# Flood Geology of the Crimean Peninsula
# Part I: Tavrick Formation

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## Abstract

Sedimentary formations of the Crimean peninsula (southeast Europe, Black Sea coast) provide evidence of catastrophic deposition in a hydraulic cataclysm. In spite of this evidence, uniformitarian geologists of the former USSR described these Crimean sedimentary formations in terms of gradualism. This article is the first attempt to reinterpret the geology of Crimea in a creationist framework. Research of the overall Crimean sedimentary sequence provides evidence of catastrophic sedimentation in the basin. The first stage of this research reconstructs sedimentary conditions for the lower part of the sequence—the Tavrick Formation. Investigation of the Crimean sedimentary sequence illustrates principles of Flood sedimentation which can then be correlated to strata in similar foldbelts in other regions. In the description of the geological structure of Crimea, I use the prevalent terms of the uniformitarian geological column, such as "Triassic," "Jurassic," and "Cretaceous." This dating is based upon the biostratigraphic assumption that strata around the globe which contain the same fossils are of the same age. Inasmuch as the synchronous nature of such strata is questionable, the absolute dating of these strata is rejected.

## Introduction

The Crimean Peninsula is located in southeastern Europe on the northern coast of the Black Sea (Figure 1). Its major geomorphic features include a plain in the north and mountains in the south. The mountains, part of the Alpine fold system, extend 200 km from southwest to northeast and reach an altitude of 1500 m. The peninsula has long been a popular site for geological field schools for many European Russian Universities.

The Crimean Peninsula has a very complex geological structure. Figure 2 shows a generalized cross section of the Crimean anticline from northwest to southeast. For easier visualization the cross-section is drawn with significant vertical exaggeration. The anticline is bounded by faulting to the southeast and folded strata to the northwest.

The basement of the sedimentary sequence is not seen in outcrop at the surface. In the northern part of the peninsula, deformed, high-grade metamorphic shales with diabase dikes and highly metamorphosed limestone are revealed by drill holes ranging in depth from 500 to 2000 meters (Sidorenko, 1969). The shales and limestones are assigned to the Precambrian and Paleozoic erathems, respectively.


**Figure 1. Location of Crimean Peninsula.**

Basement rocks are overlain by sandstones and shales of the Tavrick Formation, conventionally assigned to the Triassic System. The Tavrick Formation is also known by its informal, but widespread name—the "flysch formation"[1]. The flysch formation is separated from the basement rocks by an apparent unconformity. Another formation, exhibit-

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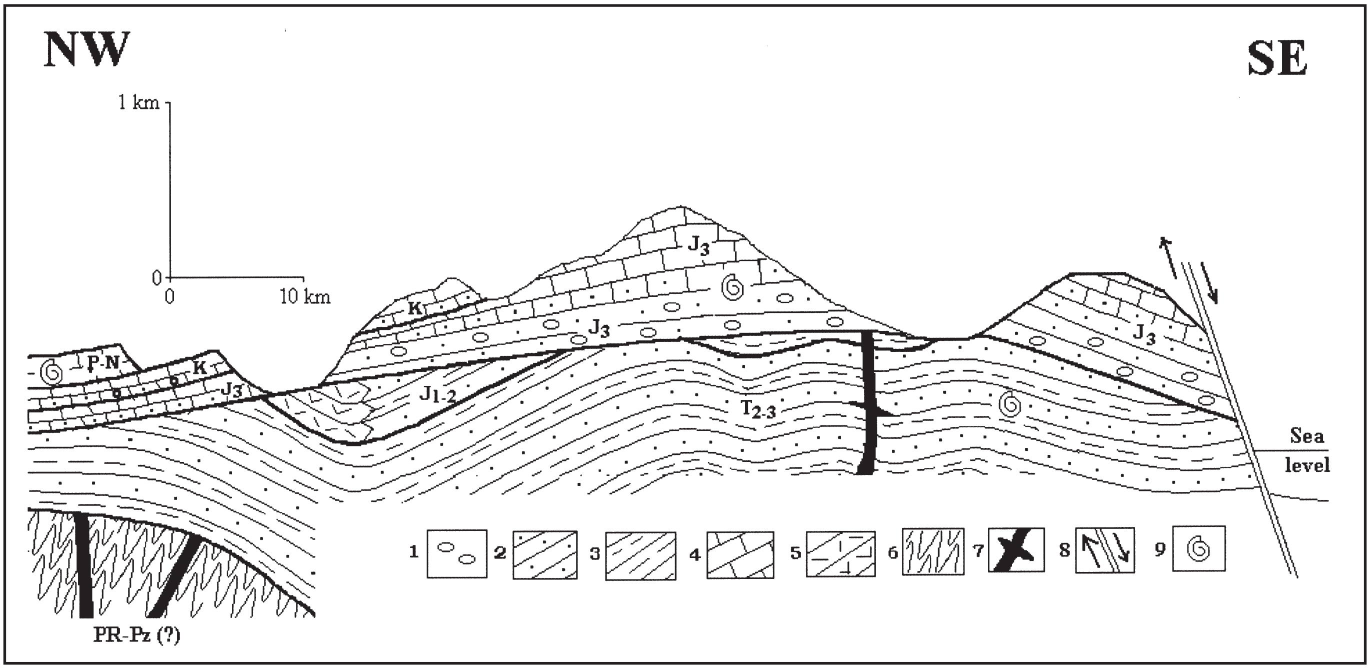


**Figure 2. Schematic cross-section of Crimea anticline. Legend: 1. Conglomerate, 2. Sandstone, 3. Shale, 4. Limestone, 5. Volcanic rocks, 6. Metamorphosed shales and limestones, 7. Diabase dikes, 8. Fault and direction of the block movement, 9. Fossils, PR-Pz(?): "Proterozoic" and "Paleozoic" strata; $T_{2-3}$: "Middle and Upper Triassic" strata; $J_{1-2}$ : "Lower and Middle Jurassic" strata; $J_3$: "Upper Jurassic" strata; K: "Cretaceous" strata; N-P: "Neogene" and "Paleogene" strata.**

ing flysch-like layering of shales and sandstones with interlayers of gravel, tuff and volcanic rocks, is conventionally assigned to the lower and middle Jurassic series. It overlies the Tavrick Formation without an angular unconformity. In some outcrops, the transition from the Tavrick Formation to overlying "Jurassic" deposits is gradational. The formal name of the "Jurassic" strata is the Eksiordian Formation. The Tavrick and Eksiordian Formations form a second structural floor of the Crimean mountains. The strata of this structural floor are deformed by folding (Figure 2).

Conglomerate, gravel and sandstones assigned to Upper Jurassic series (Callovian and Oxfordian stages) overlie the Tavrick and Eksiordian rocks across an angular unconformity (Figure 2). The erosion surface is mechanical only; there is no evidence of chemical weathering, fossil soils, or a long hiatus of sedimentation. Limestones of Kimmeridgian and Tithonian stages of the Upper Jurassic series conformably overlie (and sometimes juxtapose) the conglomerates and sandstones. Both the "Upper Jurassic" conglomerates and limestones are tectonically tilted. They form the highest mountains of the Crimean ridge. Far to the northwest they are overlain by Cretaceous, Paleogene and Neogene limestones and marls.

Under the Soviet regime, all geological interpretation was performed under the principle of uniformitarianism. Catastrophic approaches were largely unknown or ridiculed. However, at the Crimean Peninsula, there are clear field evidences of catastrophic geologic action that have been are interpreted within the framework of uniformitarianism in spite of the evidence. A clear example of this is found in the Tavrick Formation. All of the scientific papers and monographs about the geology of Crimea, and the Tavrick Formation in particular, demonstrate a uniformitarian bias. One of the most complete investigations of the Tavrick was performed by noted Russian sedimentologist, Professor, and Doctor of Science Nicholas Logvinenko—my teacher and former Chair of Sedimentology (1968–1992) in the Geology Department of Saint Petersburg State University. Although his conclusions were colored by his uniformitarian perspective, his descriptions of the flysch formation are valuable.

Austin (1994) demonstrated that a catastrophist interpretation can be made for geologic features long interpreted in the light of uniformitarianism. In a similar fashion, I propose, on the basis of extensive field research, that the flysch formation of the Crimean Peninsula yields significant evidence of catastrophic deposition.

[1]"Flysch" is an older geological term, popular in Europe, for alternating sand, silt, and shale sequences purportedly deposited in deep-water conditions. They are roughly the same as those defined by the term, "turbidite" in North America.

## Sedimentological Features of the Tavrick Formation

The oldest rocks of the Crimean sedimentary sequence exposed in outcrop are those of the Tavrick, or flysch formation. It is exposed in the central part of the Crimean anticline and on the south coast of the peninsula. The formation is composed of rhythmically alternating sandstones, siltstones, and shales (Figure 3). Limestone layers are also present, but only in the upper part of the formation. In spite of large numbers of trace fossils, the flysch formation contains few body fossils. Only in the upper part of the strata are *Halobia* fossils observed.

There have been several stratigraphic interpretations of this formation by different authors. All of these interpretations are based upon uniformitarian assumption of continuity of the strata, which in one part is based on the assumption of the simultaneous deposition of each layer in the entire sedimentary basin. The most detailed classification was made by Logvinenko (1961) on the basis of his rhythmostratigraphical method. He distinguished five members (from bottom to the top): (1) Normal Flysch, (2) Normal Flysch with Quartzite Sandstones, (3) Lower Shale Flysch, (4) Sandstone Flysch (Inter Shale Member) and (5) Upper Shale Flysch. The first three members were assigned to the Middle Triassic Series, the last two members to Upper Triassic Series. These members are not homogeneous; both lateral lithology changes and local unconformities between the members are present.

The rhythmostratigraphical method is based upon the detailed measurement of all flysch layers. The ratio of thickness of sandstone to shale layers is assumed to be unique for each flysch member. Inasmuch as there is no one continuous outcrop of the flysch formation from bottom to the top, the local lithostratigraphic column is derived by correlating various sections. However, even this lithostratigraphic column is suspect; uniformitarian geologists themselves recognize that the character of flysch can change laterally very abruptly (Sidorenko, 1969). Also, the flysch formation appears to have been deposited from moving horizontal currents (as will be shown later), not evenly over a widespread area, increasing uncertainty in interpretation (Berthault, 2000). Hence, we can speak with confidence only about the predominance of shale flysch in the upper part of the formation. Therefore I propose to divide the Tavrick into two members, typical of many flysch sequences, which represent a transgressive series. The boundary between these members is not always obvious.

- The lower member, or "Normal Flysch", with roughly equal thicknesses of sandstone or siltstone, and shale layers. The thickness of each layer varies with clast size: coarse-grained sand beds are between 40–200 cm thick; medium-grained sand beds, 10–50 cm; and fine-grained sands, 2–20 cm. The total thickness of the normal flysch member is unknown. Drilling data shows that it is at least 2000 m, although visible thickness in outcrop is no more than 800 m.
- The upper member, or "Shale Flysch", which is dominated by shales—up to 80–90 % of the member's thickness. Sandstone or siltstone layers are up to 50 cm in thickness. The Shale Flysch member is 700–800 m thick.

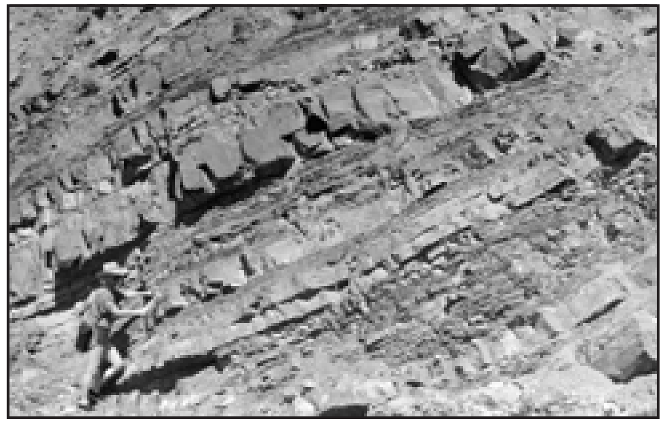

**Figure 3. Lower member of Flysch Formation (normal flysch), showing alternation of sandstones, siltstones, and shales.**

The flysch formation is deformed by folding into a series of synclines and anticlines. The amplitude of folding ranges from several meters to kilometers. Small folds occur as a result of the slumping of unconsolidated deposits, whereas large ones are associated with large-scale tectonic movements, accompanied by faulting and intrusion of igneous dikes (Figure 2).

The flysch formation has many interesting sedimentary features, such as dragging grooves, erosion grooves, cross beds, and trace fossils, which aid interpretation of its origin.

*Dragging grooves* (or their casts) formed from dragging trees or stones over the sediment-water interface by the current (Figure 4). These have widths between 1 and 2 cm, lengths between 50 and 100 cm, and penetration into the rock between 0.5 and 1 cm. These marks are evidence of deposition of stratified sediments under conditions of high current velocity. Preservation of these marks is also evidence of rapid burial.

*Erosion groove* has been defined as "a sedimentary structure formed by closely spaced lines of straight-sided scour marks. The scouring may be initially concentrated by a pre-existing groove." (Bates and Jackson, 1987, p. 227). These structures (or their casts) are common on the surface of the sandstone and siltstone beds (Figure 5). They reach 10 – 20 cm in width, 50 – 100 cm in length, and 5 – 10 cm penetration into the rock. Another evidence of vigorous erosion is the absence of part of the upper (shale) beds in the flysch sequence in the older normal flysch member. The presence of erosion grooves strongly

**Figure 4. Dragging grooves on the surface of this layer is evidence of a vigorous water current during sedimentation.**

suggests that these strata were deposited under conditions of vigorous water current (Dzulinski and Sanders, 1962). These marks also enable researchers to determine the direction and velocity of the paleocurrent. Erosion grooves demonstrate that the paleocurrent velocity exceeded the initial erosion threshold for clay particles (Potter and Pettijohn, 1963). Erosion grooves are commonly formed on the sediment surface during brief bursts of abrasion under fast-flowing water conditions (Allen, 1984). Thus, it is possible to estimate the paleocurrent velocity from the Hjulström diagram (Hjulström, 1935). For clay particles the paleocurrent velocity probably exceeded 1.0 m/s. Mapping of erosion and dragging grooves' orientations show a unidirectional paleocurrent from northwest to southeast during deposition of the flysch formation.

*Cross beds* are distinctly inclined thin layers of sand within thick sandstone stratum. The cross beds are observed in the sandstone layers of flysch. Shales are always flat-bedded (Figure 6). This is similar to what was observed by Julien, Lan and Raslan during laboratory flume experiments on stratification of heterogeneous sand mixtures in current conditions. They noted that:

> …particle segregation mechanism is at the origin of stratification structure in which a cross-laminated deposit of mostly coarse particles lies between two near-paralleled laminated deposits (Julien et al., 1998, p. 221).

Thus I propose that these structure were formed in similar current conditions, not as a result of continuous slow sedimentation in a low-energy basin.

The cross beds are generated as a result of the sand moving as waves. The thickness of the cross beds is up to 0.8 m. Because erosion has removed the top of each sand wave, the true height of each sand wave could have been double the present cross bed thickness (Austin, 1994, p. 34). Inasmuch as the sand-wave height is approximately one-fifth of the water depth (Austin, 1994, p. 34), the depth of the sedimentary basin that time may be estimated as not more than 10 m. Using the Rubin and McCulloch diagram (Rubin and McCulloch, 1980, p. 214), the velocity of the paleocurrent may be estimated between 0.8–1.2 m/s.

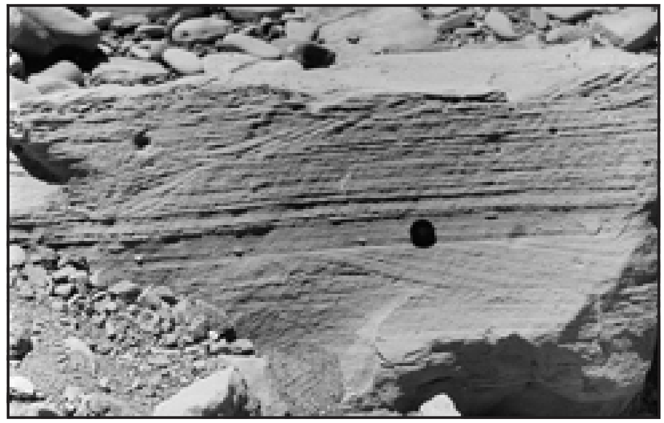

**Figure 5. Erosion grooves allow determination of both velocity and direction of the current.**

**Figure 6. Cross bedded sandstones within flat bedded shales. This type of layering of coarse-grained and fine-grained particles was observed in flume experiments on stratification using heterogeneous sand mixtures.**

*Trackways* of crawling worms and burrows of marine organisms are also observed in the flysch formation (Figure 7). More specific identification of the ichnofauna has not been made. There are both surficial and tunnelling crawling traces on the upper bedding plane of the shale layers. Usually we see only casts of these traces on the lower bedding plane of the superposed sandstone layers. Tunnels filled with sand which were later cemented. Very short fossil tracks (not longer than 0.5–1 m) are evidence of short time between sedimentation superposed strata.

*Folds* also reveal information about the geological history of the flysch formation. Detailed observation of small folds indicates that there was not a long period of time between deposition and folding. It appears that sedimentary beds were soft and plastic during folding (Figure 8); therefore deposition of strata and folding probably occurred

**Figure 7. Trackways of crawling worms. Very short fossil tracks are evidence of short time between sedimentation of superposed strata.**

**Figure 8. Folds in Flysch Formation showing plastic deformation of unconsolidated sediments during folding.**

within a short time of each other, not over a long geological time span.

Compositional similarity across all the flysch strata suggests that during flysch deposition there was only one source of clastic material for the entire basin. Moreover, the adjoining coal-bearing sedimentary sequence in the Donetsk Basin (300–400 km to the northeast) assigned to the Carboniferous System (Mississippian and Pennsylvanian) has a similar mineralogical composition (Logvnenko and Karpova, 1961, p. 262, table 63). Compositional similarities over such a broad area strongly suggests that all of these formations had one common source of sediment and were generated almost simultaneously by widespread and powerful depositional processes.

## Origin of Flysch Formation

These data support several important conclusions:

- Deposition of the Tavrick Formation occurred under widespread catastrophic paleocurrent conditions with velocities up to 1.2 m/s, not in a low-energy marine basin. These high current velocities are seldom observed over large areas of the modern open ocean (Austin, 1994, p. 35; Hamilton, Sommerville and Stanford, 1980). Therefore, conditions during deposition of the Tavrick were probably significantly different from modern analogs.
- Constancy of the mineral association both within the Crimean sequence and between it and those in the Donetsk Basin is evidence of a consistent source relatively distant from the Crimean strata.
- Preservation of dragging and erosion grooves also strongly suggests rapid sedimentation under high current conditions. At the same time, trace fossil trackways are short, suggesting short time spans between deposition of successive layers.
- The presence of erosion surfaces on the beds are not a result of long periods of time of quiescence, but are characteristic of deposition under high current velocity conditions.
- The period of time between deposition and folding of the strata was very short.

In summary, these features of the Crimean flysch formation clearly confirm the superiority of a catastrophic interpretive framework.

What does the relevant uniformitarian literature report? These papers described all of the features listed above in great detail. They were written by experienced and observant specialists such as Nicolas Logvinenko. However, the uniformitarian framework apparently prevented the proper inference of a catastrophic origin for the observed sedimentary features of the Tavrick Formation. Logvinenko wrote about the conditions of deposition for these strata:

> The presence of dragging grooves with lengths more than 50–100 cm, widths 1–2 cm, depths 0.5–1 cm and erosion grooves with lengths up to 50 cm, widths 10–15 cm and depths up to 5 cm, often S-shaped, bear witness to high-velocity, turbulent currents (Logvinenko, 1961, translated from Russian by author).

The preservation of mechanically generated textures such as erosion grooves and ripple marks is evidence of considerable rate of sedimentation (Logvinenko and Karpova, 1961, p. 27, translated from Russian by author).

> Invariability of the mineral associations is evidence of a single and complex source of detritus for all of the Crimean peninsula and adjacent territories during flysch deposition (Logvinenko and Karpova, 1961, p. 134, translated from Russian by author).
>
> The S-shaped form of sills with thickness up to 10 m is evidence of a pre-fold age of intrusives. Penetration of these sills into non-solidified sediments has

> been confirmed by the inviolate character of contacts and alteration of plagioclase near the contacts by steam (Logvinenko and Karpova, 1961, p. 199, translated from Russian by author).

> Sedimentation occurred under conditions of high hydrodynamic activity and instability of the sediment… Conditions for the existence of marine organisms were unfavorable (Logvinenko and Karpova, 1961, p. 258, translated from Russian by author).

> The amount of arriving detritus was tremendous: there was much mud not only near the shoreline, but also very far from the coast… The black color of the flysch rocks is evidence of a large amount of plant detritus and organic material arriving into the sedimentary basin (Logvinenko and Karpova, 1961, p. 260, translated from Russian by author).

What else is needed to draw a conclusion that the flysch formation was generated under catastrophic conditions of sedimentation? Thus it is interesting to note the conclusion of the uniformitarian, Logvinenko:

> The formation of flysch occurred in marine basins bordering mountain systems similar to the present day Black Sea, under conditions of small oscillatory tectonic motions (Logvinenko, 1974, p. 237, translated from Russian by author).

This is an excellent example of the uniformitarian bias. Belief in an old age of the Earth and slow processes of sedimentation seems to preclude obvious inferences from field data.

## Out-of-Order Limestones Associated with the Flysch Formation

There is another interesting feature of the geology of Crimea that appears to confound uniformitarian doctrine. This is the existence of a few large (up to hundreds of meters) blocks of limestone assigned to the Carboniferous System by paleontological dating within and above the flysch strata (Triassic System). Several uniformitarian geologists have described this feature. The many attempts to explain this paradoxical relationship include that of Nicolas Logvinenko:

> One of the features of the Main Ridge of the Crimean Mountains is the inclusion within Triassic strata of more ancient Carboniferous strata. The genesis of this phenomenon is not clear. It is supposed that these blocks were located in central parts of Triassic folds and slumped down the slopes that consisted of clay deposits (Logvinenko, 1998, p. 6, translated from Russian by author).

Once again, the bias of uniformitarianism prevents these authors from drawing the more obvious conclusion that the dating method, and hence, biostratigraphy, might be false.

## Conclusion

It is clear that a conceptual framework influences the interpretation of geologic features to a great extent. This is why researchers with similar qualifications and ability can draw radically different conclusions from the same data. Numerous investigations confirm this viewpoint. Valid interpretations have been performed based on a catastrophist framework at the Grand Canyon (Austin, 1994, pp. 21–56). Similarly, the age of submarine placer deposits in north-eastern Russia has been shown to lie in a range between 2000 and 5500 years, rather than the 40 million years estimated by uniformitarians (Lalomov and Tabolitch, 1996) and the age of associated alluvial placer deposits has been shown to be less than 2000 years—hundreds of times less than what uniformitarian geologists believe (Lalomov and Tabolitch, 1999).

In the same fashion, the flysch formation in Crimea can easily be interpreted within a creationist framework. Its rocks yield many evidences of rapid, catastrophic deposition. In spite of these, uniformitarians continue to assert that the strata were deposited over a long time span (about 30 million years) in a low-energy marine basin bordered by mountains with small oscillatory tectonic activity (Logvinenko, 1974). It is possible that uniformitarian interpretations of the Crimea were forced by the political situation of the USSR in the past. I hope that Russian scientists will reject the doctrine of uniformitarianism and consider the creationist alternative.

There are many difficult and unsolved problems in geology that require careful research and investigation. The data present challenges for both the uniformitarian and catastrophist frameworks. But in numerous cases, the principles of Flood stratigraphy and a recent creation are can be successfully applied to interpretations of field data such as the Tavrick Formation of the Crimean Peninsula. Ongoing work there will address other features of the area within the creationist framework.

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# Book Reviews

## *God: The Evidence* by Patrick Glynn

**Prima Publishing Co., Rocklin, CA. 1999, 216 pages, $14.00**

Patrick Glynn has made a remarkable transition from agnostic to believer, based on evidence from creation and conscience, the transition every intellectually honest seeker ought to make. Because of this, the book is valuable in helping others of similar bent to see the case for faith. In another sense, perhaps Mr. Glynn wrote the book too soon, because he shows signs of theological naivety that put him—and his readers—in danger of falling into a syncretistic or pantheistic version of the gospel.

In his personal search for truth, Mr. Glynn discovered that his tool of choice—reason—leads to some absurdities. For instance, a firm basis for morality is lost when the atheistic intellectual line is reeled out to the end, yet morality is absolutely necessary for society and individuals to survive. This was the dilemma of Socrates whose students apparently took the implications of the teaching a bit further than their teacher had hoped and thus he was charged with corrupting the youth of Athens. It is really a shame that the corruptors of our age do not take their crimes as seriously as the ancients apparently did.

Early in the book, the only sign of a problem is a compromise common to many believers, that of accepting evolution or at least long ages (p. 34). Most who take that position have not really thought through its implications for the authority of Scripture. In fact, if there were death long before human sin, even before human existence, then the Bible is misleading not only in its historical assertions, but also in key elements of the gospel, including the meaning of Christ's atonement as the defeat of that enemy death which entered creation because of human disobedience. Otherwise, death is just part of God's plan for creation.

Glynn goes on to delineate the evidence of God from design, including not only the complexity of living things, but also the way in which even the physical constants of the universe, the whole way in which matter and energy behave, seem designed in a way that makes life possible. He shows the silliness of some of the usual explanations of this "anthropic principle," such as the existence of infinite parallel universes of which ours is just one of those that