The Philosophy of Sequence Stratigraphy Part III—Application to Sequence Stratigraphy

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Abstract

Much of the geologic work done by creationists in recent decades has consisted of reinterpretation of uniformitarian "data," most of which results in an inevitable assimilation of elements of evolutionist stratigraphy. Sequence stratigraphy has the potential, according to some advocates, to allow creationists and evolutionists alike to break free of the uniformitarian straitjacket that has bound stratigraphy for more than a century. While some creationists advocate abandoning traditional terminology and methods in toto, others see this as an unjustified hindrance to research and to communication with establishment geologists. The philosophic background necessary to address this issue was established in Part I of this series. In Part II, it was applied to the methods of stratigraphy in general. In Part III, these principles are extended to sequence stratigraphy. The results of this application indicate that elements of sequence stratigraphy may have value for diluvialists, but must be applied prudently.

Introduction

In Parts I and II of this paper, essential philosophic background and its application to stratigraphy in general were presented. In Part III, the series concludes by narrowing that application to that school of thought within the discipline of stratigraphy known as sequence stratigraphy.

Part I, "Philosophic Background," provided the following conclusions:

- All of the various schools of thought which have arisen in stratigraphy have been inextricably linked to particular worldviews; none is philosophically neutral.
- Science is that branch of philosophy which limits itself to the empirical. Empirical science arose within the context of a Biblical view of reality. Departure from this worldview has resulted in a failure to recognize the limitations of science. History lies outside the realm of science.
- "Mixed questions" require input from a plurality of disciplines and methods. Historical geology is a mixed question, involving both science and history. Neither science nor history can exist independent of a philosophy or worldview. The uniformitarian-naturalist system is not logically correspondent nor is it compatible with the Biblical worldview.

The following conclusions were included in Part II, "Application to Stratigraphy":

- Methodological naturalism[1] is foundational to the geologic column and incompatible with natural science.
- The Establishment Geologic Paradigm (EGP) is virtually synonymous with the geologic column and fails to recognize the "mixed question" nature of historical geology.
- Of 13 common stratigraphic methods, only six are defined as purely descriptive. Unfortunately, not even these are commonly free of extrascientific or metaphysical input in practice. This precludes interchange between paradigms resulting from disparate worldviews.
- An empirically defined sequence stratigraphy and the geologic column are mutually exclusive. Sequence stratigraphy as currently practiced is not empirically defined, though this does not preclude development of an empirically defined sequence stratigraphy.
- No correlation can ever be more than tentative.

The background provided by Parts I and II (including references cited) should prove adequate for the reader to evaluate the disparate claims for the efficacy of sequence stratigraphy from the diluvial perspective. Part III builds on Parts I and II, and the glossary provided at the end of this paper is also an extension of the glossaries found in Parts I and II.

[1] (See Part II of this series for an explanation of the uses of the term "methodological naturalism.")

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What is Sequence Stratigraphy?

Although acrimonious rivalry has existed between some schools of stratigraphic thought (see Table I, Part I), most stratigraphic methods can better be thought of as tools in the stratigrapher's tool box (see Table I). Nonetheless, some sort of heirarchy in methods is necessary, since the neat, dovetail joinery of "independent" methods that the masses find so convincing does not, in fact, exist (Christie-Blick, Mountain and Miller, 1990; Oard; 1985; 1997, pp.11–13; Noël, 1977; Parkinson and Summerhayes, 1985; Thompson and Berglund, 1976; 1977; Verosub, 1975; Watkins, 1971; 1972). Some have argued that biostratigraphy should take precedence (Jeletzky, 1978), but many today promote sequence stratigraphy as the integrating stratigraphic concept or model.

As its name implies, sequence stratigraphy emphasizes sedimentary sequences. Sequences constituting a major portion of North American sedimentary rocks were recognized by Sloss (1963), who is often credited with founding sequence stratigraphy. Berthault (1997, p. 67) argues that it actually began a century ago with Johannes Walther, though its roots go back to ancient cyclic views of history (Dott, 1992). These may be moot points, since what really gave sequence stratigraphy its impetus was seismic stratigraphy. Seismic reflectors were observed in the North Sea, the Gulf Coast of North America, and elsewhere that divided the sedimentary profile into distinct packages over areas of thousands of square kilometers. These packages were interpreted as transgressive-regressive cycles and tied to eustasy, the idea that global sea level has fluctuated throughout earth history and can be used to correlate strata. Many researchers (probably the best known being the late Peter Vail and coworkers at Exxon) have promoted sequence stratigraphy over the past decade or two.

There are slight variations on the theme of sequence stratigraphy. According to R. Walker (1990, p. 780), "There are currently at least four stratigraphies that attempt to subdivide rocks into genetic packages based on bounding unconformities or discontinuities. They are largely conceptual.... They all derive from seismic stratigraphy...." Bartlett (1997) lists these as:

- Classical sequence stratigraphy (the Exxon approach)
- Genetic stratigraphic sequences (the Galloway approach)
- Allostratigraphy[2]
- Transgressive-regressive cycles

These are the methods known as "sequence stratigraphy." In the past, lithostratigraphy (correlating rocks based on lithology) and biostratigraphy (correlating rocks based on fossils) have been dominant. Magnetostratigraphy (correlation based on paleomagnetism) and pedostratigraphy (correlation based on inferred fossil soil horizons) are more recent developments. Various stratigraphic methods are summarized in Table I. For more detailed descriptions of sequence stratigraphy, see Froede (1994), Bartlett (1997), Davison (1995) and Miall (1997).[3]

[2]Of these four approaches, only allostratigraphy is recognized by the North American Commission on Stratigraphic Nomenclature, and some authors do not include allostratigraphy with sequence stratigraphy. Allostratigraphy does differ from the other sequence stratigraphic methods in its descriptive nature (it is based solely on physical discontinuities between units), but I have here followed the example of Bartlett and included it under sequence stratigraphy due to its more obvious similarities with the other methods.

[3]Froede, Bartlett and Davison write from a diluvialist perspective, while Miall is an evolutionist. Miall's book contains as extensive a bibliography on the subject as any reader could ask.

Table I. Stratigraphic Methods.

Stratigraphic Method	Ref[1]	Desc[2]	Gen[3]	Description
Lithostratigraphy	N	✔	✔	Correlation by lithology (rock type)
Magnetostratigraphy	N	✔	✔	Correlation by rock magnetic properties
Biostratigraphy	N	✔	✔	Correlation by fossils
Pedostratigraphy	N		✔	Correlation by paleosols
Allostratigraphy	N,B,W	✔	✔	Correlation by lateral facies relationships in sedimentary basin
Seismic Stratigraphy	W	✔		Correlation by geophysical properties
Sequence Stratigraphy	B,W	✔	✔	Correlation by genetic stratigraphic sequences controlled by eustatic cycles
Event Stratigraphy	W,S		✔	Correlation by identification of single geologic events (genetic interpretation)

[1]***Ref*erences: B: Bartlett (1997), N: N. American Stratigraphic Code (1983), W: R. Walker (1990), S: Seilacher (1991)**
[2]***Desc*riptive: method has the potential to be empirical (i.e. scientific)**
[3]***Gen*etic: method is usually nonempirical, speculative, or historical in practice**

Sequence Stratigraphy: A Scientific Model?

Seismic stratigraphy could theoretically be empirical, but consisting solely of geophysical constructs would afford little in the way of predictive or explanatory power for general geology. Thus, sequence stratigraphy was developed. Sequence stratigraphy offers the hope of an empirical stratigraphy based on the findings of seismic stratigraphy. Davison (1995, p. 228) recommended adoption of sequence stratigraphy by creationists:

> It is suggested that this concept be adopted for interpreting Flood geology for the following reasons: (1) [unconformity-bounded sequences] are defined by physical boundaries (unconformities), that is, they are lithostratigraphic (as opposed to time stratigraphic [evolutionary]); (2) each sequence represents the spatial and temporal distribution of a complete depositional 'cycle,' that is, a geologic history; and (3) each sequence refers to a cluster of strata of varying but continuous (relative) age, that is, relatively continuous deposition (within the sequence/depocenter).

This would be grand if sequence stratigraphy were completely objective. The need for empirical criteria is recognized by Davison in his first point above. Slight deviations from objectivity enter with the second and third points. As will be shown below, his efforts in applying sequence stratigraphy to his study area encountered obstacles of an increasingly subjective nature.

That the *genetic implications* in Davison's arguments for acceptance of sequence stratigraphy are common to the practice of the geologic establishment is made clear by several authorities:

> ...*the geologist must define time-equivalent rock packages that are genetic intervals* (Vail *et al.*, 1991, p.617, emphasis mine).
>
> Integrating the results of sequence stratigraphic, subsidence, and tectono-stratigraphic analyses yields a *geologic history interpretation with improved temporal resolution* and greater accuracy in predicting lithology. This permits the unraveling of the stratigraphic signatures due to tectonic, eustatic, and sedimentation processes. Sequence stratigraphic analysis divides the stratigraphic record into physical *chronostratigraphic units in which the lithofacies are genetically related* (Vail *et al.*, 1991, p. 619, emphasis mine).
>
> Cycles of relative change of sea level on a global scale are evident throughout Phanerozoic time. The evidence is based on the fact that many regional cycles determined on *different continental margins are simultaneous*... (Vail, Mitchum and Thompson, 1977, p. 83, emphasis mine).
>
> The physical *chronostratigraphic* units defined by sequence stratigraphic criteria are important for making more accurate basin analyses, *paleogeographic reconstructions*, *geologic history interpretations*, resource evaluations of sedimentary basins, and global stratigraphic correlations. Traditional approaches to stratigraphic analysis have different shortcomings in *interpreting paleogeography and geologic history.... Sequence stratigraphy is an interpretive approach* that can integrate outcrop, well-log, and seismic data. This approach provides correlation tools with a *conceptual model for the geologic response of depositional and erosional processes to cyclical base-level changes that identifies and defines the genetic character* of the different types of physical surfaces and stratigraphic intervals within the rock record (Vail *et al.*, 1991, p. 620, emphasis mine).
>
> Sequence stratigraphy is the study of rock relationships within a *chronostratigraphic framework of repetitive, genetically related strata* ...(Van Wagoner *et al.*, 1988, p. 39, emphasis mine).
>
> I therefore emphasize again that the only genetic factor that operates at the Exxon or Galloway scale is the *assumed relationship* between a sequence, or genetic stratigraphic sequence, and one cycle of relative sea level fluctuation (R. Walker, 1990, p. 784, emphasis mine).
>
> The sequence-stratigraphic *depositional models*, together with *detailed paleontological data*, enhance the ability to recognize *genetically related* sediment packages in outcrop sections .... Over the past several years, stratigraphers at Exxon Production Research (EPR) have attempted to produce a global stratigraphic framework that *integrates* state-of-the-art *magneto-, chrono-, and biostratigraphies* ... (Haq, Hardenbol and Vail, 1987, p. 1156, emphasis mine).

Note how seamlessly ideas such as evolutionary fossil succession are woven into the fabric of sequence stratigraphy.

Bartlett (1997, p. 6) asserts: "Time should *not* be used to define sequence-stratigraphic units. *Interpretation of global origin should now be used to define and describe sequence-stratigraphic unit types*" (emphasis his). *This indicates that while sequence stratigraphy appears to provide a means to break free from the rigid time constraints of traditional uniformitarianism, it continues to incorporate extra-scientific (i.e. genetic) interpretations into the model. It is not, therefore, a* scientific *model*.

This is clearly demonstrated by both evolutionists and creationists. In the "integrated interpretation procedure" of Vail *et al.* (1991), four or five of the six steps of their procedure clearly require acceptance of traditional historical ideas (e.g. radiometric dating and evolutionary biostratigraphy). These various stratigraphic methods (Table I) are used as adjuncts to the hypothetical eustatic curve, in which many cycles of rise and fall in sea level are assumed. That extrascientific elements are integral to sequence stratigraphy is further substantiated by Bartlett (1997, p.10): "Sequence stratigraphy offers to the Flood geologist the concept of cycles *within* cycles of sea-level change" (emphasis his). Froede (1994, p.138) says: "A key to understanding sequence stratigraphy lies in determining the position of worldwide sea-level change (i.e. eustasy) and its resulting depositional sedimentary sequences and systems tracts." Here again appears the assumed oscillation of global sea level. Davison (1995, p.228) also makes clear that his is a mixed question approach: "The hypothesis put forth here is that at certain discrete points *in time* during the Flood, sedimentation was disrupted on a global level and inter-regional or world-wide unconformities were produced, thus forming [unconformity-bounded sequences] of inter-regional scope which should be correlatable on a global scale" (emphasis mine). This is a rather speculative hypothesis on Davison's part.

Neither sequence stratigraphy nor any of the several stratigraphic approaches described above—with the possible exception of allostratigraphy—is purely descriptive. Allostratigraphy, unfortunately, is applicable only to particular sedimentary basins where discontinuities can be adequately determined to map individual units. Although of limited applicability, it may prove beneficial to particular geologic studies by diluvialists. In general, sequence stratigraphic methods are inherently subjective or nonempirical in their dependence upon genetic (interpretative) demarcations.

The Mixed Question Nature of Sequence Stratigraphy

Sequence stratigraphy exhibits a mixed question nature in two ways: 1) as a particular school of stratigraphy, it depends on genetic (i.e. extrascientific) inferences, both in its view of earth history and interpretation of the rocks[4], and 2) it incorporates other nonscientific stratigraphic methods within the EGP as part of a naturalist-uniformitarian worldview[5].

Hanneman and Wideman (1991) applied sequence stratigraphic methods to intermontane basins in southwestern Montana, terrain not conducive to lithostratigraphic correlation because of the many rapid lateral facies changes that characterize the basin fill sediments. They attribute much of the confusion in previous stratigraphic efforts to correlation of rocks of *similar lithologies but different ages* (pp.1337–1338). They used paleosols, erosional features, and angular stratal relations to identify unconformities, then traced the "unconformities" in the subsurface seismically based on the inferred paleosols. But the "paleosols" were not the only means used to piece together the "stratigraphic sequences":

> If the five major unconformities recognized in the study area are used, Cenozoic basin-fill rocks can be separated into five sequences... *the vertebrate fossil and radiometric age constraints for which are shown...* (p.1339, emphasis mine).
>
> The application of sequence stratigraphy to the Cenozoic strata of southwestern Montana groups strata, regardless of lithology, into rock units that have *chronostratigraphic significance* (pp.1342,1343, emphasis mine).

Thus, while alleviating some of the difficulties associated with lithostratigraphic correlation, they introduced new uncertainties (potential errors) from evolutionary biostratigraphy, radiometric dating, and pedostratigraphy. A U.S. Department of Agriculture soil scientist (Bandy, 1998) stated that the pedostratigraphy employed by Hanneman and Wideman in evaluating the "paleosols" differed markedly from methods employed in the field of soil science, and the interpretations presented are unconvincing. Hanneman and Wideman (1991, pp.1343–1345) go on to correlate the Montana sequences with sedimentary sequences in southwestern Washington and the central Great Plains, relying on interpretations from eustasy and plate tectonics.

Parkinson and Summerhayes (1985, p. 686) are proponents of sequence stratigraphy, yet urge caution:

> The danger in using the global curve to explain stratigraphic breaks is that it impairs thinking about local controls. We think it is time to return to the unfettered examination of individual basins on their own merits.

Sequence stratigraphy is inextricably interwoven with the older stratigraphic methods, none of which is free from EGP bias. To insist that these various methods are *independent* lines of evidence is ludicrous.

Other Problems With Sequence Stratigraphy

Although the "mixed" nature of sequence stratigraphy alone prevents wholesale acceptance into the DGP, there are other dangers. Bartlett (1997, p. 19) points out the diffi-

[4]As an example, Bartlett (1997, p. 17) emphasizes the need to distinguish between depositional environments and paleoecologic zones, but this is seldom done by geologists.

[5]Miall (1997) provides many examples documenting the subjective nature of key elements of sequence stratigraphy and other stratigraphic methods.

culty for those working from the perspective of the EGP to maintain objectivity: "What we see in the rock record—the evidence of oscillations of sequences—may be so mixed with the very real component of the *supermegasequence* signal that genuine, insightful perception may prove obscure or even impossible. The problem is an epistemological one." Yet Bartlett (1997, p. 6) confidently asserts: "Interpretation of global origin should now be used to define and describe sequence-stratigraphic unit types."

Not all share Bartlett's confidence. Roger Walker (1990, p. 777), a mainstream geologist, emphasizes contacts, the key to sequence stratigraphy (and stratigraphy in general): "The significance accorded the contacts is one of the main problems in stratigraphy and sedimentology." He continues (p. 780):

> There are currently at least four stratigraphies that attempt to subdivide rocks into *genetic packages* based on bounding unconformities or discontinuities. *They are largely conceptual*, with little or no consideration of 1) scale of application, 2) actual geological examples... or 3) the relationship between the different schemes (emphasis mine).

Walker's observations are important and at least urge a greater degree of caution than expressed by Bartlett's opinion. In addition, Walker (1990, p. 784) has pointed out flaws in the sequence stratigraphic approach of which diluvialists should be aware:

> ...there is unlikely to be a direct sedimentological genetic relationship between rocks below and above an unconformity, and below and above a [maximum flooding surface]....
>
> ...the only genetic factor that operates at the Exxon or Galloway scale is the assumed relationship between a sequence, or genetic stratigraphic sequence, and one cycle of relative sea level fluctuation.

Geologists employing sequence stratigraphy often assume a constant rate of sediment input. This assumption is obviously unrealistic, even for the EGP, but efforts to account for it invariably rely on paleoecologic indicators, inferences of subsidence and paleoclimatology, and other nonempirical variables (Einsele and Bayer, 1991). Efforts to overcome these problems within the context of sequence stratigraphy uniformly rely on extrascientific (historical) assumptions (Dott, 1992; Miall, 1997).

Some have pointed out a very serious flaw in sequence stratigraphy, that two-dimensional cross-sections do not reflect the three-dimensional complexities of even the "best" basin margins: "... since they neglect along-strike complexities, eustatic interpretations based on dip stratal geometries are potentially misleading" (Poulsen *et al.*, 1998, p.1105). "In an overall progradational situation, for instance during highstand conditions, stacked parasequences will appear to step in opposite directions in differently positioned cross-sections.... The contrasting stacking patterns are important because they contradict the basic premise of sequence-stratigraphic theory that particular stacking patterns are tied to specific sectors of the sea-level curve…" (Martinsen and Helland-Hansen, 1995, p. 439). Two- dimensional stratigraphic sequences correlated to eustatic curves do not necessarily reflect actually depositional history, and evidence may indicate that eustasy was not the most important variable (Poulsen *et al.*, 1998).

Potentially fatal to sequence stratigraphy is its mixed question formulation. "Any approach to global seismic stratigraphy requires calibration to geological time through rock stratigraphy, but there are inherent uncertainties in the time scale, and in the correlation of seismic and rock sections with one another and with the time scale .... Our ability to test the scheme of global unconformities proposed by Vail *et al.*—that is, to distinguish between global unconformities and those developed on only a regional or local scale—is limited by our ability to determine the ages of unconformities in continental-margin successions"(Christie-Blick, Mountain and Miller 1990, p. 133).

More serious obstacles to acceptance of sequence stratigraphy by creationists are pointed out by Woodmorappe (1996, p. 280):

> Recently, claims have been made of the possibility of highly detailed global chronostratigraphic correlations based upon sequence stratigraphy. Miall (1992) provides a devastating critique of these claims. He shows that the range of errors in biostratigraphy, magnetostratigraphy and isotopic dating are such that the precision claimed is a physical impossibility. Furthermore, he highlights the role of circular reasoning and fortuitous correlations in, for instance, the belief that there are 40 discernible global events within just the Cretaceous Period.
>
> There is also at least some element of circular reasoning in even the first-order cycles of the Vail curve. The times inferred for even first-order global regressive sequences contradict each other, and depend upon which database is used. Of course, the sea-level curves should not be directly imported into Flood geology. For instance, 'marine regressive' sequences need not be accepted as such in Flood geology, but may be interpreted as giant reverse-graded beds laid down by Flood waters that are increasing in velocity at that point of deposition.

Froede (1994) points out several EGP weaknesses in the Vail curve (standard sequence stratigraphic approach), including implicit confidence in the Milankovitch mechanism (Broecker and Denton, 1990; DeBoer and Smith, 1994; Dott, 1992, p. 2; Oard, 1984a; 1984b; 1985; 1990; Schwarzacher, 1991; Vail *et al.*, 1991) and Walther's Law (Berthault, 1997; Cowart and Froede, 1994; Froede, 1998, pp.7–13; Johnson, 1992, p. 47; Woodmorappe, 1980, pp.213–216). Various limitations, including the issue of tectonic overprinting, remain strong (if not intractable) objections (Algeo and Seslavinsky, 1995; Dott, 1992, p.2; Jeletzky, 1978; Johnson, 1992, pp.47,48; Miall, 1986; 1992; Parkinson and Summerhayes, 1985; Pitman, 1978; Thorne and Watts, 1984). Miall (1997, p.9), himself an establishment geologist and firm believer in the Milankovitch mechanism, points out that standard sequence stratigraphy has severe limitations in applicability, that eustasy is but one of several potential causative factors for sequence formation, and that correlation remains a significant problem. The direct connection between sequence stratigraphy as practiced and various fallacious evolutionist methods is inescapable (Algeo and Seslavinsky, 1995; Christie-Blick, Mountain and Miller, 1990; Haq, Hardenbol and Vail, 1987; Pekar and Miller, 1996; Ronov, 1994; Vail, Mitchum and Thompson, 1977; Vail *et al.*, 1991).

What may escape some (but should never escape diluvialists) is the fact that not only is eustasy itself an unsubstantiated concept, but probably impossible to substantiate (Miall, 1997). Its acceptance, like many of the reigning paradigms of geology, was not based on field evidence (Dott, 1992, pp.14,40; Johnson, 1992, p. 48). Miall (1997, p. 15) states, "... one of the principal problems with the assessment of causality is that there are no absolute reference frames for calibration of sea-level change."

Froede (1998, pp.12,13) has pointed out serious problems in identifying unconformity-bounded sequences, and in particular the application of Walther's "Law". As alluded to by Froede, a critical difference exists between the empirical, physico-chemical definition of a depositional environment (e.g. flow regime, pH) and the geographical, paleoecological definition of a depositional environment (e.g. a shallow lagoon in Cretaceous time). *The former definition is scientific and should be employed by diluvialists; the latter is nonscientific and generally employed by evolutionists.*

In summary, difficulties with the method of sequence stratigraphy include:

- Subjective elements in identification of some unconformities and many correlative conformities
- Subjective elements in reconstruction of paleoenvironments and systems tracts
- Subjective elements in identification of many sequence boundaries
- Presence of hiatus in form of maximum flooding surface (Exxon approach) or unconformity (Galloway approach)
- Assumption of relatively constant sediment input
- Extrapolation of two-dimensional simplicity not representative of three-dimensional complexity
- Assumption of eustasy
- Eustasy potentially masked by other depositional variables
- Assumption of Milankovitch mechanism
- Assumption of subaerial erosion surfaces incompatible with Deluge
- Assumption of Walther's "Law"
- Useful only for particular sedimentary basins with passive margins
- Requires considerable data to accurately define systems tracts

Problems Shared With Other Stratigraphic Methods

Still other pitfalls are common to the various stratigraphic methods employed within the context of the EGP and assimilated into sequence stratigraphy. Event stratigraphy, which addresses a smaller scale than typically addressed by sequence stratigraphy (Seilacher, 1991), is genetic by its very nature. It is often used in conjunction with sequence stratigraphy (R. Walker, 1990). As demonstrated above, sequence stratigraphy is not a departure from the geologic column or the idea of evolutionary succession in biostratigraphy. Although some creationists assert that the general biostratigraphic trends presented in the geologic column are indisputable (Mehlert, 1993a, p. 77; Robinson, 1995; 1996; 1997; Ritland, 1981; Snelling *et al.*, 1996), others have countered with qualitative arguments, generally "out-of-order" fossils or formations (Lammerts, 1984a; 1984b; 1985a; 1985b; 1986a; 1986b; 1986c; 1987; Whitcomb and Morris, 1961). I am aware of only one study to date (Woodmorappe, 1981) that has addressed fossil succession on a statistical basis. Woodmorappe admitted that his study was biased in favor of the geologic column, since he tacitly incorporated biostratigraphic "data" from the scientific establishment, with the result that they were heavily affected by EGP bias. His study also was limited to gross successional tendencies at the systems level. Even so, the "order" discovered in his study was far from unequivocal, as elucidated in his TAB model (Woodmorappe, 1983; Mehlert, 1993a; 1993b). Until additional statistical studies *free from EGP bias* have indicated a statistically significant (nonrandom) distribution of the fossils, *the alleged order of the fossils remains far from established. Neither have worldwide unconformities been confirmed* (Morris, 1996, p. 55; Vail *et al.*, 1991, p. 621; Woodmorappe, 1978, p. 193), as appealing as the idea has been over the centuries. As pointed out by other researchers (Froede, 1995; 1998; Reed, Froede and Bennett, 1996), much field work must be done before even regional correlation becomes possible. Fossil succession and worldwide unconformities, though they may be at least partially accurate, remain subjective and unsubstantiated concepts. Introduction of any one of these flawed stratigraphic methods into sequence stratigraphy hamstrings the method.

Sequence Stratigraphy: Useful Techniques for Diluvialists?

Bartlett (1997) has spoken most forcefully for acceptance of sequence stratigraphy *as a method* by creationists. Davison's (1995) efforts to apply these principles in the field may be the most ambitious by a creationist to date. Davison made a concerted effort to apply the idea of global unconformities within a diluvial context.

Some of the more "radical" (in the eyes of some) diluvialists have sought to free themselves from the shackles of the geologic column entirely. Froede (1994; 1995) and T. Walker (1994) proposed two new stratigraphic schemes within the DGP, the former inclusive of sequence stratigraphic concepts. These represent attempts to break free of the EGP baggage that stifles progress in stratigraphy with mixed question elements. Since both of these are chronostratigraphic *natural history models*, they are not scientific models *per se*. If recognized as natural history models, they may be useful in natural history research. Can sequence stratigraphy play a role in these models?

Froede (1994; 1997), while making clear that he rejects the timescale of the EGP, has attempted to extricate sequence stratigraphic principles from the EGP and use them in *local* settings within the context of the DGP, a controversial approach for some. Bartlett (1997, p. 6) states:

> Froede's (1994) and Davison's (1995) declaration rejecting the uniformitarian context of sequence stratigraphy emphasized the secularist's dependence on the evolutionary geologic timescale. Indeed, Froede (1995) proposed a creationist geological timescale including whole new units, groups, divisions, and timeframes. However, a new system of time reference is wastefully repetitious. Likewise, Davison's (1995, p. 224) suggestion that 'creationists need to reinterpret the *rocks*, and not the evolutionists' interpretation of these rocks' moves us dangerously back to square one—to the days preceding William "Strata" Smith (1769–1839).
>
> Instead of proposing a new geological timescale or starting the discipline anew from some obscure position further convoluting the creationist appeal, creationist/Flood advocates should seize and take control of the present secularist debate regarding *global catastrophe*—a philosophic appeal—having made its official debut in the uniformitarian (quietist) literature with the proposal offered by the Alvarez group .... Time should *not* be used to define sequence-stratigraphic units. *Interpretation of global origin should now be used to define and describe sequence-stratigraphic unit types* (emphasis his).

The problems with Bartlett's conclusion have already been shown. But there are problems with the models promoted by Davison, Froede, T. Walker, and others as well. These result from difficulties inherent in addressing mixed questions, a frequent paucity of diagnostic data (both historical and physical), difficulties in correlation, difficulties in matching seismic reflectors with sequence boundaries in a meaningful way, and difficulties in determining depositional environment, among other factors. One of the greatest difficulties for those attempting to utilize sequence stratigraphy (partially or wholly) within a creationist worldview is its mixed question nature. How can one accommodate seismic data while maintaining necessary skepticism toward eustasy and the geologic column? Stratigraphic analysis is not easy!

None of the creationist researchers promoting sequence stratigraphy provides a compelling Biblical case for his particular historical idea. Each of those proposing a diluvial natural history model has made a good effort to *exegetically* establish his model on a Biblical basis, but Scripture does not provide a compelling textual case for the degree of precision sought, whether sequence stratigraphic or not. *No Biblical basis is offered for the idea of sea level cycles* (other than the obvious "supermegasequence" of Bartlett). Not even the onset of the Deluge (Genesis 7:11) provides a certain basis for a global unconformity (cf. Froede, 1998, p. 13). Although the first forty days of the Deluge might have left an inter-regional unconformity, even this is far from certain (Hunter, 1996). Without a Biblical[6] basis, none of these natural history models can progress beyond "enlightened speculation" at best. To the extent that a given natural history model conforms to holy writ, the model may be useful in application to historical data or interpretations. In the majority of geologic studies, they will be limited to interpretations. The essential limitation of geology as both science and mixed question may be most unsatisfying to one who desires to know "what really happened," but failure to recognize that limitation leads only to deception.

Conclusions

Sequence stratigraphy marks a significant departure from the rigid chronostratigraphy that has characterized geology for the past 150 years. It marks a renewed emphasis on scientific data and has been a cause for great optimism on the part of some (Bartlett, 1997). Unfortunately, this optimism appears ill advised when the philosophical basis of sequence stratigraphy is examined.

Sequence stratigraphy does not constitute an empirical (i.e. scientific) geologic model. Sequence stratigraphy is presently enmeshed in the EGP, and thus is unsuitable for

[6]It is possible that extrabiblical historical accounts exist for small areas, though they would be neither as comprehensive nor authoritative as the Bible.

incorporation into the DGP. The "interpretation of global origin" recommended by Bartlett and practiced by those promoting sequence stratigraphy implies correlation, a correlation necessarily based on genetic interpretations. Evolutionists, with implicit faith, employ radiometric dating, assumed eustatic cycles, and (above all) a form of biostratigraphy which assumes evolution. To what extent can a diluvialist expect reliable data from such a source? Separation of empirical data from the "mixed" metaphysical matrix of the EGP is probably not feasible. Sequence stratigraphy is therefore suitable as neither a scientific nor a chronostratigraphic method.

Because mixed question problems require mixed question solutions, "data" cannot be shared between disparate worldviews with any reasonable degree of confidence. Empirical elements must be identified, then carefully removed from their "mixed" or metaphysical matrix. It is doubtful whether this is feasible in the majority of cases. *Because sequence stratigraphy is a mixed question approach, combining descriptive and genetic elements, it is not suitable as a stratigraphic scheme for interpretation of geologic data within the DGP*. This is true both because of the inextricably interwoven elements of the EGP in mainstream sequence stratigraphy, and because the method depends on eustatic oscillations not compatible with Scripture and not otherwise supported historically. The only potential exception to the latter objection would be Bartlett's "supermegasequence," which might result in a single global transgressive-regressive sequence. Existence of such a sequence might be difficult to establish.

This does not mean that sequence stratigraphy—or at least elements of it—is of no value to diluvialists. Sequence stratigraphy is an attempt to accommodate real (empirical) geophysical data. Further, its emphasis on unconformities is helpful to recognition of real (empirical) divisions in the stratigraphic record (R. Walker, 1990, p.785). These emphases may prove fruitful in future research. If there is an order to the fossils—and there may be—sequence stratigraphic methods may be helpful in understanding that order. This may potentially bolster or elucidate Woodmorappe's TAB model.

Bartlett (1997, p. 6) decried Davison's suggestion that 'creationists need to reinterpret the *rocks*, and not the evolutionists' interpretation of these rocks,' saying it "moves us dangerously back to square one—to the days preceding William 'Strata' Smith." Bartlett is right. And so is Davison. The whole geologic establishment went awry back then, and it is high time we did something about it!

It is highly desirable that a scheme consistent with the objective of stratigraphic analysis as expressed by the North American Commission on Stratigraphic Nomenclature (1983) be developed: "The objective of a system of classification is to promote unambiguous communication in a manner not so restrictive as to inhibit scientific progress. To minimize ambiguity, *a code must promote recognition of the distinction between observable features (reproducible data) and inferences or interpretations*" (p.847, emphasis mine). *Diligent* attention to the time-independent definitions of the descriptive stratigraphic methods listed in Table I and below may meet this need:

- *lithostratigraphy* (including lithodemic stratigraphy): recognizing facies changes
- *magnetostratigraphy*: if empirically defined
- *biostratigraphy*: if empirically defined
- *allostratigraphy*: when applicable and when sufficient data are available

The efforts of creationist researchers such as Bartlett, Davison, Froede, and Woodmorappe are commendable. Disagreement, particularly at this nascent stage in the development of the science, is neither surprising nor unhealthy. It is, however, crucial that we maintain a critical perspective toward the various ideas we encounter, including our own (Proverbs 29:25; James 1:5; II Peter 3:3–7; I John 4:1–4). Brand (1974, p. 78) put it well:

> This analysis of changing paradigms may help us in our consideration of the relation between science and religion. When a prevailing paradigm, such as the geologic paradigm requiring a long history for life on earth, contradicts sacred history, the problem will not be solved by making a few adjustments in current geologic theory.

Careful attention to the philosophic background and constraints of science, particularly in regard to mixed questions, is vital to the successful development of a scientifically and biblically sound approach to stratigraphy. Humility is also essential (Proverbs 15:33; 29:25). As others have emphasized (Lumsden, 1992; Pearcey, 1989), it is imperative that those called by Christ's name do only the finest research (Deuteronomy 6:4,5. Proverbs 3:7. Ecclesiastes 9:10. I Corinthians 10:31. Colossians 3:17,23,24). Our Lord deserves nothing less.

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Glossary

depocenter: site of maximum deposition in a sedimentary basin.

Exxon or Galloway scale: sedimentary sequences of regional,interregional or continental scale, often resembling group or supergroup rank per standard nomenclature.

intermontane: located between mountain ranges.

lithofacies: a mappable rock body distinguised by lithology (i.e. lithostratigraphically).

maximum flooding surface: the point in the eustatic cycle of maximum areal transgression preceding highstand; used as cycle marker in Bureau of Economic Geology (Galloway) approach (Bartlett, 1997, p. 17).

megasequence: sedimentary sequence of largest scale recognized in EGP, corresponding to first-order cycles of the Vail Curve.

Milankovitch mechanism (a.k.a. orbital forcing): idea that climatic change is periodic and driven by slight eccentricities in Earth's orbit, axial tilt, etc.

paleoclimatology: study (or speculation) of ancient climates, inferred from various data (lithofacies, paleogeography, fossils, etc.).

paleoecology: study/speculation relative to ecology of an area in ancient times.

paleoenvironments: past environments, generally inferred from lithofacies, fossils and other data.

paleogeography: study of geography at points in the past, often inferred from facies changes.

paleosol: a "fossil soil" or lithified soil horizon.

radiometric dating: age inferred from ratios of radiogenic isotopes.

systems tracts: related, contemporaneous depositional systems which reflect position in the transgressive- regressive cycle (e.g. highstand systems tract).

Walther's Law: doctrine that a vertical facies sequence represents a series of laterally adjacent depositional environments (i.e. geographical and paleoecological environments) and that only those environments observed in proximity today existed in proximity in the past.

well log data: geophysical data obtained from boreholes (gamma, resistivity, etc.).

References

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CRSQ: *Creation Research Society Quarterly*

GSAB: *Geological Society of America Bulletin*

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Book Review

Over the Edge by Larry Vardiman
Master Books, Green Forest, AR. 1999, 160 pages, $9.95

This humorous book describes experiences from two decades of creation tours at Arizona's Grand Canyon. These bus, raft and backpacking tours are conducted by the Institute for Creation Research. Author Larry Vardiman, research scientist and professional meteorologist, has led many of the tours, totaling more than 2,000 people. He has assembled a personal diary of highlights, while also explaining many Genesis Flood evidences found within the canyon. He describes group discoveries of artifacts and also many spiritual victories. For all who have taken one of the tours or think of doing so, this book is of interest. Larry writes down many practical tips about visiting the canyon, whether hiking or riding. And in what other book can you find a humorous sketch of creationist Duane Gish, wearing a ten-gallon hat, riding down the trail on a mule?

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