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CREATION RESEARCH SOCIETY QUARTERLY

The Universal Deluge: Alternative Hypotheses for Hardground Origins

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Abstract

Transport processes can potentially account for *in situ* hardgrounds in the sedimentary record. Steadily accumulating evidence undermines the certitude of life-position inferences of at least certain fossils. Some turbidity currents and debris flows allow for the contemplation of large-scale transport, imbrication, and coplanar deposition of large, flat slabs of antediluvian hardground origin. Modern volcanoes demonstrate that released gas can cause the flotation of large rock slabs. Finally, many *in situ* hardgrounds show evidences at least suggestive of a composite, allochthonous origin. A hardground-conduit hypothesis posits that hardgrounds formed in pseudokarstic-submarine (underwater cavelike) structures. This solves the apparent problems of time and stratigraphically superposed hardgrounds. The hardiness of hardground organisms is just one factor consistent with this hypothesis.

Introduction

Ancient hardgrounds, usually inferred from the presence of borings and/or obligate hard-surface encrusting fossil organisms, are common in the Phanerozoic sedimentary record. The reader unfamiliar with hardgrounds can find basic information at an online tutorial (Anonymous, 2001).

Owing to the time ostensibly required for their construction, they are commonly presented as an insuperable problem for Flood geology. Woodmorappe and Whitmore (2004) examined their occurrence at the famous Caesar Creek locality of southern Ohio, USA, and Woodmorappe (2006) showed that some types of hardgrounds could have formed within the Flood year.

An Allochthonous Origin of Some Individual Encrusters?

Encrusting hardground fossils have traditionally been thought to exist in their life orientation, but new research suggests this is worth revisiting. Meyer's (2006) work, though not directly related to hardgrounds, revised previously held opinions on the life-orientation position of certain brachiopods. In addition, certain closed articulated bivalves cannot any longer be automatically assumed to be in life position (Cadee, 2002; it is unclear if closed bivalves of types other than those observed in this study can also float). Placed in a broader context, a variety of once-transported organisms can be mistaken for *in situ* fossils (Woodmorappe, 1999), and a statistical analysis indicates that at least some of them could have arisen by chance (Woodmorappe, 2008).

If the "life orientation" of fossils is largely the result of uniformitarian bias, an empirical mind-set would suggest that systematic flume experiments evaluate the "life orientation" deposition of fossils and should include ostensible encrusters. The experimental verification of the hydrodynamic stability of

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Accepted for publication February 26, 2009

the convex-up orientation of concavo-convex and plano-convex brachiopods (Lescinsky, 1995) should lead to similar tests on the transport and "life orientation" deposition of seemingly encrusting mound-shaped (and, to a lesser extent, sheet-shaped) bryozoan colonies, especially if gases of decomposition—which are believed to assist the waterborne transport of dead, modern bryozoan remains (Thomas et al., 2003)—could have come into play. While such gases would not, according to conventional belief, be sufficient to float the heavily calcified Paleozoic bryozoans, they may have possessed enough buoyant action to orient the upper (convex-up) part of the bryozoan colony during transport, thus favoring its deposition in apparent life orientation.

Flood currents could have initially picked up organisms with their shell-mold base "plumbs" or "anchors" still attached. These bottom-heavy encruster-mold combinations would thereby tend to be stranded in life orientation (Waddington, 1980). Moreover, to the extent that the matrix and some of the inferred hidden molds are microscopically indistinguishable, the foregoing process can take place without leaving any independent evidence of its occurrence.

What about the "cemented in" look of hardground encrusters? In certain situations, precipitation of carbonate can be so rapid that plant leaves are coated with a thin veneer of lithified carbonate within hours, especially in mechanically agitated water (Zhang et al., 2001). Instead of being self-cemented to the hardground surface, bryozoans and other encrusters actually could have been washed into position and pressed into a surficial veneer of "instantly" lithifying carbonate. Such near-instantaneous precipitation is favored by mechanical agitation of water, with obvious relevance to Flood-related events. Furthermore, there is much that is unknown about rapid precipitation of carbonates (Silvestru, 2004).

Origins of Obviously Allochthonous Hardground Constituents

Most ancient hardgrounds are a blend of obviously allochthonous hardground clasts and inferred *in situ* hardground surfaces, with the former sometimes predominant (Wilson and Taylor, 2001). In situations where clast-only hardground remnants include a few clasts containing faunules in "life position" (Wilson, 1986), it is reasonable to suppose that this occasional "life position" is the outcome of fortuitous deposition. Owing to the fact that, under certain conditions, carbonates can indurate in a matter of hours (Zhang et al., 2001), and appreciable boring can occur in a matter of weeks (Woodmorappe, 2006), ample time was available for carbonate muds to lithify during the Flood (with embedded shells, etc.) to undergo subsequent Flood-related erosion and then to experience one or more generations of boring during the Flood year itself.

An Allochthonous Origin of Seemingly *In Situ* Hardgrounds?

The foregoing reasoning is now extended to situations where there is a hardground surface in outcrop, which is conventionally interpreted as a complete *in situ* surface.

Several mechanisms exist for the coplanar deposition of slabs up to at least a few meters length. One of these is submarine sliding, which is capable of moving blocks as much as tens of kilometers in size (Sigler, 1998) and with slopes as low as one degree (Wingerden, 2000). Possibly certain hardground slabs of antediluvian origin even could have been "wedged-in" into soft sediments.

Certain high-density turbidity currents or debris flows have the capability of entraining large slabs (Postma et al., 1988). These slabs "ride" the interfaces that exist in these turbidites in a manner reminiscent of a water skier pulled by a motorboat and maintain an imbricate orientation during this time (Postma et al., 1988). Those especially flat slabs that happened to be deposited with sufficient regularity and spacing would be mistaken for continuous, even stratigraphically traceable *in situ* hardground surfaces. Isolated slabs deposited upside down would usually tend to be dismissed as locally eroded pieces of a hardground surface. When found occasionally imbricated against, and cemented to, respective *in situ* slabs, upside-down slabs would be misinterpreted as overhangs. A thorough understanding of massive movements of water, occurring on a currently unobserved scale is necessary to test the foregoing hypothesis.

Evidences for Transport of *In Situ* Hardground Surfaces

Many features of *in situ* hardgrounds are consonant with this type of composite origin. To begin with, laterally persistent hardgrounds commonly show considerable change over distance. Ostensibly diagnostic hardground characteristics appear inconsistently from locality to locality (Dogan et al., 2006). Frequently, hardground surfaces exhibit some areas that are strongly encrusted and large areas that are barren of encrusters and/or borings (Gruszczynski, 1979). This patchiness is usually blamed on the hypothetical presence of patches of sediment overlying the surface, denying access to borers and encrusters. The carbonate microfacies types of underlying and overlying strata, relative to hardgrounds, may or may not differ in texture and biotic content (Flugel, 2004). Hardgrounds can be intercalated with sediments exhibiting indicators of dynamic current action (Goldring, 1995), even acknowledged storm deposits (Woodmorappe and Whitmore, 2004).

Other common hardground features suggestive of a composite, allochthonous origin are more explicit. Numerous ostensibly *in situ* hardground surfaces exhibit cracks or fractures, and even one hardground slab overriding another. Although these are blamed on stresses caused by submarine cementation, the latter may simply indicate imbricated transported hardground slabs. Hardgrounds containing synsedimentary faults, Neptunian dykes (see glossary; Eren and Tasli, 2002; Tucker, 1973), and/or possible dewatering structures (Misik and Aubrecht, 2004) may reflect the squeezing out of soft sediment around the margins of stranded antediluvian hardground slabs. The existence of numerous pelmatozoan (see glossary) holdfasts on the underside of certain hardground overhangs, described as a puzzling observation (Brett and Brookfield, 1984), find a straightforward explanation in terms of allochthonous deposition. These authors suggest that the pelmatozoans in question grew on the underside of overhangs, tolerating upside-down growth until their stalks could curve 180° to grow upward. It makes at least as much sense to instead question the conventional overhang interpretation. Perhaps these submeter-to-meter-sized, so-called overhangs are misidentifications of slabs that were deposited in an upside-down orientation, having experienced a prior history of successive encrustation on both sides, including the normal upward growth of pelmatozoans.

The relative thinness of most *in situ* hardground constituents and that of entire hardgrounds facilitate a prior history of transport. Overhangs in hardgrounds, which range from tongue-shaped to mushroom-shaped, are usually less than 20 cm tall (Brett and Brookfield, 1984; Koch and Strimple, 1968; Palmer and Fursich, 1974). Even very complex hardgrounds are usually less than 50 cm thick (Lindstrom, 1979), and this also holds for cavity-bearing hardgrounds (Brett and Brookfield, 1984). These figures are probably maxima, as most putative ancient hardgrounds, especially the complex ones, probably consist of multiple sheets deposited serially.

Flotation of Hardground Constituents Mediated by Gas

Attention is now focused on the potential for flotation of entire hardground faunal assemblies. This includes the surficial layer of the bored or unbored carbonate rock to which they are attached.

Kelp, with its air-filled vesicles, and operating under the constraints of normal marine processes, has been proven capable of rafting rocks at least 38 cm long and 6 kg mass, and then decaying away readily, leaving no trace of its former presence (Emery and Tschudy, 1941). The size limit of rocks rafted by kelp, of course, would have to be determined experimentally, especially when one considers the unprecedented large sizes and thicknesses of kelp rafts probably arising during the Flood.

Hardground faunas commonly consist of organisms that are intertwined with each other, and attention is now focused on the transport of hardground constituents that do not float but are attached to organisms that do. The prominence of hardground bioimmuration processes (Wilson et al., 1994; bioimmuration being the process by which soft organisms are molded by the hard, preservable organisms that overgrew them) point to the onetime existence of unpreserved soft-bodied animals on the hardgrounds. Soft organisms, candidates for bioimmuration processes, are prone to decompose (Voight, 1979), releasing gases that may have floated the entire assemblage, perhaps even with some of the subjacent, often-bored crust still attached. The latter would be most applicable to Mesozoic and Cenozoic hardgrounds, whose faunas tend to be thicker and more areally extensive than their Paleozoic counterparts, and which therefore would be expected to release and trap more gas as a result of decomposition.

An additional, or alternative, source of buoyancy is provided by air spaces that sometimes occur in the limestone itself. Surprising instances of floating coral (Kornicker and Squires, 1962) illustrate this. Sketches in profile of *Trypanites* in densely bored cross sections of certain hardgrounds (Hecker, 1970, see his Figure 1b, p. 218) suggest that the minimum 60% of rock has been hollowed out. This alone would allow for the hardgrounds' potential flotation. At an assumed density of 2.5 g/cm^3 for carbonate rock, just over 60% of it would have to be replaced with air to reduce the average density of the slab below 1.0 g/cm^3 and allow it to float. Of course, borings containing trapped air or other gas would have to be sealed at this time, as would preferentially have occurred in complex hardgrounds slabs owing to their multiple layers of superposed and sealed, bored surfaces. The flotation of partially hollowed-out carbonate rocks should be tested experimentally.

Submarine gas releases occur today (Kuscu et al., 2005), and any Flood model must factor the vast amounts of gas that were probably released from subterranean sources during the Flood. Experimentation is needed to determine if large slabs of antediluvian hardground surfaces could have been made buoyant by trapped gas (Figure 1). Some evidence for the workability of this mechanism comes from observations of lava crusts floating atop molten lava, the result of gas trapped under the crusts (Perret, 1913).

The Proposed Conduit-Hardground Hypothesis: A Submarine Pseudokarstic Origin of Hardgrounds?

What if ancient hardgrounds did not form directly on ancient seafloors but on the seafloors of cavelike water-filled conduits that in turn occur within recently lithified, Flood-deposited sediments (Figure 2)? The actual water-sediment interfaces would usually be very subtle. If so, then unmistakably superimposed hardgrounds could be constructed concurrently and not just successively.

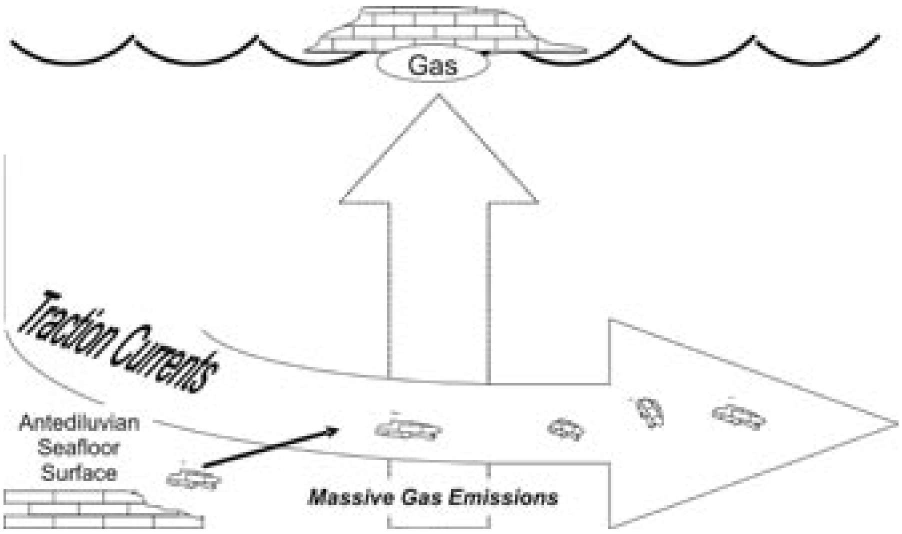

Figure 1. Massive gas emissions during the Flood potentially allow for the flotation of antediluvian hardground slabs, to be subsequently redeposited as both obviously allochthonous and seemingly autochthonous Phanerozoic hardgrounds.

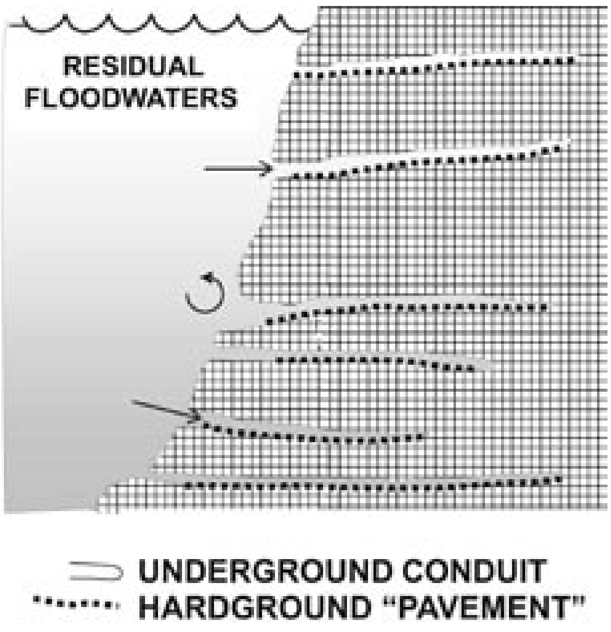

Figure 2. The conduit-hardground hypothesis. Horizontal conduits form in previously lithified Flood-deposited strata. Thanks to episodic forced movements of water, hardgrounds of varying complexity form on the floors of these flat submarine cavelike conduits. Note the potential ability of multiple horizons of hardgrounds to form long after the Flood itself and the extreme vertical exaggeration in this figure.

Note that this hypothesis proposes that hardgrounds formed during the late Flood and post-Flood period and within previously Flood-deposited sediment.

Of course, the existence and temporal persistence of the conduits implies that the strata are sufficiently lithified to open up as conduits, support the overburden, and maintain the conduits for significant periods of time. Research is needed on the dynamics of rapid lithification of considerable thicknesses of rapidly deposited sediment.

One might expect the postulated conduits (Figure 2) to have opened up along planes of weakness in strata. Interestingly, many hardgrounds are associated with obvious lithological changes (Eren and Tasli, 2002). Middle Paleozoic ones commonly occur below the shales of limestone-shale couplets (McLaughlin and Brett, 2004), and as illustrated elsewhere (Woodmorappe, 2006).

There is some overlap of hardground and karstic phenomena, as manifested by paleokarst/hardground associations that range from controverted (Keith and Wickstrom, 1993) to accepted (Desrochers and James, 1988; Vera et al., 1988). In the latter case, it was supposed that a karst was overlain by a hardground caused by a subsequent marine transgression. Otherwise, the postulated conduits should not be confused with caves as is usually understood by this term. Caves originate primarily from solutional activity, to which forced-water action is very much subordinate (Palmer, 1999). In contrast, the postulated conduits, generally devoid of karstic features and therefore termed pseudokarstic, must have formed almost entirely as the outcome of tectonic action and forced-water movements.

Field Testing of the Conduit-Hardground Hypothesis

One obvious way of testing for the onetime existence of horizontal subterranean conduits is to locate the corresponding vertical conduits. However, this may not be straightforward. To begin with, vertical conduits may be much less common than horizontal ones, as is the case with some modern karsts (Ford and Ewers, 1978), in which the horizontal flow of water (along bedding planes) is much more common than the flow of water in the vertical direction. To the extent that late-Flood and post-Flood conduits originated largely from tectonic action, this disparity may have been even more pronounced. The investigator must factor the post-Flood re-equilibration processes (e.g., regional downwarp) as ones that favored the slippage of rocks along bedding planes over the cracking of rocks perpendicular to the bedding planes. There is also the bias introduced by erosion: The same erosional processes that made the hardgrounds visible in outcrop also likely removed the overburden and the vertical conduits that it contained. Furthermore, the remaining vertical outcrop surfaces may not intersect the remaining vertical conduits.

Another way to test for the existence of onetime horizontal conduits is to check for evidences of collapse just above the hardgrounds. A thorough understanding of collapse processes is necessary because this, too, may not be as straightforward as it appears. Especially when the conduits were not large (perhaps a few cm tall for a simple hardground surface, and a series of closely-successive few-cm-tall conduits producing meter-thick complex hardground surfaces), their eventual crushing probably left little notable geologic evidence, being subsumed within the normal range of sediment-compaction processes, such as those that are already prevalent in chalks, including hardground-bearing ones (Garrison and Kennedy, 1977).

The Biology of Organisms in Conduit-Formed "Hardgrounds"

The testing of the conduit-hardground hypothesis must also extend to the biology of hardground-dwelling organisms. Of course, most of the organisms that formed ancient hardgrounds are extinct, and we can only draw analogies with their extant counterparts.

Modern boring organisms are not as delicate as sometimes supposed. *Lithophaga* can continue boring for at least a year despite no feeding and no change in water (Kleeman, 1973). Polychaetes and bivalves include organisms tolerant of dysoxic conditions in sediment, a trait that varies greatly within species (Wignall, 1994), perhaps extending to some borers (Alexander, 1994). Other borers are only slightly affected by the dimming of light (Hill, 1996). The microboring fungi, whose traces have been found on some hardgrounds (Misik and Aubrecht, 2004), are aphotic (Perkins and Halsey, 1971), and the extent of their ability to modify carbonate fabrics is not fully understood (Jones and Pemberton, 1987). Extending this, one wonders if macroboring fungi existed during the Flood and if any of them were capable of making *Trypanites*-like borings.

Facultative borers (see glossary) can burrow through a soft surface before encountering a hard surface and boring into it (Macchioni, 2000; Stearley and Ekdale, 1989). This is true, for example, of sipunculan worms, responsible for *Trypanites*. The presence of these types of borers has been inferred in certain ancient hardgrounds (Goldring and Kazmierczak, 1974). Sharp-edge borings continue as fuzzy-edge burrows, proving that the same organism bored through a lithified layer before burrowing through a soft layer. Otherwise, when covered by a few to several centimeters of overlying sediment, organisms boring a modern limestone vary considerably by species in their tolerance of this sediment, with a few individuals being capable of boring under a much thicker sediment overburden than their conspecifics (Stearley and Ekdale, 1989).

Except for instances where organisms from the photic zone were washed down into the subterranean conduits, their inhabitants must have been aphotic. These organisms were probably comparable to those modern bryozoans that prefer cryptic habitats (Kobluk et al., 1988). Interestingly, many encrusters and borings found in modern submarine caves can tolerate complete darkness as long as there is adequate circulation of water (Macintyre et al., 1982) for the delivery of nutrients and the removal of wastes, and such conditions must have been facilitated by the mechanical pumping of water taking place within the conduits during late Flood and post-Flood readjustments of the earth's crust.

Hardground Features in the Light of the Conduit-Hardground Hypothesis

The conduit-hardground hypothesis offers considerable potential explanatory power with regard to various hardground phenomena. Let us consider some of them.

Overhangs and cryptobiontic faunas may represent instances of preservation of the ceiling as well as floor surfaces of the conduits, surfaces that had undergone colonization by both borers and/or encrusters. It is unclear what factors would control the frequency of occurrence of colonized "overhangs."

Now consider rounded hardground clasts. These are commonly found alone or in association with *in situ* ancient hardground surfaces. Although the rounding of hardground clasts can readily be explained by the processes of syndepositional transport, in the present instance within the postulated conduits, unconventional processes that produce clast rounding (Clark, 1990) should also be tested, especially when there is a pronounced overlap of erosional and tectonic effects observed in hardgrounds. Rounding of clasts may result from transport in a gaseous stream, hydrothermal effects, subsurface chemical corrosion, abrupt decompression, etc.

Attention is now focused on the mineralization commonly encountered in ancient hardgrounds. Analogous to hypogenic karsts, mineralized zones can develop around solution conduits (Palmer, 1995). Processes of biokarst, a little-understood set of processes (Cunningham et al., 1995) includes bacteria, fungi, deposition of manganese and iron, and patches of fungal colonization. These likely played an appreciable role in the subterranean/substratal/submarine conduits. Experimentation is needed to determine to what extent bacteria and fungi can cause hardground mineralization outside of a conventional seafloor environment.

Complex hardgrounds may be the outcome of a complex, alternating series of water flushings, erosion, boring and encrustation, mineralization, etc. In the end, several mineralization events may have ended up alternated with several episodes of soft-sediment deposition followed by hardground "overprinting."

Conclusions

Conventional hardground-related thinking is so profoundly steeped in uniformitarianism that it takes a great deal of mental effort to free oneself from actualistic mental boxes. Far from being an insuperable obstacle to Flood geology, ancient hardgrounds provide the investigator with a wide-open field of research initiatives that could reconcile Phanerozoic hardgrounds with the universal Deluge.

Much experimentation is needed to clearly understand the ability of waterborne transport processes to account for such things as individual "encrusting" organisms, turbidite-mediated transport of imbricated hardground slabs, gas-mediated flotation of both individual and collective hardground constituents, etc. Such experimentation appears to be very much underperformed by uniformitarians, especially with relevance to hardgrounds.

The understanding of Phanerozoic hardgrounds as the outcome of pseudokarstic/submarine instead of conventional-submarine processes suggests its own set of research projects. Analogies with the hardgrounds found in modern submarine caves are intriguing but, owing to the matter of scale, can only be of limited value in this regard.

Glossary

Facultative borers—organisms that can switch from boring in hard sediments to burrowing in soft sediments, and back again. (Most organisms can bore or burrow but not both.)

Neptunian dykes—intrusions of soft sediment upward into cracks that occur within lithified sediment.

Pelmatozoan—refers to certain bottom-dwelling organisms, the best known of which are crinoids.

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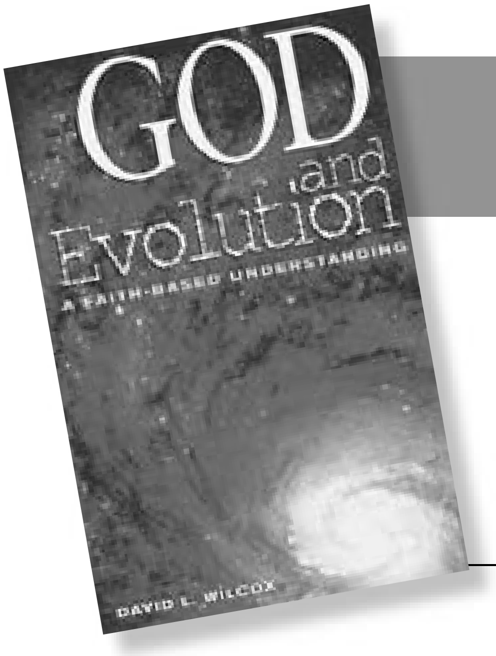

Book Review

God and Evolution: A Faith-based Understanding

by David L. Wilcox

Judson Press, Valley Forge, PA, 2004, 165 pages, $14.00.

David Wilcox is a biology professor at Eastern University, St. Davids, PA. He asks the reader to consider a "perspective of faith that does not ignore facts or compromise scientific integrity." His opening sentence is a quote from a nine-year-old girl, "I can't believe in both God and dinosaurs, so I picked God." He then laments how Christians from all walks of life face the same disorienting choice—either choose facts, or choose faith. Unfortunately this false caricature of creationists warring against facts is a common theme throughout the book.

Wilcox never revisits the opening sentence about dinosaurs, which reveals he is not current with the solid answers from creationists. Not only do we find good descriptions of dinosaurs in the Bible (Job 40:15–19, Isaiah 27:1, 30:6), but we also have powerful evidence that they were contemporary with man in the not-so-distant past, such as the recent discovery by Mary Schweitzer of T-Rex blood vessels and soft tissue that prompted *Discover Magazine* to surprisingly print that her "dangerous discovery… erased a line between past and present" (Yeoman, 2006).

Chapter 1 begins with something we can all agree on: "No matter what the topic, the starting point for Christians is the Bible" (p. 1). Wilcox quotes Colos-