite. These peculiar tubules provide the capillary action that draws the moisture up from the bedrock. This peculiar vertically oriented structure led geologists to state that this formation was vertically stratified, probably giving the reader the mistaken belief that the materials were conventionally stratified into some sort of bizarre vertically oriented structure.

The Meteoric Hypothesis

The process by which loess is cemented together is not well understood, but it is obviously some alluvial or draining process.

In 1930 and 1931 Pennisto, writing in *Popular Astronomy*, suggested that loess was meteoric in origin. He also offered an explanation for the formation's vertical stratification and noted the unlikelihood that the sharp-edged grit could have been worn down by water. After noting the similarity loess shared with meteoric and volcanic particles, and its dissimilarity to "rock flour," the product of glacial grinding, he turned to the peculiar calcareous tubules, suggesting that "water, as from a fine drizzle of rain, would descend unevenly, and coming in contact with newly fallen meteoric matter, the finest material would be segregated along these lines of flow, ultimately becoming crystallized as is found in the hollowed tubes in the loess."

The most interesting element of his hypothesis was his choice for the mineral source of the calcareous tubules. The loess deposit itself, devoid as it was of fossils, made a poor source of calcium. The hard shells of some marine organisms, even if they contributed to the materials, would have had to undergo bathing in carbonic acid or other organic acid baths in order to dissolve. Ordinary rain water would not do the job. The astronomer indicated that calcium oxide (slaked lime) would do the trick, but it was not normally found in earth minerals. Pennisto then pointed out that meteorites did contain calcium oxide in appreciable amounts. If this calcium oxide were scattered amongst the larger meteoric debris in fine dust, then it would mix with rainwater and carbon dioxide, becoming the raw material source, in both suspension and solution of the tubules.[57]

Eskers and Loess Conclusion

So far, in reconsidering Donnelly's thesis, we have, in addition to reestablishing the legitimacy of his original observations, extended the evidence of exogenous sediments to eskers and loess. What is still before us is the prospect of the vast deposits of sedimentary rocks, by far the most extensive source of the earth's solid crust. Sandstone, for instance, which represents one quarter of the earth's rocks, is essentially cemented particles of

[56]Corliss, page unknown.

[57]Corliss, p. 114[?].

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organic and inorganic matter. Limestones, which compose the next largest category, are much the same, except that the cementing agent is more likely to be limestone solution. The theories concerning the formation of both rock types are controversial, but the matrixing agent for both is understood to be a cementing agent.

It is conceded, however, that many silica based rocks are "the products of the varying amounts of dilution of the chemically precipitated silica by solid terrigenous detritus or by biogenically formed carbonate."[58] Both limestone and sandstone share this critical element in common with all rocks that are made up of sediment, so that the observer looking into the Grand Canyon is not looking at the process of compaction and pressure, but the result of an enormous cementing operation. The mudstones (shale, etc.), which represent a much higher percentage of the sedimentary column, are an exception, for the microscopic structure of the matrix leaves little or no pour spaces, effectively excluding most cementing agents. Unless turned into composite structures of detritus and baked clay, called hard pan, the material remains ductile and tends to spread under pressure. The particles become oriented so their longest axes lie parallel to the bedding plane, forming into the characteristic patterns that we see in the brittle shales and slates that are gathered into the general category of mud rocks.

EVAPORITES

A Wide Field

Most sedimentary formations can be described as evaporites, since the theory of formation requires that solutions of limestone (calcite) and silicate require some degree of concentration before they precipitate. As a result, many of the earth's minerals are to be the product of the evaporation of the seas and oceans of the world. It is conceded that many of the great deposits of minerals may have been due to the invasion of seas into great basins, which provided no natural outlet to the sea. We see this process taking place today in smaller 'dead-end' basins such as the famous Dead Sea and many other 'pluvial' lakes of the world, such as the great Salt lake of Utah.

When the great beds of salt, limestone and sandstone are explained by evaporation the theory begins to come apart somewhat, for the processes required to produce these thousands of cubic kilometers require unique conditions of climate, surface area and tectonic processes that are not in existence today.

And where did the raw materials required for this task come from? Apparently animal parts and volcanic rocks are the source of this earth-binding exercise. The uniformitarianistic injunction to look only for presently occurring processes does not help here, for large scale cementing of bedding planes does not seem to be part of current earth building activity.

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[58]Britannica/86, vol. 24, p. 240.

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THE CYCLOTHEM

The Comet Model Reconsidered

Our reconsideration of Donnelly's work leads to the conclusion that the shape, markings, distribution, chemical composition, biological and ferrous content, geographical location, and laydown pattern of the world's sediments do not conform to explanations based on weathering alone, and that a meteoric hypothesis has either already been suggested for some of these materials or would simplify the current hypothesis.

The more massive and deep a sedimentary formation is, the less tenable a weathering hypothesis becomes, for each distinctive stratum, be it shale, limestone, coal or sandstone, suggests a unique set of time-dependent circumstances.

Limestones

The deposits of loess, limestone, sandstone, and clay, are continental in breadth, sometimes many thousands of metres in depth. The deeper and wider they are, the less they conform to uniformitarianistic analysis. For example, the formation of limestone deposits on the continents cannot be adequately explained by current methods of limestone formation, which is mainly achieved in shallow warm seas, far from river estuaries. These coral reefs, however, are not the stuff of typical ancient limestone formations. As a result geologists have invented a unique continental-sized Epeiric Sea, only a few metres deep, extending from one side of the continent to another, in which marine organisms of a special type could flourish and supply the hard parts from which the limestone beds would grow.

These are precisely the extraordinary phenomena that Charles Lyell prohibited in his *Principles of Geology*. There are no Epeiric seas in the world today producing limestone beds.

Neither are large beds of sedimentary rocks being formed by cementing. We see plenty of sediment being brought down to the seas, but have no precise idea how it was fragmented from sedimentary rocks. Where are the kilometre deep oceans presently evaporating to produce the bewildering array of deep successive layers of phosphates, salt, iron, and the more than 70 varieties of evaporitic minerals that form an integral part of the geological column?

Best Evidence

The meteoric hypothesis, radical as it may seem, not only fulfills the criterion of rationality, it lends itself to a unique test: establishing the age of an enigmatic formation in the Carboniferous, the age of the amphibian. This model, if it is to succeed, must encapsulate and freeze in time a full sample of the outfall of a giant comet's tail. The Cyclothem fulfills this criterion. The first clue to our test formation comes from one of the very few pieces of evidence linking drift to its locale.

Flint states, "...sediments of which an esker is built are closely similar to the lithology of the till or the bedrock in the vicinity. The similarity suggests that they have a common origin in the drift carried in the ice." If, as Donnelly suggested, the comet's tail carried a comparable amount of dust, then it follows that the soluble elements would settle in local

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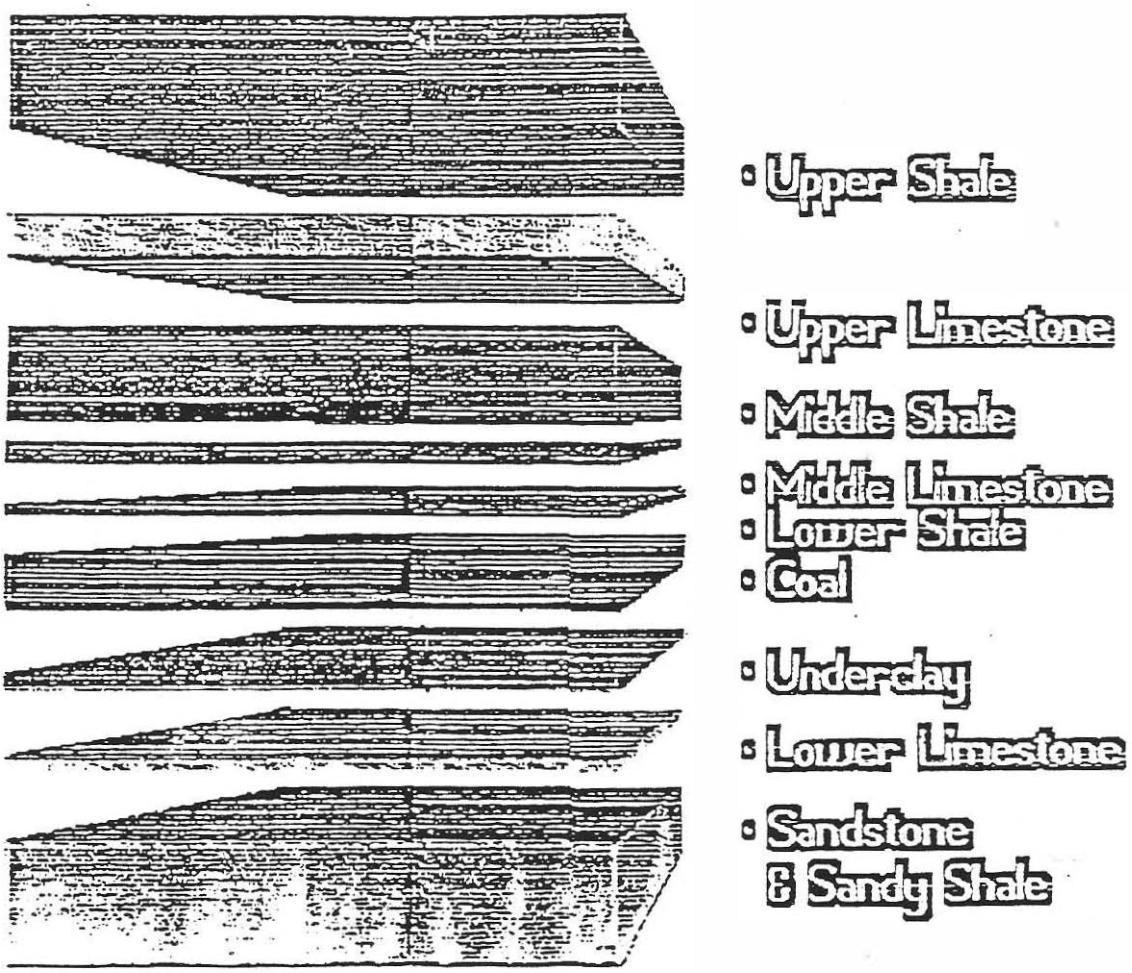

The layers of a typical cyclothem. This typical sequence may repeat itself up to 100 times. These sedimentary rhythms build upwards until they reach the top of the channels and basins in which they form.

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basins and channels. But how does Flint define "local bedrock and lithology"? He doesn't say, but there is a formation which is closely associated with the retreating continental ice-sheets, and it is called a cyclothem.

The Members

First classified in 1931, the cyclothem is basically a repetition of from five to ten layers of sedimentary materials. What characterizes a cyclothem is the cycle itself, and not the composition of its collective members. A sequence may repeat itself up to 100 times, or as little as a dozen. Once the sequence is established, however, it persists until the sequence ends or the contents of an individual member peter out as the cyclothem climbs the geological column.

The members (layers) of a cyclothem are sedimentary, mostly rock. An ideal 10-layer unit consists of the following:

1. Sandstone, consisting of pebbles, abundant mica flakes, and undecomposed feldspar;
2. Sandy and silty shale, generally thin, which succeeds the sandstone without abrupt transition;
3. Lower sandstone (no marine fossils), thin, fine-textured and confined geographically;
4. Underclay, which may have plant rootlets;
5. Coal (note that underclays are often associated);
6. Rootlets, and sometimes marine fossils;
7. Limestone - relatively rare and inconsistent;
8. Shale, fossiliferous;
9. Upper limestone, lightly coloured fossiliferous. Most predominantly exposed;
10. Shale, predominantly silty. Fossils rarely present. Ironstone present.

Cyclothems never go over 50 metres in height and only rarely exceed 30 metres. Because many cyclothems contain coal and its companion underclay, they are relegated to the Carboniferous Era, and the entire system thus comes under the aegis of geological time. Coal, after all, requires the growth and decay of forests, and this takes time. It is estimated that four centimetres of coal requires a millennium, and even such hard-boiled skeptics as the anomalist Corliss relegates dense coal to biogenesis. It is not surprising then that geologists estimate each cyclothem to be 75 to 100 thousand years in age. There is no need for a time variation, however, for cyclothems are precisely one year old.

Current Explanations

We will not dwell extensively on current explanations for the cyclothem, for there is no clear scientific idea on how they arise. The major contenders are the sea incursion and the glacier incursion factions. Both factions focus on the sandstone base of the cyclothem, the former requiring the advance and retreat of the ocean and its adjacent beach, and the other faction two glacial ages per cyclothem.

Each layer of the cyclothem has its own peculiar problem in adhering to the major hypothesis but the Britannica, in referring to the sea beach school, conveys a criticism that

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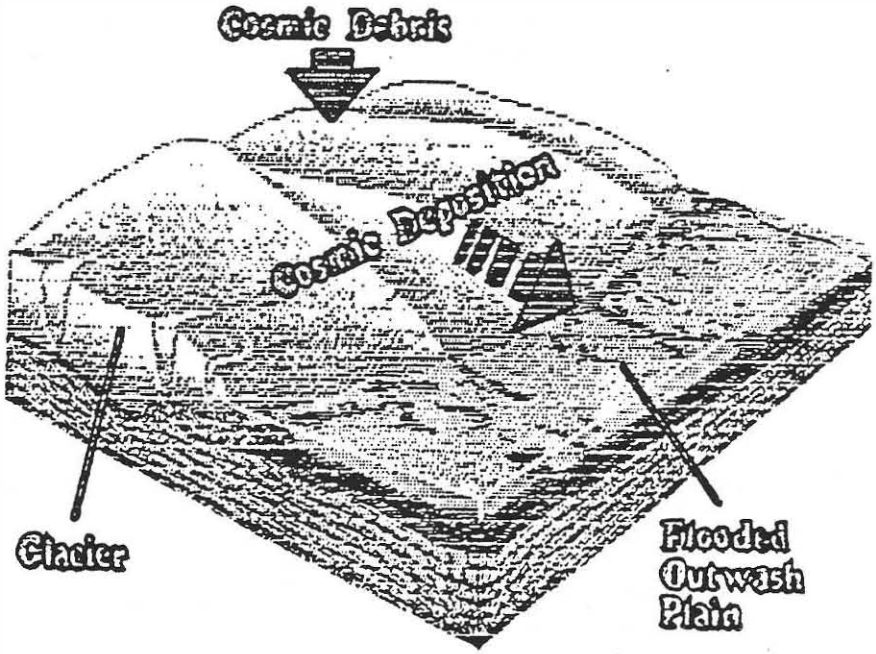
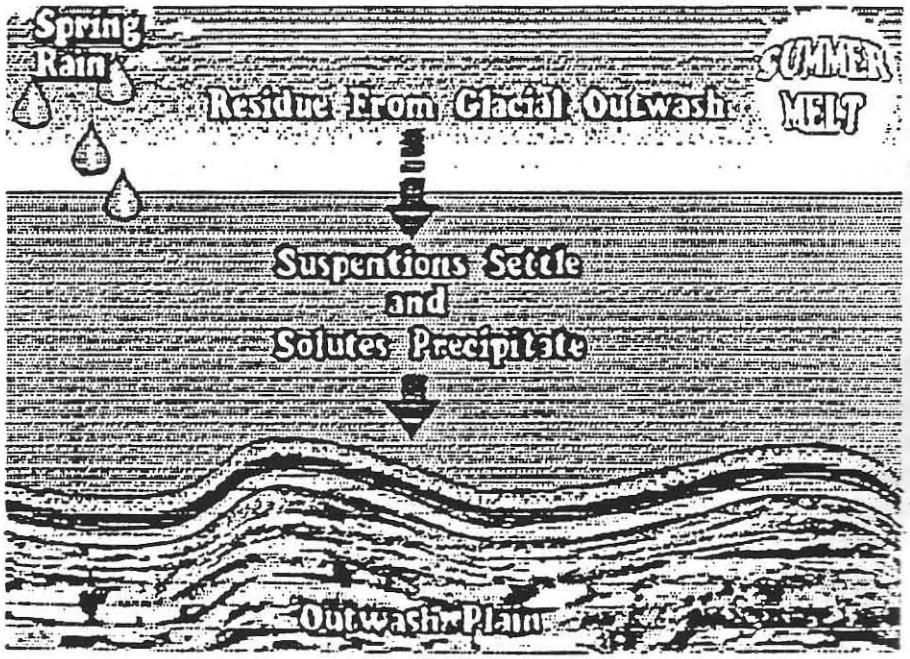


Cyclothem. Isometric Section



Cyclothem. Lateral Cross Section

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can be applied to both - "this theory has been criticized as invoking a repeated series of earth movements so regular and mechanistic as to be unreasonable." The Britannica also has a problem with the repeated rise and fall of the land, so reminiscent of the obsolescent Davisian school of the pennaplain, and the Britannica marvels at the unique circumstances associated with the phenomenon. "...This general pattern of incursion and reversal of the sea may not have been restricted to late paleozoic time but a special combination of conditions, including rapid intermittent erosion of upland regions, sea level critically located with respect to continental platforms, the existence of an abundant and vigorous land flora adapted to marshy conditions, and favorable climates, all combined to produce unique results that were never duplicated exactly before or since." The writer concludes that "all present attempts at explanation of cyclothem development are excursions into the realm of theory."[59]

Aside from the general uniformitarianistic taint the explanations have, and the lack of confirming climatic evidence, there are more specific problems with cyclothem theory. First there are no marine fossils in the first sandstone layer, an important omission. Secondly, the fossils found throughout the entire cyclothem formation show little or no faunal evolutionary change. "Comparisons of the fossilized remains of similar animals contained in several successive cyclothems may show minor morphologic differences that characterize more closely spaced steps in their progressive evolution than can ordinarily be detected."[60]

The reflexive attitude towards any sedimentary body that included coal precluded any serious examination of this formation in proper uniformitarianistic terms for, ironically, the cyclothem is a perfect uniformitarian feature. It is almost pure cycle and virtually no substance. One formation will not contain limestone, another will have smudges instead of coal. Very few cyclothems contain 10 layers and there are little understood cyclothems which are bigger and sloppier versions of their cousins. They are called mega- and hyper-cyclothems.

Glacial Outwash

Cyclothems are the annual accumulations of glacial outwash. They form in the same way a clay varve would form in a deep glacial lake.

Varves

Varves are discernable because they turn off and on as summer turns into winter, radically changing the quality and amount of outwash. Varves also have two components, which are the result of the chemical nature of the detritus and the quality of the water in which these particles settle and dissolve.[61]

Geologists do not exclude the varve from ancient formations, and concede that carbonates,

[59]Brittannica/86, "Geochronology," p. 771[?].

[60]Brittannica/86, "Geochronology," p. 770.

[61]*Principles of Physical Sedimentology*, p. 291.

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organic matter, and other evaporites may be found in formations going back as far as 200 million years.

The author of a text on physical sedimentology has attempted to reconstruct the genesis of ancient clay stones in Africa which possessed repetitions of differing carbonates by using the glacial varve model: "Sediments were deposited in the lake, which warmed in summer, therefore lost carbon dioxide, and precipitated $CaCO_4$ from solution. In the same warm season, floating microscopic organisms reached a peak of abundance. Relatively heavy carbonates sank promptly and formed the summer layers; lighter organic matter sank much more slowly to form an overlying layer."[62]

Conventional sediments and muds are not the only minerals to show this distinct double layering, consistent with annual outwash patterns.

In noting how varves respond to seasonal variations, the Britannica gives the example of the Mexican Castile formation consisting of "alternating layers, gypsum and calcite, that may reflect an annual temperature cycle in the hypersaline water from which the minerals precipitated. In moist, temperate climates, lake sediments collecting in the summer are richer in organic matter. Most of them settle in winter." There is nothing to distinguish this and other rhythmic alternations of sediments from annual varves except for the scale and content of the formation.

The order of a cyclothem's members from bottom to top shows a rational succession connected to climatic and chemical composition. In the spring the initial floods would bring the sand and pebbles into the basin, clearing both channel and ice sheet of its annual dividend of these materials. Representing the largest particulate matter, these sands and pebbles would form the first layer. Following the spring flood, the occasional freezes, combined with early settling, would produce the next shale layer.

The first layers of dirty limestones would be early precipitates of calcium carbonates, using the settling detritus as nuclei. This stage would be followed by the finer underclay. The warming trend of spring and summer would cause further carbon dioxide to escape and cause further precipitation of limestones. The finer particles of silt and clay continuously settling during the fall and winter would be cemented by the solutions and suspended cement of the following season.

In broad outline, this explanation accounts for:

1. The geographical location of these formations in the northern hemisphere in the same locale in which the terminal moraines of the last glaciations have been found.
2. The lack of fossil change, the longest succession of cyclothems requiring only 100 years.
3. A logical reason for the disappearance of these systems, once the glacier retreated or when the basin containing these sediments had overflowed.
4. A rationale for the relationship of the local lithology to the surrounding till.

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[62]*Principles of Physical Sedimentology*, p 291.

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5. An explanation for the existence of large amounts of liquid mortar for the sedimentary rock.

More specifically:

1. The pebbles and sandstones of the first layer are graded from coarse to fine as the member grows, a feature more consistent with an annual laydown of sediment than one lasting hundreds or thousands of years. An annual quick spring settling would account, as well, for the non-fossiliferous nature of the sand.
2. The rootlets in the underclay would represent vegetation stifled before its full growth by the settling gelatinous hydrocarbon. Fully preserved rootlets, in the conventional biogenetical explanation, could not remain untouched while entire forests were required to decay to coal, immediately above the delicate emerging plants.

COAL

Presumption of Organic Origin

The most important argument against this hypothesis would be the assumption that the source of the coal seam was non-organic.

A cursory examination of the geological literature, however, shows that the organic genesis of anthracites (hard coals) is far from proven.

Although it is still maintained that all coal evolves from peat beds, it is now conceded that not all coals, such as brown coal and lignite, have the same genesis. It is not clear how coal became such an obvious candidate for an organic origin. First, there is no organic matter to be found in coal. Second, we do not observe hard coals or brown coals presently forming.

Third, hydrocarbon based materials are not good agents of biodegradation; they preserve organic materials. Fourth, life forms concerned with the conversion of vegetation to coal cannot live at the depths that require conversion of non-anthracite coals. And fifth, heat and pressure, according to physicists, are not sufficient on their own to create anthracites.

Coal Jelly

Aside from these uncontroversial objections, hard coal betrays, in its solid form, a gelatinous past. Splash marks, suspended rocks, dinosaur prints and perfectly preserved animals and nodules of plant remains are commonplace in the literature.[63]

It is hard to conceive of coal going through a gelatinous phase while submerging during the millennia it takes to form the material, playing host, during the descent, to the footprints of fauna and rocks with perfectly preserved vegetation still clinging to them.

To add a somewhat bizarre note, some coal seams have formed around fossil forests. One such example, near the Bay of Fundy, has four coal seams surrounding the fossil

[63]Corliss, page unknown.

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trunks. One wonders how the four eras of glacial grinding, or the many convergings of seas, failed to topple or engorge this coal fodder.

Finally, though there are no examples of the present day coalification of anthracite, there are examples of naturally occurring gelatinous hydrocarbons which, when exposed to air, solidify into a material which cannot be distinguished from anthracite. This material, which is similar to doplerite, a brownish flexible hydrocarbon found in peat bogs, was uncovered in the late nineteenth century while workers were excavating for a court house near Scranton, Pennsylvania. The black gelatinous material, when exposed to air, solidified into a glassy solid which burned like coal and left a red ash, similar to some grades of anthracite.

CONCLUSION

There is no middle ground in the question of sedimentary production. If a cyclothem is a giant varve then it must have come from glacial outwash. There is no way to account for the presence of materials on an ice sheet except if they were deposited through the air. Whereas materials such as loess and sand may be explained away as windborne debris with great difficulty, there is no uniformatarian explanation for the other enormous deposits of gravels, ferrous clays, hydrocarbons, and calcium oxides that eventually built themselves into the consecutive rhythms of the cyclothemic formation.

Conybeare, when he first investigated and named the carboniferous era in 1822, recognized the succession of sandstone, clay, coal, and limestone, as a single interrelated unit. The cyclothem, acknowledged to belong to the same era, cannot be a repetition of dozens of Carboniferous eras, each stacked up in multi-million year replicas of its counterpart. This would lead to the absurd conclusion that each successive cyclothem, which is part of the Carboniferous, is longer than the whole era.

The identification of the dust and gases in comet tails and the tons of cosmic debris that fall upon the earth daily are now recognized as containing most of the important elements found in sediments. Radar and satellite monitoring have also established that the dust is preponderantly the product of materials orbiting the sun.

That the earth's crust is made up principally of comet-borne materials would not be a great surprise to our ancestors who feared and worshipped the earth that descended from heaven. What becomes more apparent to the investigator are the new links between the sudden periods of sedimentary accretion in the Quaternary, and the advance of the Hominid to nomadism, agriculture and ultimately, civilization.

If sediment, as is generally assumed, is produced from the gradual erosion of the crust, it well may be a condition to which the biosphere could adjust without recourse to extraordinary genetic tools. If, however, the very nature of the earth's chemistry was changed in a matter of hours or days, then it is unlikely that life as we know it could adapt, without some
radical systemized response.

Geology, which borrowed the bones of species buried in the sediments of

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extinguished world ages to name their stratigraphic column, should be aware of a new question being asked by paleontologists in their quest to understand extinctions in the age of man.

The appropriate question is not "Where were today's biotic provinces during the late Pleistocene?" Rather, "Why were the late Pleistocene biotic provinces so different from those of today?"[64]

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[64]*Quaternary Extinctions* (Cock Robin Review), p. 786[?].

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