# THE ROLE OF GEOLOGIC ENERGY IN INTERPRETING THE STRATIGRAPHIC RECORD

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## Abstract

*A creationist "geologic column" has a place in Earth history interpretation. None has been widely accepted and applied, although preliminary constructs have been proposed. We suggest that a graph of geological energy vs. time, keyed primarily to events, can form a basis for future correlation and interpretation. Although creationist field synthesis is limited, recognition of the role of extrascientific information in Earth history validates the present graph as constrained by the Bible's historical accounts. Complete development of this graph awaits extensive field research.*


## Introduction

In the marketplace of ideas, creationists are at a disadvantage because advocates of a naturalist-uniformitarian Earth history possess a well-developed interpretive construct in the form of the geologic column. Instead of rejecting the construct, many creationists have attempted to utilize the geologic column in their interpretations (Robinson, 1996; Garton, 1996, Garner, 1996). However, extrascientific considerations (such as consistency between fundamental assumptions and derivative conclusions; see Reed, 1996) render the present uniformitarian column untenable. Any advantage gained by having a comprehensive interpretive synthesis, such as the geologic column, is lost once the fundamental assumptions of that synthesis are shown to be wrong. Thus a complete solution would include two steps; the rejection of the uniformitarian geologic column, and the rebuilding of another based on assumptions of the biblical Christian worldview. Once past the first step, creationists still need to develop their own synthesis as a basis for interpretation of geologic earth history. Preliminary efforts have been advanced (Walker, 1994; Froede, 1995). However, there is still much work to be done.

Any new construct will be subject to various qualifications (e.g., Reed and Froede, in press), including the fundamental emphasis on the geologic event rather than geologic time as the basis for field interpretation. Often, field evidence is insufficient to define and link geologic events. Therefore, extrascientific information is utilized to help define the events to be described in the field. For example, the assumption that past geologic processes are reflections of present processes cannot be based on science, but it allows field data to be evaluated in terms of modern environments of deposition. Hence, elevating uniformitarianism over empiricism limits interpretative options that may be readily available within the same dataset. Most creationists do not accept this relationship between uniformitarianism and observation because it disallows catastrophic, large-scale, and unique events. Properly recognizing and balancing extrascientific constraints and clear implications of field observations are important for any geologist. Force-fitting geologic evidence to events defined only within a modern depositional environmental context, or doing so within a rigid speculative construct associated with the Genesis Flood, both disallow a proper emphasis on field data as the crucial component in detailed interpretation.

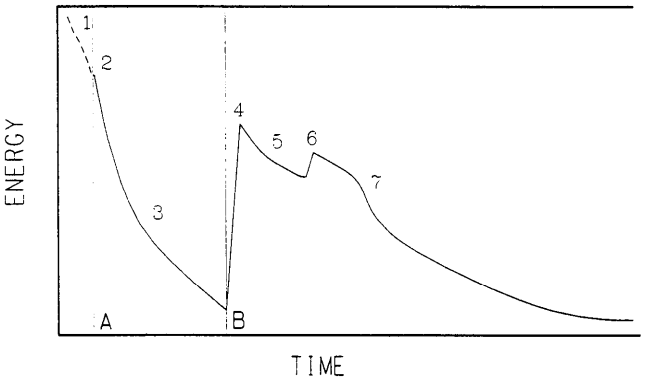


**Figure 1. Proposed geologic energy versus time plot based on Scriptural interpretation. Key geologically significant dividing lines A and B mark the third day of creation and the onset of the Genesis Flood respectively. Segment 1 represents the geologic energy prior to the third day of creation; because geologic events prior to that day are not described, the line is dashed to represent uncertainty, however, it is assumed that energy levels were higher during initial creation events. Segment 2 represents the geologic upheavals caused by the separation of the land and waters on the third day of creation. Segment 3 represents the decreasing energy levels between the events of the third day and the onset of the Flood. A steady, and somewhat exponential curve is deduced by analogy to many modern natural processes. Segment 4 represents the onset and early stages of the Flood. The relative tectonic to hydraulic contributions to total energy probably were higher during segments 4 and 6. The slope of segment 4 reflects some time period for the Flood to reach its highest energy levels, rather than immediately upon onset. Segment 5 represents the decline of energy as the early Flood upheavals subsided. Segment 6 represents an increase in energy from late-Flood tectonic readjustment. Segment 7 represents the initiation of a steady energy decrease marking the post Flood and present-day times. Please note that below the level of detail of description of trends, the particular shape of a particular segment of the plot is speculative and open to further refinement.**

Because the biblical Christian view of geologic Earth history lacks a comprehensive interpretive synthesis, we propose a graph of geologic energy vs. time as a preliminary step to framing such a synthesis (Figure 1). Since the major barrier to a robust creationist geologic column is the relative paucity of field interpretation performed by creationist geologists to date, this step is explicitly presented as a top-down extrascientific contribution, and it will be subject to revision based on

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field studies. However, we believe that such revision will result in the better definition of the graph, not radical changes in its general structure, since it is defined outside of science.

## Geologic Energy

Energy is commonly defined scientifically as the capacity to perform work. Many scientists (engineers, physicists, chemists, etc.) have refined concepts of energy in their particular fields, and have been able to quantify energy transfers for many processes. However, geologists have generally not reached such levels of refinement. Even many modern geologic events are poorly understood with respect to energy transfers and have not been or cannot be quantified. For creationists, this problem is compounded by biblical reference to unobserved and non-repeatable past events that may have been unique in process as well as result. Therefore, the use of the term, "energy" (as well as the curve in Figure 1) in this paper must remain nonquantitative, and related to the capacity to perform work in a geological sense. An abbreviated presentation of the relationships of energy to several representative geologic processes is presented in Table I.

| Geologic Product | Geologic Process | Specific Process | Transport Medium | Energy Type |
|---|---|---|---|---|
| Granite Pluton | magma intrusion | melting, intrusion, cooling, crystallization | crust | thermal, gravitational, hydraulic |
| Flood Basalt | lava extrusion | melting, extrusion, cooling, crystallization | crust, air, water | thermal, gravitational, hydraulic |
| Pyroclastic Deposit | volcanic eruption | melting, outgassing, explosive eruption | air, water | thermal, pressure |
| Faults, joints, and fractures | earthquakes | crustal dislocation | crust | acoustic, mechanical displacement |
| Sedimentary Rocks | erosion, sedimentation diagenesis, lithification | erosion, fluid transport, settling, compaction, chemical alteration | water, air, glaciers | mechanical, hydraulic, gravitational, chemical, thermal |
| Mountains | orogenesis | uplift, faulting, plutonism, volcanic eruption | crust, air, water | mechanical, thermal, tectonic, gravitational |
| Landforms | climatic change | weathering, erosion | water, air | mechanical, chemical, solution, hydration |

**Table I. The relationships between various common geologic phenomena and their related processes are presented in terms of associated energy types. Although this presentation is simplified, the complex interrelationships between different types of energy transfers are illustrated. Please note that thermal energy includes thermodynamic effects such as mineral crystallization and hydraulic energy includes pressure effects, combined with density and viscosity properties. Tectonic energy includes mechanisms poorly defined or unknown, such as mantle motions and flow.**

Other limitations of the definition of "geologic energy" are formed by the complexity of geologic processes and their natural setting and scale. Earth processes are complex, and require numerous overlapping sources of energy in their function. Also, spatial and temporal scales of these processes are not conducive to laboratory repetition. While it is helpful to consider the different types of geologic energy contributing to an energy-based approach to event definition, overdefinition would exceed the bounds of current knowledge. We believe that biblical inference does allow differentiation into tectonic and hydraulic components of the energy graph. Tectonic energy would include any structural processes of crustal dislocation including faulting, rifting, uplift, downwarping, and fracturing. Hydrodynamic energy would encompass the processes of moving fluids on the Earth's surface. However, for the purposes of this paper, we will focus on the more general "geologic energy."

## Concept of a General Energy Curve

Because any creationist geologic interpretation will emphasize events rather than time, methods of defining and delineating geologic events are of prime importance. This is a dramatic shift from the interpretive framework of the uniformitarian geologic column. In that framework, because time is the crucial factor, the column is defined by time periods, and the field evidence is examined in terms of a paradigm (i.e., evolution) that places high value on time indicators. Geologists recognize the concept of event as significant, but have not made the shift in thought that would transpose the importance of event-oriented interpretation over time-constrained interpretation. This framework creates a tension in geologic interpretation that can be resolved through a biblical Christian approach to earth history research.

One major difference between how creationists and Uniformitarians view events in the geologic record is that the latter view singular events recorded in the rock record as generic examples of types of processes that can be related to observed modern processes. Creationists, in contrast, see the record of singular events in the rock record as singular events, and have a primary interest in describing these singular events in their own light, rather than using them to extrapolate some generic process. For example, a coal seam may be of interest to a uniformitarian researcher as an example of an ancient swamp deposit (based on accepted modern analogs). Because a creationist recognizes the possibility that the coal seam is diagnostic primarily of unique past processes, he will be more concerned with its specific descriptive aspects, and his interpretation may be much more tentative regarding depositional environment. Without the comfort of a correlative modern depositional setting to frame interpretation, a potential approach to interpretation may be the inferring of an energy environment, and related minimum energy requirements for the seam's formation.

There is no lack of precedent for defining geologic processes (albeit qualitatively) by energy environments. For example, fluid transport of sedimentary materials produces a variety of bedding types that are characterized by the increasing energy levels of the fluid flow (Table II). We propose that the products of major geologic events of the past found in the rock record can be classified based on the energy environments in which those processes occurred. Even when the exact nature of the process cannot be defined, different geologic products can be compared or ranked in terms of minimum energy requirements. This approach provides a basis for the complementary use of field interpretations and extrascientific input, because extrascientific information, derived from the biblical record, allows the general definition of such a curve prior to field investigation. Field evaluation will be a further step beyond the scope of this paper.

Relating predicted relative energy levels to time allows the events of the geologic past to be defined in at least one sense in a predictive manner, and compared

| | Lower Flow Regime | | | Upper Flow Regime | | |
|---|---|---|---|---|---|---|
| Bedform | ripples | ripples on dunes | dunes | plane bed | standing wave | antidunes |
| Sand Motion | <------ | intermittent | -----> | continuous | ------> | intermittent or continuous |
| Sediment Transport | low concentrations | | | | | high concentrations |
| Stratification Type | small trough sets | tabular sets | large trough sets | tabular sets planar stratification | | massive to crude foresets dipping upstream |
| | -----> Increasing Flow Strength ------> | | | | | |

**Table II. An example of geologic classification by energy environment is provided in the sedimentological classification of flow regimes as they relate to sediment transport and bedforms (and thus, stratification types). Modified after Blatt, Middleton, and Murray (1980) and Lewis (1984).**

to field data as they are gathered. Having a predictive construct based on the biblical narrative can both constrain and direct field research. For example, there is much discussion in creationist circles (Snelling, 1996) regarding the relationship between event boundaries and the systems of the uniformitarian geologic column (e.g., Flood strata = Paleozoic). The fundamental disjoint between time and event perspectives reflected in such comparisons can be resolved by relating events to energy environments instead of time sequences. The assignment of an event correlation to various strata in the field and the resulting derivation of event boundaries in the rock record can be constrained if the relative minimum energy requirements of the strata in question can be determined and compared to the predicted curve, rather than to the uniformitarian column.

We recognize that geologic energy will be distributed spatially as well as temporally, and the construction of a three dimensional framework that would illustrate such variations is beyond the scope of this paper. However, we are confident that spatial variations can be incorporated into the general temporal graph, based on the assumption of the global nature of the Creation and Flood events. Positing regionally widespread post-Flood events such as an ice age and volcanism can also help further define the graph. Detailed constraints from these phenomena are not included here, since this graph is explicitly derived from the biblical account, which does not directly reference these events. The true extent to which global energy environments define regional and local ones will only be defined in the field.

## Structure of a General Energy Curve

The structure of a general energy curve will be derived from a geologic assessment of historical information presented in the Bible. Because that source is not specific and detailed from a geologic point of view, there is admittedly a level of inference built into the structure of the curve. We welcome discussion from both biblical scholars and scientists. The energy curve is defined in general categories by the events of creation and the Flood, with inference of conditions for the times between the two, and following the Flood (Figure 1).

## Creation Events

The formation of the physical universe was an event of unimaginable energy transfer. The supernatural aspect of the creation, however, precludes any substantive scientific discussion. Although geological processes are dependent on the properties of the Earth as it was created, there is not sufficient description of the creation event to discuss them. The initial geological events that invite speculative interest during the creation week are the emergence of dry land from the primordial ocean, and the initiation of climatic controls of night and day cycles, vegetative proliferation, and "normal" geologic processes which may or may not have a modern analog. For example, the weathering and erosion generally associated with rain in the present appear to have not been operative during this time.

Our understanding of the physical and chemical properties of the Earth at the present time suggests that the energy environment initiated at the creation did not instantaneously subside to an antediluvian equilibrium. For example, isostatic rebound of the uplifted continental masses, potential tectonic activity associated with crustal dislocations, and even the establishment of fluvial baselines following the day three events all would probably continue in some measure through time. The curve in Figure 1 reflects that attenuation.

There is nothing in the historical record to suggest any major non-equilibrium events during the antediluvian period. Any geologic processes or events during this timeframe can only be speculative since (1) there is no detailed extrascientific historical record, and (2) physical crustal evidence of processes during that time period was most likely eradicated during the Flood.

## Flood Events

The most dramatic geologic energy event following the Creation week was the Genesis Flood. Many authors (particularly Whitcomb and Morris, 1961) have detailed the biblical passages that describe the magnitude of these events, and they can be summarized succinctly in those passages that describe the Flood in terms of destroying the Earth's surface. A detailed analysis of the different energy environments and their relative importance during the Flood event is beyond the scope of this paper; however, we will present a rough outline of those in the following discussion of Figure 1. We agree with the historical chronology of the Flood outlined in Whitcomb and Morris (1961, p. 3).

The historical record clearly implies a sudden onset of high-energy geological events at the initiation of the Flood. These include the breakup of the fountains of the great deep. This episode has been discussed in detail (Austin et al., 1994; Brown, 1995; etc.), and although its exact technical meaning is unclear, it does clearly imply a transfer of massive amounts of thermal energy and associated crustal dislocation. Additionally, this episode marks the beginning of inundation by violent rainfall and probable associated storm events characterized by high winds, rapid and dramatic ocean surge from wind and ocean crust dislocation, and violent rainfall. Tsunamis would necessarily result from shallow dislocation of oceanic crust. The geologic results of this combination would have included pronounced erosion of the existing sediment cover and exposed igneous and metamorphic rocks, local uplift

and downwarping of the crust, intrusive and extrusive igneous activity, and rapid deposition of poorly sorted and reworked sediments deposited into local zones of crustal downwarping and faulting. Catastrophic crustal dislocation could also have created isostatic non-equilibrium conditions that would be manifested in geologic processes for a period of time following the onset of the Flood event itself.

The historical account next describes the transgression of the world's oceans over the entire surface of the continents. During this relatively short, but energetic, phase the "fountains of the great deep" continued their tectonic upheavals and storms continued unabated. Thermal and tectonic energy levels remained high, and hydraulic energy levels increased. Massive erosion, reworking, and rapid deposition would have occurred during this time. As the Flood advanced, there would have been a corresponding band of high-energy geologic activity marking the continually changing ocean-continent margin. This margin would have been subject to the conjunction of catastrophic drainage and large-scale wave and tidal actions. Field investigators should consider that as the waters moved inland, the available clastic sediment source could have been continually diminishing, and that field evidence of a decreasing clastic/carbonate ratio and decreasing grain size may not indicate decreasing energy levels.

Following the rapid transgression of the global ocean over the continents, the Flood entered a longer period of highstand. During this time the new global ocean reached a state of metastability, and we assume that the intense tectonic activity of the early phase of the Flood declined. Hydraulic interactions with land were all submarine, but would have been intense and effective nonetheless. Although clastic sources consisted entirely of reworked sediments during this time, the chemical and thermal equilibration of waters from a variety of sources would have resulted in the precipitation of a variety of chemical sediments (i.e., carbonates, halites, etc.). Several creationist authors have discussed the implications of a global ocean on winds, currents, and climatic conditions, and we defer to those discussions here (e.g., Baumgardner and Barnette, 1994; Oard, 1990).

The final phase of the Flood, the regression of the world's oceans into approximately the present accommodation space, was apparently the longest phase, commencing on the 150th day of the event (Whitcomb and Morris, 1961), and continuing into the present. The reemergence of land implies (at a minimum) vertical tectonic adjustments to create accommodation space. The same emergence would have interrupted and redirected the previously unrestrained ocean currents and winds. As the relative mean water level decreased, increasingly localized drainage patterns would have developed, and ongoing decrease of mean sea level would have contributed to comparatively underfit fluvial systems in larger drainage systems. All of these physical changes, reflecting lower levels of geologic energy, would have had profound effects on geologic processes.

In addition, initial rapid fluctuations in ocean depth, especially at the new basinal margins, could have resulted in renewed chemical sedimentation, perhaps aided by thermal anomalies associated with renewed tectonism. The same event would have produced a period of shallow epicontinental seaways with high potential for explosive biotic development, and resulting biochemical sedimentation. Newly uplifted areas would have contributed increased clastic sediments, and the modern river-delta-shelf-slope-fan lateral depositional style would have been initiated on a globally decreasing scale. Just as the early Flood transgression led to an increasing carbonate/clastic sediment ratio (with no real change in energy level), so also the reverse processes could have led to a dramatically increasing clastic/carbonate ratio based on source, rather than energy factors.

Although the historical record describes a definitive end to the Flood from an anthropomorphic point of view, the geologic effects of the Flood probably continued for an extended period of time, and may be still at work today. However, energy available for geologic processes (e.g., erosion, sedimentation, volcanism, faulting) would have continued to decrease, and the energy curve (Figure 1) shows the decline of those levels to the present.

The basic difference between the initiation and termination energy requirements for the Flood raises an interesting point for those workers seeking to drive "golden spikes" in the Flood stratigraphic record. Figure 1 predicts much less success in finding a definitive post-Flood boundary than one for the onset of the event. Current disputes over the location of the post-Flood boundary may result more from the actual lack of any such clearly defined global horizon in the record, rather than the inability of workers to define it. The increasingly local and regional control of deposition during this period of time would also seem to preclude a global horizon definable as the post-Flood boundary.

## Post-Flood Events

Although there may not be a globally correlative post-Flood horizon in the stratigraphic record, there are several manifestations of the readjusting energy environments coincident with the re-establishment of a modern relative mean sea level. The two most prominent of these events were the widespread latest Flood and later volcanism caused by renewed tectonism, and the climatic readjustments punctuated by a post-Flood ice age. Establishing the intensity of late-Flood volcanism relative to its onset and duration will be a function not only of the intensity of volcanic processes, but also of that of declining sedimentation, which would tend to mask the early effects of volcanism (Figure 2). Therefore, comprehensive field interpretation is required to relate volcanic intensity to event sequences. Sea-level reequilibration is evident in more recent sedimentary and geomorphic relicts, but the exact relationships between these events has not yet been described.

## Conclusions

Extrascientific historical constraints can be used to form a general, yet predictive tool of geologic interpretation via changing energy environments inferred from the events described in the biblical record. In turn, this preliminary correlation chart offers a means of directing and constraining field research. Creationist field investigations may confirm the relative structure of the naturalist-uniformitarian geologic column, but even if

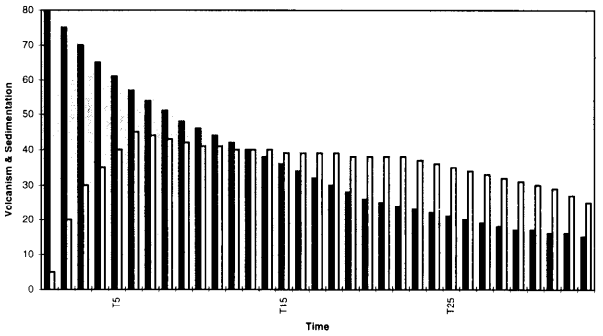


**Figure 2. An example of an "energy interpretation" pitfall shown in the influence of varying sedimentation rates on perceived rates of volcanism. Even though volcanism (represented by the lighter columns) peaks early an begins to decrease, the apparent rate continues to increase because sediments (represented by the darker column) competing for volume in the rock record are decreasing more rapidly. This general configuration may reflect actual late-Flood to post Flood processes in some places. Numbers on the Y axis are arbitrary.**

it does to any degree, the perspective of interpretation must change from the generic (i.e., "what depositional analog does this strata represent?") to the specific event interpretation ("what were the specific processes and corresponding energy levels required for the deposition of this strata?").

Field interpretation must recognize the general sequence of two similarly shaped energy curves in the geologic record. The first records the abrupt onset of the creation events, and the subsequent attenuation into antediluvian times. The extent of preservation of the geologic products of the creation curve is currently problematic, and requires resolution in the field along the lines of Austin and Wise (1994). The second records the dramatic and abrupt increase of energy levels at the onset of the flood, followed by the attenuation through the late Flood and post Flood times. Secondary variations in this second curve may be expressed by late-Flood increases in tectonism and orogeny, and by climatic readjustment, however, the basic shape remains. Several geologic consequences of this energy structure have been touched in this paper, and remain to be more thoroughly discussed at a later time. These include:

(1) a more readily definable basal Flood boundary based on physical field evidence;
(2) the predicted ability to recognize one massive, global transgressive-regressive sequence pattern overprinting local and regional variations;
(3) potentially anomalous carbonate/clastic ratios that may reflect relative sea level (and thus, source availability) rather than energy levels;
(4) difficulty in recognizing a "post-Flood" boundary in the physical rock record, based on the gradual attenuation of geologic energy in the late-Flood/post-Flood periods;
(5) an increase in local and regional variation in the later stages of the stratigraphic record.

As the earth approached its new equilibrium (if it has indeed even reached it yet) following the Flood, the energy level of geologic processes decreased and became much more localized. Therefore, the bulk of the existing geologic record is associated with a relatively almost non-existent time frame (see Walker, 1994), especially when compared to the move away from a time-based correlation chart, which assumes roughly equal energy in separable and roughly uniform time units, to an event-based chart, which measures energy against geologic processes and products in an entirely different perspective. Thus, just as events are presented in the uniformitarian time scale only in a secondary fashion, so time is relegated to a similar priority in this proposal.

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## Quote

In 1980, noted paleontologist Niles Eldridge commented on the lack of transitional forms in the fossil record: "The pattern that we were told to find for the last 120 years does not exist . . ."

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