

## THE HYDROTHERMAL BIOME: A PRE-FLOOD ENVIRONMENT

KURT P. WISE  
CENTER FOR ORIGINS RESEARCH AND EDUCATION  
BRYAN COLLEGE, BOX 7802  
DAYTON, TN 37321-7000

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### ABSTRACT

[2] argued for a pre-Flood/Flood boundary in the lower part of the Kingston Peak Formation in the East Mojave of eastern California and western Nevada. Diabase and associated evidence of contact metamorphism and rapid cooling in the Crystal Spring Formation, as well as solution pipes, chaotic bedding, dome structures, and massive precipitate production in the overlying Beck Spring Formation suggest that hydrothermal activity associated with the cooling of the diabase generated the Beck Spring sediments in pre-Flood times. The swelling of the Crystal Spring sediments by the intrusion of the hot diabase is thought to have brought the sediments at or to sea level. A shallow water status was maintained for an extended period as the shrinking of the cooling diabase was equalled by the generation of the primary dolomites of the Beck Spring Formation. The presence of these rocks in what [2] interpret as deep continental rise sediments combined with the evidence of shallow marine sediments to the west suggests that this environment was located far offshore on the edge of the continental shelf, creating landward, a several-hundred-mile wide, marine lagoon on the continental shelf. Abundant cryptalgal structures and stromatolites in East Mojave and Grand Canyon sediments suggest that the seaward portions of this lagoon may have been ideal for stromatolite growth. Sediments overlying the Beck Spring Formation contain a sequence of fossils, from stromatolites, to Ediacaran organisms, to small shelly fossils, and finally to traditional 'Paleozoic Fauna'. This suggests that the pre-Flood continental shelf housed a spectrum of marine ecosystems from the margin landward: (a) a shallow-water, stromatolitic, hydrothermal, carbonate reef environment; b) a deep-water, sandy(?) environment, with an Ediacaran benthos; c) a carbonate(?) environment populated with the organisms which generated the small shelly fossils; and finally d) a non-carbonate(?) muddy environment populated by the 'Paleozoic Fauna'. The wide-spread nature of similar diabase in the Southwest suggests that the hydrothermal environment may have been at least regional in extent. The similar sequence of rocks and fossils at a number of locations worldwide suggests that the hydrothermal biome evidenced in what is now Southwestern United States may have been a widespread feature of the pre-Flood world.

In this interpretation, on the first day of the Flood, the breakup of the 'fountains of the great deep' (Genesis 7:11) collapsed a portion of the distal carbonate bank onto the continental rise. The earliest Flood sediments were poured through the resultant hole in the reef, resulting in rapid and deep burial – and thus preservation – of these earliest Flood deposits. The extinction of many of the creatures of this biome (many of the stromatolite taxa, the Ediacaran Fauna, the small shelly fossils, and most of the Paleozoic Fauna) is explained by the failure to regenerate the same protective regime in post-Flood times. The few survivors from this fauna/flora (stromatolites, thermophilic bacteria) are relegated to relict localities in the present world (e.g. mid-ocean ridges, geysers, hypersaline intertidal environments).

### INTRODUCTION

The nature of the fossil record has long played a substantial and nagging role in origins debates. In modern times, Nicolaus Steno, in a book written in 1669 [12], is thought to be responsible for convincing the western world that fossils were actually remains of once-living organisms. Steno's strained attempt to explain these fossils in terms of Biblical events started a long debate on what version of earth history best explains the fossil record. Nearly two centuries after Steno, Darwin [8: Chapter 9] struggled to explain the major features of the fossil record in his evolutionary theory. Now, nearly a century and a half after that, young-age creation theory also struggles with the fossil record.

One of the most difficult segments of the fossil record for virtually all theories of earth history is the sudden paleontological change at the base of the Phanerozoic. On the one hand, the sudden appearance of animal phyla at the base of the Cambrian (the 'Cambrian Explosion') creates a challenge for evolutionary theories of biology. Most creationists are not so much bothered by the Cambrian Explosion as they expect such a paleontological discontinuity with the initiation of Flood sedimentation (e.g. [2], [63]). On the other hand, the presence of bacterial, protist, and algal, fossils without definitive evidence of animal, fungal, and plant fossils *below* this boundary does create a challenge for creationist theories of earth history. Whereas evolutionists

would expect a period of early earth history where 'lower' organisms existed without 'higher' organisms, this is not an intuitive expectation of creation theory. As an example of the difficulty this creates for creationists, just the early stages of a debate between two young-age creationists has resulted in no less than three theories of interpretation of Precambrian fossils [58, 65, 69].

Since what follows is only a brief summary of the paleontological data which must be explained in any comprehensive theory of Precambrian paleontology, [41], [52], and [53] should be consulted for more details.

Although Precambrian sediments are discontinuously distributed across the earth, they are often kilometers thick when they are found. Distributed among these sediments from the bottom of the pile to the top are hundreds of horizons where stromatolites have been found (see, e.g. [58]). Many of them can be rather definitively argued to be biogenic and some of them (e.g. a stromatolite bed in the Kwagunt Formation of the Grand Canyon: [69]) are extensive and almost certainly *in situ*. Scattered among the stromatolite horizons there are scores of stratigraphic horizons which have yielded body fossils of bacteria. In the upper portion of the Precambrian sediments one begins to find body fossils of microscopic protists and algae. At the very top of the Precambrian sedimentary pile – beginning in Vendian sediments – is found a succession of animal fossils leading into the Phanerozoic. This succession includes the large, flat, soft-bodied Ediacaran organisms, followed by tiny, shelly fossils, and finally by the abundant Atdabanian olenelid trilobite fossils, signalling the beginning of the traditionally understood Phanerozoic fossil record.

This paper will attempt an explanation of the broad characteristics of the Precambrian fossil record by proposing a pre-Flood environment along with a mode of Flood deposition. It is hoped that this theory will serve not only as a paleontological model, but also as the beginning of an understanding of the more general fields of Precambrian and pre-Flood geology.

### **A STROMATOLITE EDEN**

The true nature of the fossil stromatolites has been debated for a very long time. Modern microbial mats produce a certain small range of stromatolite-like structures (see [3]). Communities of bacteria are organized into sticky mats. Inorganic particles, such as allochthonous sand grains and/or autochthonous precipitates, accumulate on the sticky mats, and then the organisms grow around these particles to create another organic layer. In this way successive organic and inorganic layers are generated. This process creates morphologies which range from planar mats to broad or narrow mounds to columns and toadstool-shaped structures. The ecological range of such microbial mats runs from geothermal effluents to lacustrine to intertidal or subtidal saline or hypersaline.

Although stromatolites in Precambrian sediments are rather common, often large and extensive, and occasionally huge, they are rare in Phanerozoic sediments and both rare and small in the present world. The decline in stromatolite size and abundance has traditionally been blamed on the evolution of grazing animals [62]. It is thought that grazers prevent organic mats from getting large enough to form large stromatolites. In fact, it is generally believed that the hypersaline conditions of Shark Bay, Australia are incompatible for most grazers, and that is why some of the largest known stromatolites in the present are located there.

Optimum conditions for stromatolite development would seem to be 1) intertidal to shallow water for optimum photosynthetic activity and thus optimum organic mat production; 2) high precipitate production to maximize accretion rate of inorganics; and 3) a lack of grazers. A shallow-water to intertidal hydrothermal regime would meet all three conditions.

### **A FRAGMENT OF PRE-FLOOD MARGIN**

In the Eastern Mohave Desert in Southeastern California and Southwestern Nevada up to 20,000 feet of Precambrian rocks are resting conformably beneath Cambrian sediments and unconformably atop crystalline rocks [2]. Bacterial microfossils [7, 26, 34, 44, 45] and stromatolite-like algal structures [7, 9, 14, 28, 35, 49] are scattered throughout the section beginning in the lowermost of the sedimentary units. Eukaryotic fossils have been reported from the second formation up from the base of the section (the Beck Spring Formation: [22, 24, 43]). Whereas olenelid trilobite fossils first appear in the Middle Wood Canyon Formation, Ediacaran fossils are found in the base of the same formation [23, 15]. Between the Ediacaran and Atdabanian fossils, correlative rocks in the White-Inyo Mountains of California and Nevada [11, 33, 40, 42, 56, 57, 59, 61] have yielded small shelly fossils. Rocks of the East Mojave, then, contain a representative sample of the Precambrian fossil record which is reported worldwide.

In [2]'s interpretation of these sediments, the lowermost two formations in the East Mojave, the predominantly silico-clastic Crystal Spring Formation and the overlying Beck Spring Dolomite, were formed in shallow water on the edge of the pre-Flood continental margin. The sediments of the Crystal Spring

Formation [20, 21, 29, 36, 37, 38, 39, 48, 49, 50, 51, 70, 71, 72, 73, 74, 75, 76] are about 3100 feet thick and rest unconformably on gneiss (Figure 1; [50]). The Crystal Spring Formation has been informally divided into seven members (Figure 1; [50]). From the bottom up they are: a) the arkose member, which is dominated by eight cyclical couplets of grey to green conglomerate and arkosic sandstone [50]; b) the feldspathic sandstone member, which is dominated by cycles of red to purple sandstones, siltstones, and shales [50]; c) the purple mudstone member, which is dominantly a red to purple, silty to sandy mudstone [50]; d) the dolomite member, which is dominated by alternating beds of different types of dolomite [74, 50]; e) the chert member, which is dominated by dark, dense, fine-grained chert, and f) the upper member, which is dominated by 6 cycles of coarsening upwards shales and sandstones capped by dolomite [21, 37]. The clastics of the uppermost cycle of the upper member grade into the dolomites of the overlying Beck Spring Formation [4, 20, 36, 81].

In all places where it is exposed, the Crystal Spring Formation contains huge masses of diabase [70] in the form of a sill or sills. In some cases it has nearly doubled the formation's thickness. In all places where it is well-exposed, the diabase is differentiated – with heavier mafics at the bottom and lighter felsics at the top. This suggests that the diabase is a single body and not a number of thinner units. The fact that it was very hot is suggested by the internal differentiation, what looks like flow banding at various levels, as well as extensive skarns at various carbonate contacts in which are found minable talc deposits. On the other hand, the inclusion of diabase clasts in Kingston Peak breccias and the rough, step-down type erosion of diabase where it is in contact with Kingston Peak and Noonday Formation sediments, suggests that the diabase was in most places cool and brittle at the time of deposition of the Kingston Peak and Noonday Formation.

[2] suggest Flood sedimentation began in this area with the deposition of the Kingston Peak Formation, so its brittle nature suggests that the Crystal Spring Formation diabase must have been cool by the time of the Flood. A molten diabase mass thousands of feet thick could not cool by conduction at modern rates in the pre-Flood period. Therefore it was either created in a cooler condition and/or it cooled by some other means. Although the carbonates of the Crystal Spring Formation at its type locality do not seem to be strongly metamorphosed, large marble blocks – possibly from Crystal Spring Formation carbonates – are found in the Kingston Peak Formation east of the Kingston Range and in the Silurian Hills. This suggests that the cooling rate of the diabase was non-constant – slow in some areas and rapid in others. This suggests that a mechanism of post-creation cooling may have been involved.

Atop the Crystal Spring Formation and its contained diabase is the Beck Spring Formation [13, 14, 20, 21, 25, 26, 30, 31, 32, 35, 36, 44, 46, 47, 60, 80, 81]. Interbedding with the underlying Crystal Spring [4, 20, 36, 81] indicates that the 1300 feet of dominantly dolomitic Beck Spring Formation sits conformably atop the Crystal Spring Formation. The Beck Spring Formation has been informally divided into four dolomite-dominated members [13, 14, 35]. Intraformational breccias [60], vertical breccia pipes (interpreted as paleokarst by [60] and [25]), and linked domes [60] are found in the Beck Spring Formation – especially in the two lowest members. These structures as well as the Beck Spring's primary lithologies – dolomite and chert – can be generated under hydrothermal conditions. Pervasive secondary mineralization of many of the East Mojave diabases [27, 78], suggests the diabases interacted with a lot of water. [27] even suggested that water could have played an important part in the emplacement of the diabases. Since a large amount of water running through a hot igneous body will both rapidly cool the igneous body and generate hydrothermal conditions, I suggest the Beck Spring Formation was actually generated by the cooling of the Crystal Spring Formation's diabase.

The base of the lowermost sandstone unit of the Kingston Peak Formation in the Kingston Range is interbedded with the top of the Beck Spring Formation [54]. These sandstones were also deformed in the avalanche-related deformation of the Beck Spring Formation [68]. Thus some of the Kingston Peak Formation sediments were also in place at the initiation of the Flood. The lack of carbonate production suggests that hyperthermal conditions had ceased in at least some portions of the larger hydrothermal field. This conclusion seems reinforced by the brittle nature of at least some of the diabase at the time of shelf collapse as well as inferred temperatures of secondary silica production of only 34-43°C in the the upper Beck Spring Formation [31]. This may even suggest that hydrothermal activity was as patchy and ephemeral in this hydrothermal regime as we find it to be in hydrothermal fields of the present (e.g. in Yellowstone National Park, Iceland, and the mid-ocean ridges).

Although there are a host of possible ways to include this into the young-age creation model, this author considers the most likely possibility should be one of three: 1) during the Creation Week God created the entire sequence complete with the appearance of age and history; 2) during the Creation Week God created the Crystal Spring Formation complete with a hot diabase, whereupon the Beck Spring Formation was

formed in the post-Creation, pre-Flood period; 3) the diabase actually intruded the Crystal Spring Formation after creation, subsequently producing the Beck Spring Formation – all before the Flood.

Based upon Precambrian rocks preserved in the Grand Canyon to the West [1: Fig. 4.5], [2: Fig. 2] suggest that in pre-Flood times the shallow-water continental shelf may have been several hundred miles wide. The Crystal Spring and Beck Spring sediments, then, were on the shelf margin, far offshore. At the same time, the substantial thickening of the shelf sediments by the diabase seems to have elevated these sediments to or above sea level [4]. The photosynthetic activity suggested by cryptalgal structures throughout the sequence suggests a shallow water zone. If the diabase was created or intruded hot (scenarios 2 or 3 above) the pre-Flood continental margin would have supported an offshore, shallow-water, hydrothermal realm (see Figure 2). The development of carbonate reef (the Beck Spring Formation) may have offset the subsidence caused by cooling of the diabase beneath. The hydrothermal, possibly hypersaline, conditions combined with the distant, off-shore position of this ecosystem may have prevented the survival of grazers. This area, and the protected area landward of it might well have been an ideal environment for stromatolite production.

The Bass Formation of the Grand Canyon contains a diabase both positionally and mineralogically similar to the diabase in the Crystal Spring Formation of East Mojave. In the Grand Canyon Precambrian, in fact, are not only cryptalgal structures similar to those in East Mojave, but also extensive stromatolite ‘forests’ (Wise & Snelling, in preparation). Postulating a hydrothermal ecosystem would not only explain the nature of many of these rocks and sediments, but also provide an ideal setting to explain the origin of the stromatolites. Diabases similar to those in East Mojave and Grand Canyon are found in several other locations in southeastern California and Arizona [10, 16, 17, 18, 19, 27, 79], suggesting the hydrothermal biome may have existed on a regional scale.

## **FLOOD SEDIMENTATION**

According to [2], at the initiation of the Flood, subsidence of the protopacific plate beneath the continental margin under the Crystal Spring and Beck Spring sediments collapsed the entire upper shelf. Huge megaclasts of that shelf edge – including various combinations of Crystal Spring and Beck Spring Formations and the crystalline rocks beneath – were transported into the deep water of the continental rise by an underwater avalanche deposit. These clasts were buried by subsequent Flood sediments, beginning with the Kingston Peak Formation containing the megaclasts.

Subsequent and ongoing research [54, 55, 64, 67, 68] has continued to reinforce the subaqueous landslide interpretation of the Kingston Peak Formation. The overlying Noonday Dolomite also shows evidences consistent with it being an avalanche deposit [66]. The abundant stromatolites of the Noonday Dolomite [77] would then represent the collapse into the reef gap of an extensive stromatolitic biome immediately landward of the Beck Spring sediments. Perhaps this was a newer patch of active stromatolite production just landward of this formerly active region. Mass flow avalanche deposits of Noonday dolomite and stromatolites gradually gave way to more laminar deposits as depositional energy dropped towards the end of Noonday sedimentation. As Flood waters rose and began their erosive effects on the continental shelf to the west [1: Fig. 4.12], clastic sediments poured through the breached continental margin, forming the sedimentary layers above the Noonday (the Johnnie, the Sterling, and Wood Canyon Formations). In basal Wood Canyon sediments Ediacaran organisms were deposited [15, 23]. Above them in correlative rocks, small shelly fossils were deposited [4] and by the time the middle Wood Canyon was deposited, trilobites were being buried. This sequence suggests that landward of the Crystal Spring/Beck Spring margin may have been a sequence of environments in the large continental shelf ‘lagoon’ – from the stromatolite-dominated hydrothermal biome, to one where the Ediacaran organisms lived, to one where the organisms lived which generated the small, shelly fossils, and finally to the trilobite-brachiopod-dominated waters farther to the east (see Figure 2).

Since other Vendian localities around the world have sediments similar to the Kingston Peak Formation of East Mojave (e.g. [5], [6]), [2] suggest that the Flood may have begun by the collapse of continental margins at a number of localities worldwide. Since the sequence of fossils is also similar (stromatolites to small shelly fossils to Ediacaran to ‘traditional’ Cambrian fossils), perhaps the reconstruction of the continental shelf from East Mojave and Grand Canyon is how the continental margin looked at many locations around the world. And, since many of the Ediacaran fossils are found in sandstones, many of the small shelly fossils are found in limestone, and many of the early Atdabanian fossils are deposited in shale, perhaps the sediment in these environments was sand, carbonate, and shale, respectively (see Figure 2). Finally, since many deep ocean creatures are large, flat, soft-bodied organisms such as the Ediacaran organisms are, perhaps the Ediacaran biota inhabited the deepest waters of this epicontinental lagoon (see Figure 2).

## CONCLUSION

Postulating a marginal hydrothermal biome for the pre-Flood continental shelf provides an explanation for both the nature of sediments and fossils around the world found near the initiation of the Flood in the sedimentary record. The Flood destroyed this biome. Most of the organisms which thrived in its protective structure (the Ediacaran organisms, the organisms which generated many of the shelly fossils, many of the stromatolites, and perhaps even the Paleozoic fauna of Sepkoski) could not re-establish themselves in the post-Flood world and became extinct. The few surviving taxa may have been preconditioned to survive in extreme conditions and are thus relegated in the present to relict localities (e.g. hot springs, shallow-water hypersaline, and occasional lacustrine conditions).

Although this hypothesis has some explanatory potential, much research and testing is still to be done. Among the East Mojave sediments themselves, there is still much reinterpretation of conventional research and perhaps modification of creationist theory which must be done to explain the data available. On a larger scale, the Uppermost Proterozoic sediments worldwide should a) be shallow-water shelf deposits transported into deep water by initial Flood activity; b) be underlain by or be near to hydrothermal sources; and c) have sedimentary structures, chemistry, and biology consistent with hydrothermal generation and/or influence.

Further study may also elucidate a) how many of these deposits were created rocks; b) how many of the deposits could have been produced by runoff from the continents (e.g. the clastics of the Crystal Spring Formation); c) how many of the deposits could have been produced by biological and geological activity before the Flood (e.g. the carbonates and stromatolitic textures of the Crystal Spring and Beck Spring Formations); and d) what role the pre-Flood weaknesses of the crust suggested by diabase intrusions played a part in where, when, and how rifting, faulting, and subduction occurred during the Flood.

## ACKNOWLEDGEMENTS

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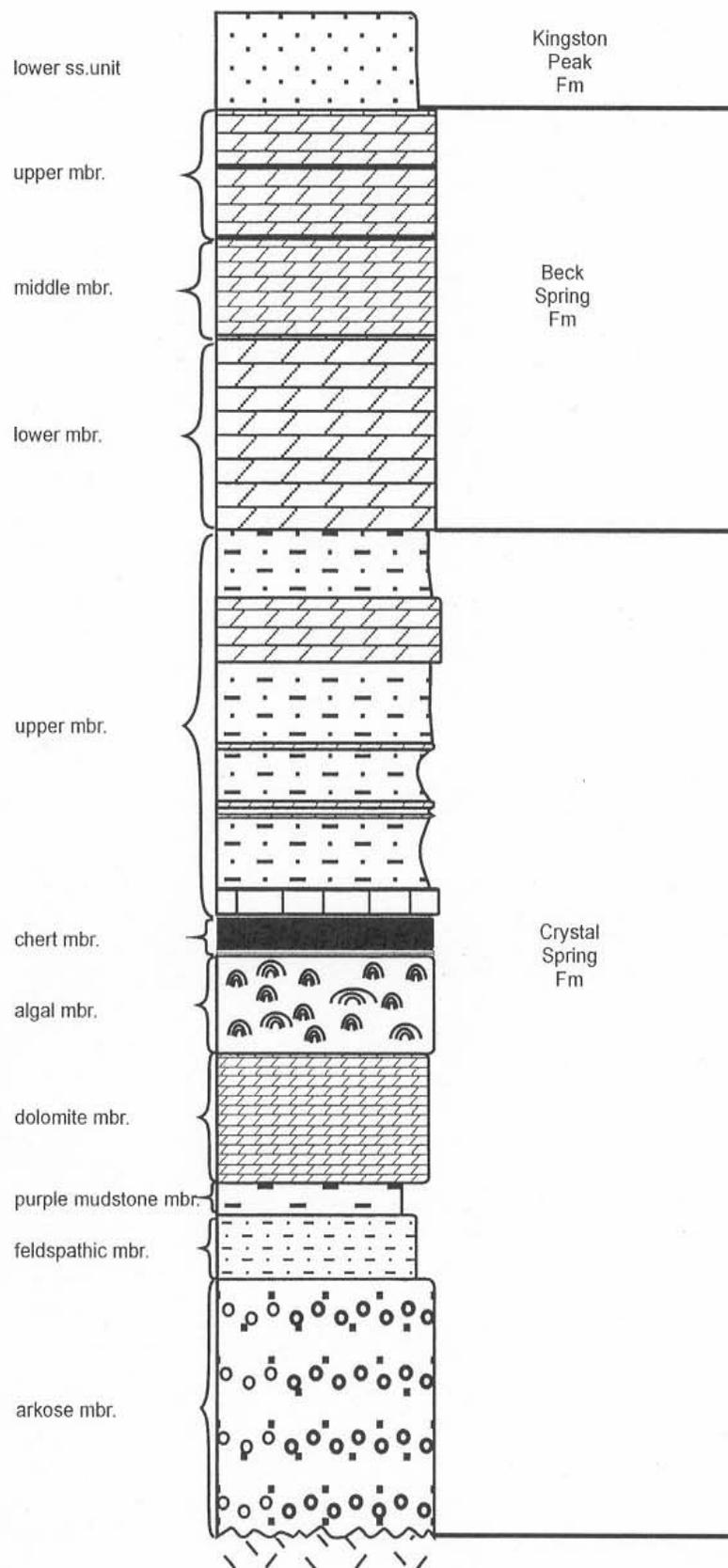
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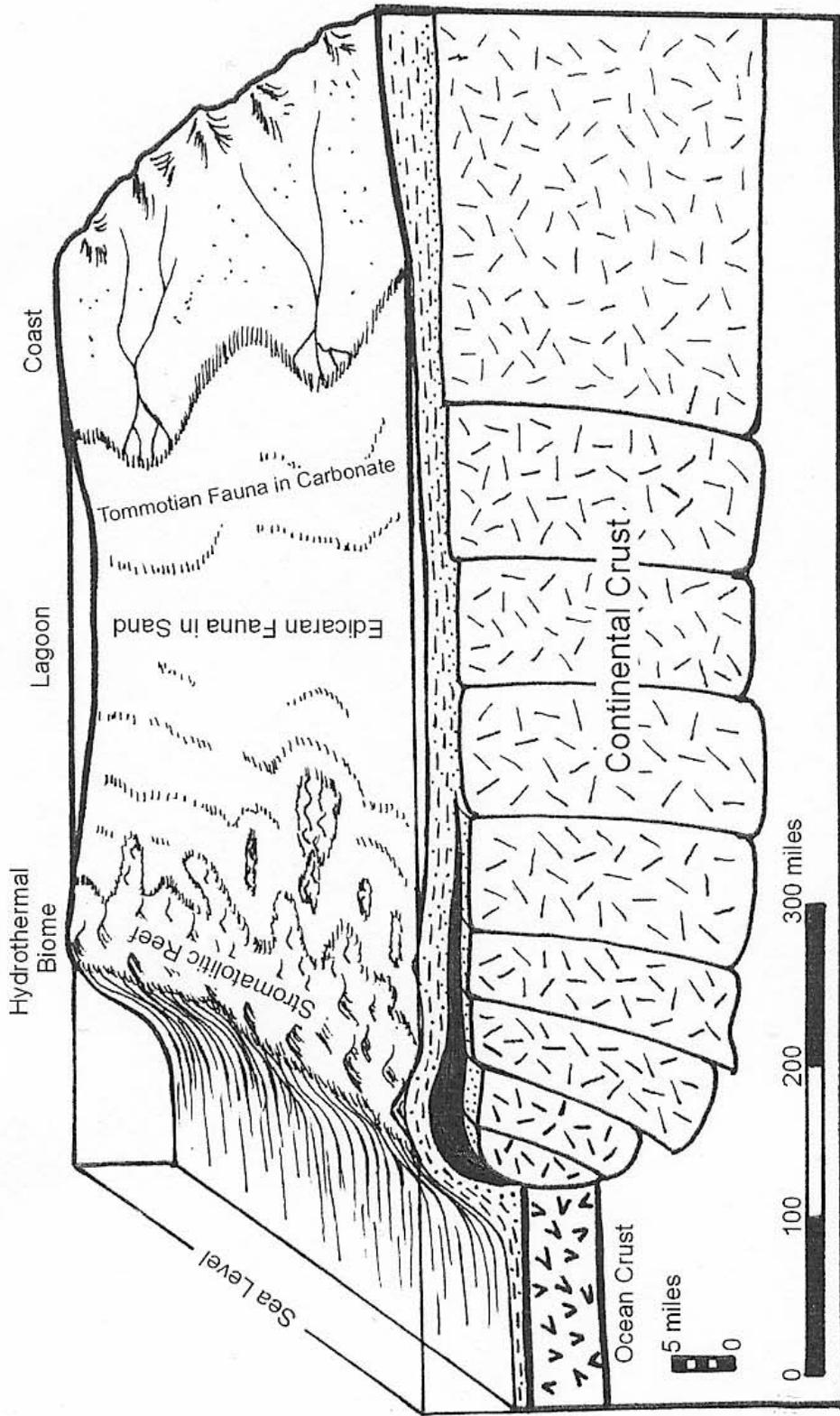
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**FIGURE 1: GENERALIZED STRATIGRAPHIC SECTION OF PRE-FLOOD SEDIMENTS FROM EAST MOJAVE.** Derived from personal observations plus stratigraphic descriptions in [50] for lower six members of the Crystal Spring Formation, [21] and [37] for upper member of the Crystal Spring Formation, [13] and [14] for the upper three members of the Beck Spring Formation, [35] for the basal member of the Beck Spring Formation, and [54] for the Kingston Peak Formation sediments. The diabase, which is generally found in the middle of the Crystal Spring Formation is not included in this section.



**FIGURE 2: RECONSTRUCTION OF HYDROTHERMAL BIOME IN WHAT IS NOW THE MOHAVE DESERT.** Viewed from the south, this diagram is modified from Figure 2 in [2]. The western (left) edge of the stromatolitic reef approximately corresponds to the current California/Nevada border and the coastline to the east (right) corresponds approximately to the Arizona/New Mexico border.