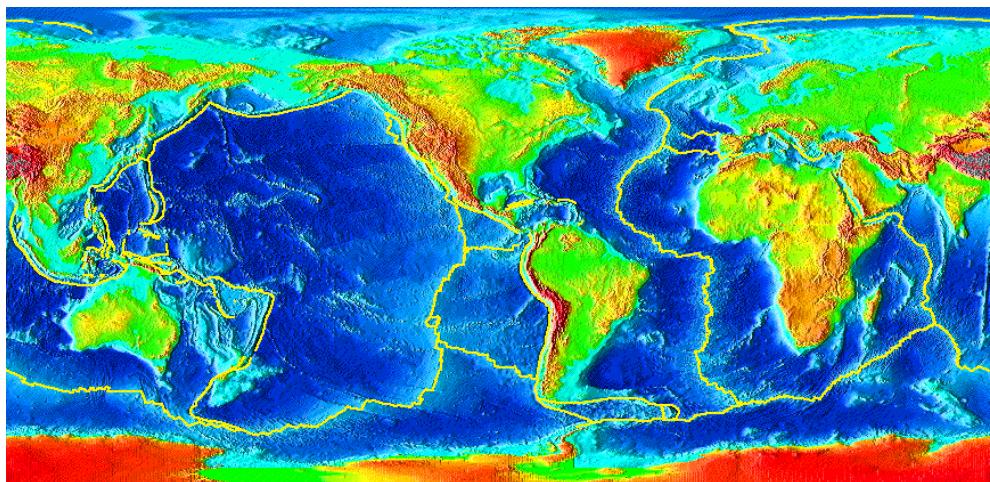


A Christian Physicist Examines Noah's Flood and Plate Tectonics

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Dedication

I dedicate this work to my friend and colleague Rodric White-Stevens, who delighted in discussing with me the geologic wonders of the Earth and their relevance to Biblical faith.

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Introduction

It seems that no subject stirs the passions of those intending to defend biblical truth more than Noah's Flood. It is perhaps the one biblical account that appears to conflict with modern science more than any other. Many aspiring Christian apologists have chosen to use this account as a litmus test of whether one accepts the Bible or modern science as true. Before we examine this together, let me clarify that I accept the account of Noah's Flood as completely true, just as I do the entirety of the Bible. The Bible demonstrates itself to be reliable and remarkably consistent, having numerous interesting participants in various stories through which is interwoven a continuous theme of God's plan for man's redemption. Noah's Flood is one of those stories, revealing to us both God's judgment of sin and God's over-riding grace and mercy. It remains a timeless account, for it has much to teach us about a God who never changes. It is one of the most popular Bible stories for children, and the truth be known, for us adults as well. It is rather unfortunate that many dismiss the account as mythical, simply because it seems to be at odds with a scientific view of the earth. I believe we have too easily jumped to conclusions that are not warranted.

Having placed myself squarely in the camp of biblical truth, I now confess that I do not reject modern science either. As a scientist who is very much concerned with truth, regardless of whether it is revealed by nature or the Bible, I find solid evidence that the geologic history determined by a careful study of the earth's rock layers is a valid and trustworthy account. It speaks of vast ages and reveals to us the processes that have shaped the landscape of our planet. One of the most fascinating of these processes is that of plate tectonic movement. The theory of plate tectonics is one that is shaped by an understanding of physical forces and principles, but also by the preponderance of observational evidence. What has this to do with Noah's Flood? Excellent question! The answer: nothing! So why do I discuss them both in one booklet? There has been much wild speculation on how Noah's Flood can account for features of the earth's landscape, thus mixing in biblical perspectives with scientific ones. But all of it has turned out to be neither very biblical nor scientific in the end.

I invite the reader to take a hard look with me at both of these topics, Noah's Flood and Plate Tectonics. I hope that some misconceptions can be cleared up and that when you read it, you will be able to reason along with me. If there are any weaknesses you find in these descriptions, I'll take full responsibility. But I won't apologize for writing on these when I'm neither a geologist nor a Hebrew scholar. I believe that a layperson should be able to see and understand the things that have become clear to me. I can't help but wish to share these things with you. I'm a teacher at heart and believe that knowledge and understanding were meant to be shared. No, you don't need a guru to tell you what to believe. I ask you to use your God-given mind and pursue knowledge and understanding on these matters. Let us settle for nothing but the truth, even when it isn't popular, and acknowledge the God who gives it.

Chapter 1

An Earthshaking Realization

Where would you look to find information about an internationally recognized person? You might find some useful information in the library, maybe even a biography on this person. Failing the latter, perhaps the best you can do is to find a highly reliable history book, which only refers to this person in a few passages in which the primary focus is someone else. You find a few tidbits of information in passing, but not much else about her life. That may not be very satisfying if you are really interested in learning more about this person such as when and where she was born, significant events in her life, places she has lived, etc. But then you make a startling discovery. This same person actually lives next door to you! Assuming she is willing to talk with you (and hasn't become senile), it only stands to reason that you will learn a whole lot more about her. You have a primary source right in front of you. The account of her life she gives you can be checked for self-consistency. And you may even be able to crosscheck her account with other reliable information. You stand to learn a lot!

The situation is actually not much different if we are interested in learning about this planet we inhabit. Some wish to infer the earth's history from accounts in the Bible [1]. The Bible is certainly much more than a reliable history book. But even so, a scientific record of the physical earth is not a primary focus of the Bible. We find occasional references to the earth in passages where the primary message is about something or someone else. In the final chapter we will discuss what the Bible has to say about the physical earth. But where do we go to learn about the earth in the meantime? Does the earth have something to tell us about itself? We can't really talk to it. Yet could it have recorded its history for us in some way and preserved its records? Then we should be able to learn about the earth from a primary source, if only we can learn to read such records.

Learning to “Read” Earth’s Records

From the lightning-like speeds of electrical storms to the extremely slow, gentle build-up of stalactites and stalagmites inside of caves, we see a vast scope of natural processes in time and space on Earth. The Earth can be examined on a microscopic level to reveal the activity of microbes and chemical reactions or it can be examined on a much larger level using modern satellite global positioning capabilities to reveal whether mountain ranges are rising or falling. By examining the wide range of activity on Earth we come to appreciate how dynamic the Earth really is, from the smallest measurable levels in space and time up to vastly immense distances encompassing the Earth and vast time periods stretching back to its very beginning. Although the Earth is dynamic and even turbulent in many ways, much of its history of activity has been recorded for us. If we are interested in activity during the last few years or decades we may examine the condition of the soil and vegetation, the condition and thickness of tree rings, the top layers of sediments laid down in rivers and streams, among many other records. Such investigations can reveal recent trends in the weather, the activity of creatures, even longer-term changes in the climate, or significant impacting events such as recent forest fires or floods.

If we are interested in much earlier history we need to look at more durable and long-lasting indicators such as rocks and sediments buried much deeper, laid down ages ago, or perhaps in the climatic record stored within the several thousand feet thick ice layer in Antarctica. We may

be fortunate, and erosion has uncovered some ancient records for us, as is the case of the Grand Canyon. Or we can be equally fortunate if the climate conditions were such as to preserve the ancient records from weathering and erosion, which may be true in old caves or extremely arid or frozen regions. But even if weathering and erosion has erased past records of activity, we can learn something from these processes as well in our attempt to understand this dynamic planet we live on. In each case we must learn to correctly read the exposed records in order to discover details about the past activities on Earth. Although that is the job of a geologist, even a non-specialist can learn many of the basic principles that permit a glimpse into the Earth's past. A natural curiosity of the Earth's past arises within each of us, a desire to know what has transpired during the ages before us. This should motivate us to learn the basic principles, which serve as keys to unlock the secrets of the ancient passages recorded all around us.

Learning to decipher this recorded history will involve understanding the chemical and physical processes at work, and how their record is etched into the various enduring "books" of the Earth. We find it is possible to learn how the Earth has been radically changing, such as when regions of the North American continent were earlier submerged under an ocean, whereas massive glaciers repeatedly covered northern regions during Ice Ages. Our understanding of the ocean floor has been dramatically changed by 20th century discoveries. Careful examination of many such indicators allows us to piece together a history of the planet Earth. Some amazing concepts have emerged in the last few decades, which now shed light on how much of this history can be understood. One of the most important of these concepts is how the crust of the Earth is divided into many sections or plates, which move in response to forces arising from the deep interior of the Earth. This concept is called the theory of plate tectonics. This theory provides a good explanation for why the continents are slowly gliding across the face of the Earth, as well as why volcanoes and earthquakes are located predominantly along certain lines or faults rather than just anywhere. Many other observations both in the ocean and on the continents can be understood from this concept. It represents a tremendous advance in scientific knowledge.

Reaction of Christian Community

What has been the reaction of the Christian community? It seems that this doesn't yet fit well into the worldview of most Christians. One of the biggest difficulties of plate tectonics for such Christians is that it involves vast ages in shaping the surface features of the Earth we see today. The reluctance of the Christian community to come to grips with an approximately 4.6 billion year old Earth is the topic of a similar booklet, *A Christian Physicist Examines the Age of the Earth* [2]. Unfortunately, this resistance has a far-reaching impact. This unwillingness to "read" the remarkable history of planet Earth, of the solar system, and of the universe, has prevented many Christians from recognizing God's incredible design "written" into the physical realm around us. Since much of the design involves processes stretching out over long periods of time, avoiding all but the last 6000 years of history requires discarding 99.99987 % of the evidences for His handiwork here on Earth, and even more of His handiwork in the heavens. Meanwhile, the very same record of how this remarkable planet has formed and changed through the ages to become the "oasis" of the universe is bringing many who are willing to read it, to the "earthshaking realization" that there must be a God who meticulously designed it all.

Our technological capabilities have allowed scientists working on "the cutting edge" of research to piece together the inner workings of planet Earth with increasing clarity. This is no small feat, considering that we have been able to drill only a few miles into the Earth's crust, whereas the

center of the Earth is nearly 4000 miles deep. We have developed many instruments to help us “see” into the Earth’s interior. But before we discuss these findings, let us examine our perspective on what we are studying. The importance of contributions to our knowledge of physical science is being recognized throughout the world. Indeed scientific research has become increasingly international, as various nations lend their expertise in collaborative efforts. The whole world is learning to understand the language of modern science, since it is universally recognized as a successful means of discovering truth. Nearly every school, college, and university requires the study of natural science for all students. It has become an indispensable body of knowledge that enables us to understand the physical realm.

But those who hold Christian beliefs have shown widely varying reactions to modern science. The confidence placed in science by the world at large is seen by many Christians to be a kind of religion, the religion of scientism. Scientism holds the belief that ultimately all important questions can be answered through science. Indeed there does appear to be a widespread attitude among various intellectuals that modern science renders the Christian worldview obsolete. For such individuals the general consensus is that Galileo proved the Church wrong and that suffices to prove the entire Christian faith wrong. If one is truly bent on discrediting the Christian faith, one can always pull out the “ace” card and appeal to the crusades of the Middle Ages as the end product of too much Christianity. But this attitude actually hinders such individuals from recognizing the message being given to us by modern science, which is revealing to us a physical universe full of symmetries and precision balance, as well as an earth with remarkable life-supporting features. Science has revealed to us much that it cannot fully explain. Intellectuals who reject Christianity on the basis of science have not been heeding the evidence. Likewise, the Christian who reacts with the unfounded fear that science itself is striking at the foundations of the Christian faith, also fails to see the message being given to us by modern science. How ironic it is that both ends of the spectrum with regards to the Christian faith are failing to heed what modern science is revealing to us!

Displacing the Earth, not Christianity

Certainly the understanding of the physical realm held by the Vatican leadership of the Roman Catholic Church in Galileo’s day was incorrect. Their insistence that the Earth must be at the center of the universe was based on the widespread influence of Aristotle’s teachings and on demanding a literal interpretation of Scripture passages such as Psalm 104:4, “He established the earth upon its foundations, so that it will not totter forever and ever.” Rather than examining the evidence through the lenses of Galileo’s telescope, they insisted that they already had the truth as given by Scripture. And they refused to entertain the idea that their interpretation of Scripture could be flawed. They considered the issue to be a question of authority, to which Galileo was not properly submitting himself. To this very day, the mistake made by the Church in forcing Galileo to recant his views serves as a barrier to the Christian faith in the minds of many intellectuals. The 1992 reversal of the Roman Catholic position by Pope John Paul II to admit failure in this regard is admirable [3] yet does little to change the general consensus that the Church and modern science remain at odds.

But displacing the earth from the center of the universe and proving Church doctrine wrong does not invalidate the Christian faith any more than some examples of poor scientific measurements serve to invalidate science. We often see politicians using one or two bad examples to discredit opponents, but if we desire to know the truth then we won’t make sweeping conclusions based

on such limited data. Unfortunately, there will always be examples of poor judgment by professing Christians, just as there will always be mistakes made by practicing scientists. The former does not render the Christian faith “false” just as the latter cannot render science a “flawed” pursuit of truth. It is easy to understand why an outsider would be turned off by such behavior. Nevertheless, in an honest search for truth we must look at the foundational basis of each and examine the credibility of the claims before rendering judgment.

Truth revealed by nature also reveals God

Truth revealed to us by the Bible and truth revealed to us via the scientific method share some important characteristics. Both can be carefully examined for their foundational basis and the credibility of the evidence supporting each. We find that both stand up to a close and careful examination. Neither requires a blind faith approach. But if Christians are expecting the world to pay attention to the message of Christianity, we must not be hypocritical. Now more than ever before is it important for us to pay attention to the “voice” of the physical realm we live in. The physical realm has always provided one of the strongest witnesses for the Christian faith, as indicated by Paul in his letter to the Romans, “because that which is known about God is evident within them; for God made it evident to them. For since the creation of the world His invisible attributes, His eternal power and divine nature have been clearly seen, being understood through what has been made, so that they are without excuse.” We see that Paul did not view truth as revealed to us by the physical realm as a threat to the Christian faith. Rather he saw the physical realm providing an intrinsic witness for the existence and nature of God.

Even more compelling reasons exist today for us to recognize the witness of the physical realm. Our growing knowledge of it has allowed a deeper insight into the principles and laws governing it, as well as providing us an account of the physical history of our planet and universe. Through these investigations a remarkable story has emerged, one that can only be described as a miraculous sequence of events unfolding to prepare a world capable of supporting human life. This incredible planet exhibits a number of processes, making it unique certainly to this solar system and perhaps unique among planets in general. Plate tectonics is only one of these processes, but it is a very important one, as we shall examine. For the person studying this for first time, these discoveries have a profound influence, one that I call an “earthshaking realization” about this planet we live on. It also has something profound to tell us about what lengths God is willing to go to in his detailed care for us.

Physical History according to the Bible

Of course, a Christian attempting to digest this knowledge also faces the challenge of seeing how it fits with his or her understanding of the Bible. Christians recognize the enduring value of God’s Word as pointed out by the prophet Isaiah, “The grass withers, the flower fades, but the Word of our God stands forever.” Thus it is clear to see how science, which represents the attempts of man to understand the physical realm, would be viewed as a less reliable source of truth and knowledge. So in an attempt to understand the physical history of earth, one may first look to the Scriptures for guidance. But as mentioned previously, the Bible does not give us much direct information on the physical history of the Earth.

The passages in the Bible referring to the physical earth include the creation account in Genesis, the flood of Noah, various depictions in the poetry books of the Bible, and occasional brief

references in the prophets and New Testament books. It is clear that none of these passages was written primarily to teach us something about the physical history of the earth. In each passage the central message is something far more important and valuable to us than this. Yet what the Bible does describe should be true of the physical earth, if indeed the Bible is the inspired Word of God, without error. The passage that appears to have garnered much attention in recent years is the account of Noah's flood. Since this has been pointed out as an example from the Bible that conflicts with the commonly accepted geological history of the earth, we need to give some detailed attention to this passage.

Hebrew scholars appear divided on how to interpret the historical account of Noah's flood as given in Genesis 6-8. We recognize that the first 11 chapters of Genesis differ sharply from the remainder of Genesis, beginning with Abraham and the age of recorded history. Oral traditions were passed down many centuries prior to the development of written language. However, the premise that these traditions are rooted in historical fact is supported by the parallel accounts recorded by the Sumerians and Accadians, which differ in names, various details of the accounts, and most importantly in the manner of divine involvement [4,5]. Yet the accounts, particularly of the flood, are remarkably similar, leaving no doubt as to their common origin. The questions regarding the flood are many. Was the flood global or local? Where did the ark end up? Where did the water come from and disappear to? These are the kinds of questions we are curious about in our modern scientific age. But alas, the answers to these questions are not entirely clear from the Scripture text. Rather we must accept that the account was given for readers of all ages, and that priority is given to the relationship of God to man rather than questions concerning the physical earth. Nonetheless, that has not deterred people from focusing on these questions.

“Flood Geology”

In an attempt to explain the vast layers of rock sediments, fossils, and various features of the earth's surface, an entire field of “flood geology” has been popularized in the Christian church by proponents such as Henry Morris with his book *The Genesis Flood* [6]. The main thrust of this movement is to discredit the commonly accepted geologic ages and explanations for the earth's features, while promoting “catastrophism” with special emphasis on a recent global flood as a means of explaining the same features. Flood geology is strongly linked with the “Creation Science” movement, which holds that there is scientific support for a 6000-year old earth. Does this approach represent a breakthrough in understanding the earth, or is it simply an attempt to attribute everything with an older appearance to effects of the flood? Is it driven by a desire to understand the physical earth, or by a need to promote a particular understanding of Scripture? We need to ask ourselves these questions if we are honestly concerned about the truth. I believe that if we are honest, we will conclude that “flood geology” is driven by a rigid understanding of Scripture, and has very little basis in science. Furthermore, if the only true basis for claims concerning the physical earth is from interpreting Scripture, the claims become further suspect if the interpretations are questionable. Appealing to the inerrancy of God's Holy Word does not lend substance to claims based on highly questionable science and biblical scholarship.

An honest appraisal of the physical evidence we see on earth reveals no evidence for a global flood in the last 10,000 years. A broad range of evidences attest to this, revealed through the record of sediment and rock layers, the life forms unique to certain regions, the fossil records, and the ongoing processes of mountain building and erosion. A recent flood could not have laid down the vast layers of sediments we see exposed in the Grand Canyon and many other places.

The nearly one mile thick layer seen in the Grand Canyon speaks of vast ages of sedimentation and the changing record of life on Earth. The tenacious cutting action of the Colorado River has since then carved out multiple distinct layers of sediments, including time hardened metamorphic rock, exposing the still older schist below. Many ecosystems throughout the earth reveal strong evidence of having been isolated for much longer than 10,000 years, by the uniqueness of life forms and the extensive fossil records. Various mountain ranges such as the Appalachians reveal extensive weathering and erosion indicative of much older ages whereas sharp craggy mountains still being formed in the Andes and the Himalayas do not. But none reveal any evidence of recent flood deposits, as we shall discuss further in chapter 3. So what of Noah's flood? Is there any real scientific support for it? There is actually.

There are some interesting discoveries that pinpoint potentially catastrophic floods in the Middle East within the last 10,000 years. The well-known excavations made by C.L. Woolley during 1929-30 in the region of the Euphrates River revealed possible widespread flood deposits dated to around 3000 B.C. [7]. Later findings questioned the actual extent of the flood and its date, but it is clear that massive floods did occur in the basin of the Tigris and Euphrates Rivers of present day Iraq, much greater than the annual spring flooding seen today. A much different scenario has been given by recent evidence that the Black Sea was at one time much smaller, until water from the Mediterranean Sea broke through the Bosphorus Strait, inundating the coastal areas, nearly doubling the size of the Sea and raising its level by 350 ft. This was determined to have occurred suddenly about 7600 years ago, wiping out coastal communities and dispersing various people groups [5]. These floods may be the historical source of numerous flood stories passed down the generations in people groups scattered about Europe and the Middle East. Neither represents a global flood, yet each one may have been a flood inundating the known world from the perspective of someone who experienced it.

But none of these findings satisfies the one who insists that Noah's flood was a worldwide flood. In the last chapter we will examine the account of Noah's flood in more detail. Although there is good evidence from the Bible itself that the flood was local in extent, many believers remain firmly convinced that the Bible clearly specifies a global flood. And since the scientific community does not recognize any scientific support for a worldwide flood in recent geologic history (and certainly not for as long as man has existed on earth), such Bible readers are bound to reject any other claims concerning the geologic history of the earth. Here we find the more in depth reason for the cool reaction of the Christian community to Plate Tectonic theory. Unless it accommodates a recent global flood, it is not acceptable.

Noah's flood represents an event within the last several thousand years, whereas Plate Tectonic theory describes a slow geologic process at work in the earth over much vaster ages. In this respect there isn't much commonality between them. Attempts by "creation scientists" to connect them [8] have only served to confuse the scientific layperson. We shall see that there is strong evidence that Plate Tectonic movement has been a slow, gradual process for millions of years. Indeed there is a wealth of scientific evidence supporting Plate Tectonic Theory, as we shall examine in the next chapter. This is one aspect that makes it a scientific theory. Its rise to prominence in science is very similar to the rise of the Big Bang Theory. Both were considered highly speculative until the accumulation of observational evidences became too great to ignore. The other important aspect of a scientific theory is that it should be understandable on the basis of well-established scientific principles, yielding plausible mechanisms to explain the observational evidence. In both respects the theory of Plate Tectonics represents good science.

But the evidence for Noah's flood, of its extent and impact on the earth, is still uncertain. What is certain is that there is no credible physical evidence for a recent global flood. None of the supporting evidences proposed by "creation scientists" are true evidences of a global catastrophe. It is long overdue for advocates of "flood geology" to admit that the only basis for claiming a recent global flood is their understanding of Scripture, certainly not the scientific evidence. And appealing to repeated miracles to erase the evidence of a global flood is neither reasonable nor scriptural. The God of the Bible is not a deceptive God. Rather, He has left us not only a scriptural record of the past, but also a trustworthy physical record of the past. It can be shown that these records do not conflict with one another. And this brings us to a very important issue.

Problems using Scripture to understand the Earth

The question that concerns a believer in the truth of the Bible, is whether a correct understanding of the geological records actually agrees with or conflicts with biblical accounts. If they are perceived as being in conflict, then one will inevitably be rejected. Tragically, that has been happening to a great extent in the Christian churches of North America. Far too often it is presumed that modern geology is merely construed to serve as support for Darwinism. Far too seldom is consideration given to the possibility that our understanding of the Scriptural accounts is unclear. It is rather silly to accuse scientists of erring in their interpretation of the physical evidence, yet never give thought to the fact that piecing together a physical history of the earth from the Bible requires some interpretation, and even some speculation on our part. This is precisely where some reason and humility are needed. If we are willing to look carefully at some of these interpretations, I believe that we will find that accepting modern geology does not require compromising the validity of Scripture.

It is well that we consider the same questions God asked of Job. God asked him,

Where were you when I laid the foundation of the earth? Tell Me, if you have understanding, who set its measurements, since you know? Or who stretched the line on it? On what were its bases sunk? Or who laid its cornerstone?...Have you understood the expanse of the earth? Tell Me, if you know all this [Job 38:4-6,18].

It is clear from God's questions that Job did not have all the answers. And neither do we. Nor does Scripture give us the answers to all of these questions. While Scripture does inform us of who the Creator is and His relationship to man, the secrets to how God created the heavens and the earth are not included. We should be careful to distinguish between what is clear from the Scriptures and what is not. Trying to piece together a physical history of the earth from Scripture is fraught with difficulties. If a physical history of the earth interests us, let us investigate the earth itself for answers. Although it may be difficult to extract answers in this way, at least there is a primary record left behind for us to investigate. And it is sitting right next to us. Let us explore what the earth has to say about itself.

Chapter 2

Evidence for Plate Tectonic Movement

I can still remember quite well having to teach my first course in physical science. As an experimental physicist, I felt quite comfortable teaching physics and astronomy. But I was expected to teach earth science as part of the course. This part was quite unfamiliar to me. I began to study it in earnest, hoping to at least digest it well enough that my complete lack of experience with it wouldn't be immediately obvious to my students. In all honesty, I thought that this would be the least interesting part of the course. After all, how interesting can rocks be?

When my chemist colleague found me in the lab studying geology he sat down and asked me if I needed any help. I'm not too proud to admit it when I don't know much about a subject, and being a teacher means that I love learning...when the subject appears interesting. I think he realized my situation without a full explanation. He proceeded to describe the fascinating story of how we finally determined that the continents were drifting apart and by bringing many different fields of research together we arrived at a plausible explanation for the continental drift. Amazingly, it can be understood on the basis of sound physics principles. I was completely engulfed during this tutorial session. Suddenly, geology wasn't about dry classifications of rocks. Revolutionary new concepts were emerging from this field using the same physics principles I valued and taught. It made beautiful sense and the evidence was very convincing. Now my students must endure my unbridled enthusiasm when I describe these things in my physical science course. I hope you find this story as fascinating as I do.

Early Speculations on Continental Drift

The Austrian meteorologist Alfred Wegener was the first person to promote the idea that the continents are drifting [9]. But in 1912, the evidence to support it was inconclusive. The strongest evidence at that time was the simple fact the continents appear to fit together like giant pieces of a global jigsaw puzzle. He called this supercontinent "Pangaea", meaning "all lands". While this was very suggestive, the very notion of something as large as a continent moving over the surface of the earth appeared absurd. In the absence of plausible mechanisms, more convincing evidence was required before an idea of this magnitude could be accepted. There did exist some, but their importance would be recognized only much later. These include matching ore belts and rock formations found in North and South America corresponding to ore belts and rock formations on the coast of Europe and Africa. In other words, if North and South America are physically brought together like a jigsaw puzzle piece until they lay next to Europe and Africa, we find several belts of ore, rock types, and even fossil beds that seem to be continuous across the continents. Even the older fossils in the separate continents bear stronger resemblance to one another than many indigenous life forms do today. Also, explorers of Antarctica found coal and fossil remains, suggesting a much warmer climate in an earlier period. Yet these evidences remained insufficient to convince the scientific community that the continents could be drifting across the surface of the earth.

Meanwhile, it was speculated that the ocean floor was a rather bland depression in the earth containing some of the oldest rocks on earth since it was believed to be protected from much of the weathering and erosion processes constantly at work on land. The question facing Wegener was how could entire continents glide over such an ocean floor? His suggestion that the

continents are like rafts floating about was rejected, since the enormous weight of the continents should cause them to sink somewhat into the harder rock below it, preventing any such movement. Sadly, Wegener died during an arctic expedition in Greenland in 1930 while trying to find further evidence for continental drift. Aside from a few daring scientists, the idea of continental drift remained obscure and unaccepted for nearly two decades, awaiting further technological advances, which would permit the investigation of the ocean floor.

Discoveries with Sonar

World War II stimulated a period of unparalleled growth in technological advances designed to give an advantage in the struggle for freedom as most of Europe lay under the shadow of Nazi dominance. In this period, tremendous advances would be made in both jet and rocket engine development, atomic bomb assembly, communications, guidance systems, and radar and sonar technology. Sonar was developed in response to the ominous threat of German submarines, which were sinking an alarmingly high rate of allied ship transports. The hard hulls of the German submarines would easily reflect the sound waves transmitted across large distances. Geologist Harry Hess, also Navy captain of the assault transport Cape Johnson in the Pacific theatre, recognized the value of sonar beyond locating German submarines. A sufficiently strong sonar could be used to map out the completely unknown terrain of the ocean floor. At the completion of World War II, Harry Hess returned to geology research, utilizing the new sonar technology to study the Atlantic Ocean floor.

The biggest surprise in store for Hess was the discovery of a long mountain range running straight down the middle of the Atlantic Ocean, roughly parallel to the coastal features of North and South America and Europe and Africa. Named the Mid-Atlantic Ridge, at over 40,000 miles long it is easily the world's longest continuous mountain range. This dispelled the notion that the ocean floor is a bland empty basin in the earth. Further mountain ranges were soon discovered on the ocean floor all over the world. One interesting chain of undersea mountains, called seamounts, was found to stretch from the Hawaiian Islands to the coast of Siberia in the northern Pacific. Deep trenches were eventually discovered near the continental shores, including the seven-mile deep Marianas Trench, south of Japan. Most importantly, mapping the topography of the ocean floor stimulated further research into the geology of the ocean floor. Independently, Harry Hess and Robert S. Dietz of the U.S. Coast and Geodetic Survey proposed a new theory of continental drift based on a spreading ocean floor [10]. Convection currents from deep within the mantle were responsible for rising magma, continuously forming new rock along ridges and thereby forcing the entire ocean floor to spread outward. But Hess relegated his theory to "geopoetry", far from being confirmed by hard supporting evidence. He could not imagine how quickly that would change.

Magnetic Polarization of Ocean Rocks

The Mid-Atlantic Ridge in particular revealed some intriguing clues to its very nature. In the 1950's sensitive magnetometers were developed to measure the magnetism of the ocean floor rocks. When basaltic rock is first formed, even while still cooling from a molten state, any iron in the rock responds to the magnetic field of the earth. Upon cooling below the Curie point temperature, the rock is solidified with a net magnetic alignment along the earth's magnetic field. If the orientation of the rock is undisturbed and reheating above the Curie point is avoided, then it preserves a record of the magnetic field of the earth at the date the rock solidified. When

measurements were made of the rocks near the Mid-Atlantic Ridge it was found that a strip of ocean floor within a few miles and continuous parallel to the Ridge, was aligned with the present North geomagnetic pole, as expected. Beyond this narrow strip on both sides of the Ridge lay parallel strips of ocean floor magnetized in the opposite direction, that of the present South geomagnetic pole. This alternating pattern continues outward from the Ridge, forming “zebra stripes”. Such “zebra stripes” are found in all of the ocean floor basins around the Earth.

Meanwhile, Allan Cox, Brent Dalrymple and Richard Doell of the U.S. Geological Survey were pursuing an explanation for the alternating pattern of rock magnetism in the igneous rock layers of the Sierra Nevada and similar volcanic regions on earth. These basalt layers were laid down during successive periods of volcanic activity. They also found that the rocks’ magnetization exhibited either a North or South orientation. It was clear that geologic activity could not explain a physical reorientation of the rocks. By dating the rocks via radiometric means, they discovered that the rock polarization correlated to when the rocks solidified. On the basis of their observations they concluded boldly that the Earth’s magnetic field reversed its polarity 9 times in the last 4 million years [11]. In other words, the present magnetic North pole, which actually lies near the geographic South pole, was once located near the North geographic pole and visa versa. Such reversals of the Earth’s magnetic field polarization are difficult to comprehend, since the earth’s magnetic field is attributed to the motion of liquid iron deep under the earth’s thick mantle, in the earth’s core. But the evidence for reversals is unquestionably rock solid. This sequence of field reversals has been recorded in basalt rock formations on different continents and on the ocean floor, providing an invaluable record of the earth’s past, still accessible to us today.

When Cox, Dalrymple and Doell compared their results with the “zebra stripes” data for the ocean floor surrounding the Mid-Atlantic Ridge, they confirmed what Harry Hess and Robert Dietz had previously proposed. New rock is continuously forming at the Ridge, while the older rock is pushed outward. Further confirmation came from directly measuring the ocean floor rock layers. Seismic measurements indicated only a thin layer of sediments, typically 300m to 600 m thick [12]. Rock samples were also brought up from the ocean floor near the Ridge. Young igneous rock was found, with virtually no sediment. These findings were quite a surprise to geologists who favored an ancient ocean basin, in which a several kilometer thick layer of sediment was expected. The obvious conclusion was that the ocean floor is much younger than the continental crust! Furthermore, the spreading oceanic rock must be forcing the continental crust to drift outward away from the Ridge as well. Supporting this was the discovery that the precise magnetic pole locations as given by older rocks on different continents in the Americas and Europe match only if the continents are brought slowly back together. We can trace the history of the continental drift by using the rocks. Amazingly, Wegener’s wild idea of continental drift was suddenly finding hard scientific support, but not in the way he envisioned.

The emerging scenario was that the continents are simply the lighter crust of the Earth, riding on top of a denser and thicker layer of rock underlying both the oceans and the continents, all of which is being driven along the surface from convection forces in the deeper interior of the Earth. Still, much remained to be understood. If scientists found Wegener’s idea of “floating continents” preposterous, how could they possibly accept that an even thicker layer of rock was drifting over the surface of the Earth? And if new crust is being formed in some places, shouldn’t it be disappearing in other places? And what is the source of the convective forces in

the deep interior of the Earth, which drive the continental drift? Answers would come from widely different areas of research.

Earthquakes and Volcanoes

Drilling into the earth has allowed us to examine only a few miles beneath the earth's surface. How can we know what goes on deeper than that? It turns out that it isn't necessary to reach the earth's interior with a drill bit, since other things travel through the earth much more readily. The primary investigative tool is the motion of seismic waves produced by earthquakes. These can travel through the crust, through the thick mantle, and in some cases through the earth's core, bringing us information about the earth along with it. The main idea is that the wavefronts of seismic waves get bent or refracted when the medium through which it travels changes. This idea can be visualized by looking through the lens of a pair of glasses, when held at arms-length, at a more distant object. Note how the image in the lens differs from looking directly at the object. Glasses of a nearsighted person reveal an upright image, somewhat smaller and closer than the actual object viewed. Glasses of a farsighted person reveal an inverted image. The wavefront of the light is shaped by the medium of the lens it passes through. Likewise the wavefronts of seismic waves are shaped by the layers of materials in the earth. Utilizing several different seismic wave detection sites, we can locate the epicenter of an earthquake, and even infer properties of the layers of earth the seismic waves have traveled through.

We find that there are discontinuities in the earth at certain depths, implying changes in the rock material or in the rock properties. The most important discontinuity for plate tectonic movement turns out to be a gradual one in the upper part of the mantle, from 30 to 60 miles below the surface of the earth's crust. The part of the mantle above this level is called the lithosphere, which is predominantly a hard, rigid rock layer. One misconception frequently encountered in the study of geology has to do with the nature of rocks. We tend to think of rocks as being completely rigid, unyielding to stresses and pressures. However, rocks do bend, deform, and can even "flow", depending on the extreme pressures acting on them. For example, we occasionally see folds in the earth's crust in exposed layers of sediment. These layers were probably formed as straight, horizontal layers, but yielded to folding stresses over time. Viscosity is a measure of how resistant a rock layer is to such distortions. It is now known that a layer of rock directly underneath the lithosphere, called the aesthenosphere, has a relatively low viscosity compared to the rest of the mantle. The extremely high temperatures (1400°C) and composition in this part of the mantle results in a plastic-like property of the rock, allowing the rigid lithosphere above it to slide over the rigid inner mantle below it. This is the basis for plate tectonic theory. Indeed, the word *tectonic* comes from a combination of the Greek words *tec* (melt) and *ton* (stretch) [13], alluding to the deformation of rock under the intense pressures and temperatures in the Earth's interior. Here is an essential mechanism Wegener had lacked in his theory of continental drift.

But if molten rock is rising to the surface along a ridge spreading center, then somewhere else the rock must be sinking back down into the interior. Here is where the study of earthquakes and volcanoes has yielded valuable information. We find that the locations of twentieth century earthquake epicenters and volcanic activity appear to trace out lines along the surface of the earth, such as the famous Pacific ring of fire. Along these lines there is good evidence that separate sections or plates of the lithosphere are colliding, forcing rock back down into the interior. These intersections are called subduction zones, since rock is being subducted back into the interior of the earth, completing a slow but steady rock cycle. The rate of rock subduction

appears to be equal to the rate of new rock formation at plate ridges, thus maintaining an equilibrium layer of lithosphere. In places where continental crust lies above the subduction zone, rather than being forced into the earth's interior, the lighter rock is buckled upward, forming long mountain chains along the intersection. This is the mountain building mechanism on earth, the collision of plates. Particularly revealing is the observation of volcanic activity along these lines. As we shall soon discuss, this volcanic activity is the source of continent formation, which is proceeding at a rate slightly in excess of the rate in which the continental land mass is being lost through erosion back into the oceans.

All of this has given us strong evidence that the earth's crust is divided into several plates, each intersection being a ridge of new rock formation, or a subduction zone where rock is forced beneath the earth's surface, or a fault line along which plates are sliding by each other. A well-known example of the latter is the San Andreas Fault, running down the length of California, separating the North American Plate from the Pacific Plate. Here, the earthquake activity arises from the friction encountered by the two plates grinding along side each other, the Pacific Plate moving northward relative to the North American Plate, opening the Gulf of California in its wake. The fact that earthquakes and volcanoes occur predominantly along these intersections strongly supports the premise that the earth's crust is divided into sections of the lithosphere, now referred to as plates. The movement of the plates over the plastic-like aesthenosphere layer drags the lighter continental crust on top along for the ride. In other words, the continents are not moving with respect to the denser plates beneath. Rather, the entire 50-mile thick plates sitting above the aesthenosphere layer are slowly moving. The mechanism of continental drift is now well established.

Further support for continental drift has been obtained using highly accurate laser reflections off of the Moon. Such measurements reveal that North America is gliding away from Europe at the rate of 2 centimeters per year. Since the record of rock magnetism shows this to be a steady movement over many millions of years, we can estimate when the continents first broke apart from the supercontinent Pangaea. Approximately 200 million years ago Pangaea broke apart, being driven by the convective action along the Mid-Atlantic Ridge. North and South America have been drifting westward while Europe and Africa are still drifting eastward. Utilizing Global Satellite Positioning (GPS), this has been measured even more accurately, confirming a present continental drift of 2.5 centimeters per year and even larger drift rates up to 15 centimeters per year in the Pacific Ocean [14]. Such drift rates are comparable to the rate of human hair growth.

Convection

One remaining key to understanding the process of plate tectonic movement is an explanation for the driving forces from deep in the earth's interior. This is more difficult to measure, being hidden far beneath the earth's surface and acting extremely slow. However, convective action is observed to take place on a much more dramatic scale on larger planets and on the surface of the Sun itself. All of these bodies reveal convective motion whereby heat generated in their interiors is brought up to the surface, where radiation allows it to escape. While the tremendous source of heat in the Sun is primarily from nuclear fusion of Hydrogen into Helium, the milder source of heat in planets is from gravitational pressures and the decay of radioactive elements. From studying the convective action in larger planets and the Sun, we can better understand the convective action occurring on earth.

Upon looking closely at detailed images of the Sun's surface using visible light, we see a granularity of bright spots ringed with dark borders. Studying the development of these granules over time reveals that these granules grow from a small bright spot into a larger one, gradually fading back into a smaller one until disappearing. The explanation for this behavior is that heated plasma is rising from the Sun's interior via convective cells, following a looping trajectory whereby hot regions expand and rise in large plumes like a spewing volcano while radiating bright visible light, then falling back into the interior to be reheated. Convective action is the primary means of the Sun's heat transport throughout the outer 200,000 km of the solar interior to the visible surface. The temperature of the Sun's core, approximately 15 million degrees Kelvin, allows the process of nuclear fusion to take place, producing an outward pressure strong enough to prevent gravity from collapsing the Sun any further. This is transported outward from the Sun's core via highly energetic radiation, a rather inefficient process since the radiation is continuously emitted and absorbed within the Sun while gradually working its way toward the surface. When it reaches the outer convective layer, violent currents efficiently sweep the heat up to the surface of the Sun, where it is finally radiated as visible light out into space.

We also see convective action on the surface of the large gaseous planets, particularly Jupiter. In even a small telescope it is possible to see the bands of color, layered in a fashion parallel to the plane of the four Galilean moons. The bright bands are called belts, where bright, hot gases are rising up from Jupiter's interior. The darker red bands are called zones, where cooler gases are sinking back into Jupiter's interior. Rather than forming cell pockets or granules as we see on the surface of the Sun, Jupiter's extremely fast rotation period of only 10 hours forces the convective action to be quickly spread in a wide sweeping circle around the perimeter of the massive planet, forming the long bands of color. Jupiter's great Red Spot, sitting near Jupiter's equator, is a giant hurricane several sizes larger than the Earth, forming an Eddy current inside of one of Jupiter's belts. Similar but less violent convective action can be observed on the other gas giant planets: Saturn, Uranus, and Neptune. Conversely, no convective action is observed on any of the planets smaller than the Earth, although extremely slow convective action would be very difficult for us to detect.

These observations of violent convective action in the presence of enormous gravitational pressures allow us to understand the convective action inside the Earth, in much milder and slower conditions. Rocky planets such as the Earth do not have the violent convective action of the Sun or the larger gaseous planets, which are fluid in composition. The Earth appears to have just sufficient mass and internal heat to power a very slow convective action in viscous rock. The plastic-like aesthenosphere underlying the lithosphere of the Earth allows the convective flow of heat from deeper in the Earth's interior to rise up to hot spots (ridges), then spread outward toward cooler spots (subduction zones), sinking downward to complete a convective cycle deep within the Earth's interior. In the process of convective action the plates of the lithosphere are moved over the surface of the Earth as a natural response.

Plate Tectonics and Continent Formation

We now understand that the continents were built up gradually through the same forces that drive plate tectonic movement today. From our present understanding of plate tectonics we can confidently state that prior to the formation of our continental crust, the earth was completely

covered with a global ocean [15]. During the first several hundred million years of earth history, no rocks could form on the surface of the earth due to the extreme temperatures of the molten earth. The first crust to form on earth did not have the continental mass we see today. Rather molten rock first cooled and solidified, forming a temporary crust and the earth's oldest rocks approximately four billion years ago. When the earth had cooled sufficiently to below 100 °C, liquid water began to condense on the surface of the earth, forming a vast global ocean. Still, the continental crust had not begun to form. It would require the onset of plate tectonic movement.

The continents are composed of granite, a composite of lighter elements. But separating out the lighter elements from the earth is an extremely slow process. It began slowly with convection currents deep in the mantle, powered by heat from the earth's interior. Hot spots developed, bringing basaltic rock to the earth's surface, and with it a small fraction of lighter elements. However, the small amounts of lighter elements do not easily dissociate from the basalt. The slow-acting catalyst of this precipitation is water. The minerals of lighter elements are chemically altered as they gradually become hydrated, their melting points lowered. Finally the basalt is ready to have its lighter elements precipitated out. But it must wait until the basalt is transported to subduction zones, the slightly cooler regions of the mantle just below the earth's surface, where the basalt is drawn back down into the earth's interior. When this happens, the light elements are the first to melt, and are then easily separated out from the basalt and stored in magma chambers. Eventually the magma is forced back to the surface through fissures, forming granite or andesite rock. In this way continental mass is continually increased. Between two and three billion years ago, the rate of continental mass build-up greatly exceeded the rate of erosion. But it now appears that the two processes have nearly come to equilibrium, with the continental build-up rate just exceeding the erosion rate. In other words, the continental land mass remains nearly constant at present due to the close balance reached between these processes [16].

Mountain Building

The expression “as old as the hills” infers that mountains have been around for a long time. While most are very old, different mountain ranges can be quite different in ages. Notice how mountains seem to usually form long, thin ranges. We seldom see an isolated mountain sitting on an otherwise flat plain. The explanation is a simple one. Mountains are formed all along the intersection of colliding plates. This occurs when the crust is buckled by the colliding action of two plates. The Himalayan Mountains are still rising today as the Indian Plate continues to plow into the Asian Plate, causing the mountains to rise at the rate of 2 centimeters per year. Mount Everest, the highest mountain on earth, stands at 29,035 ft. above sea level [17]. This means the Himalayan Mountains are relatively young, still rising ever since the ancient coastlines of India and Asia began to plow into one another over 40 million years ago, buckling the coastal land mass and the initiating the formation of the Himalayan Mountains.

But shifts in plate movement can also bring mountain building to an end. Indeed we see older mountain ranges nearly weathered away completely. An example is the Appalachian Mountains, whose mountains are worn smooth and low by the long acting erosion of wind and water. A middle age mountain range would be the Rocky Mountains, which formed along a minor fault down the middle of the North American Continent about 80 million years ago. Previous to this an ocean covered much of the central states of the modern USA. The continued spreading of the Atlantic Ocean floor pushed the eastern North American Continent against this fault, causing the Rocky Mountain range to rise up and the mid-American ocean to recede into the Gulf of Mexico.

The vast layers of limestone containing oceanic fossils now found at high elevations throughout the mid-west attest to this earlier ocean. The slow acting movement of plate tectonics has left its mark all over the features we see along the continents today.

When we look at the other rocky planets in our solar system we don't see long thin ranges of mountains. On Mars we see the largest extinct volcanoes in the solar system, isolated from each other. Many evidences point to the earlier existence of hot spots causing the continued growth of these volcanoes over eons. Olympus Mons, the largest one, grew over five times higher than Mount Everest. On earth a similar hot spot acts under the Pacific Ocean to produce the Hawaiian Islands. But since plate tectonic motion continues to move the crust, the hot spot doesn't continue building one enormous volcano. Rather a long chain of volcanic islands was built as the Pacific Plate slowly slid over the hot spot. We see no evidence of plate tectonics anywhere else in the solar system. This has caused many scientists to speculate just how unique the earth may be. While over 100 extra solar planets have been discovered thus far, none are earth-like, since only large planets are presently detectable. But even when earth-sized planets are eventually discovered, will they have plate tectonic action?

Scarcity of Earth-like Planets

Several reputable scientists have estimated that earth-like planets are very rare in the universe [16]. To be earth-like, a planet must have plate tectonic activity. It now appears that plate tectonics is as necessary for life as liquid water. Plate tectonic action provides a stabilizing influence on the level of carbon dioxide in the atmosphere, and several other parameters as well. An equilibrium level of carbon dioxide is reached between the competing processes of carbon dioxide emission (volcanic activity) and carbon dioxide removal (subduction zones). The level of carbon dioxide is high enough to trap sufficient heat to keep the earth comfortably warm, but low enough to avoid the runaway greenhouse effect that occurred on Venus. These discoveries, in addition to many other unique qualities of our planet, have revealed to us that we are living in an oasis of the universe, one perfectly tuned for life.

In conclusion, plate tectonic movement is demonstrated by a wealth of observations. Measurements of the ocean floor, including sonar measurements revealing long ridges, patterns of rock magnetism, and direct observation of young igneous rock found on the ocean floor all concur with evidence from the continents, including earthquake and volcanic activity, the observed rate of continental mass build-up and mountain range formation, in support of the theory of Plate Tectonics. We understand the mechanisms driving the plate tectonic movement by observing convection in several larger bodies in our solar system. But the earth appears to have just enough mass and internal heat to provide the convective forces to power the slow, gentle plate tectonic motion we presently observe. This slow, gradual process, acting over millions of years, has produced the continental landscape we see today, and an environment suitable for life.

Chapter 3

Evidence for a Global Flood?

When visiting the Grand Canyon, tourists can elect to visit the National Park's visitor center and go on special guided tours to learn about the unique geology of the Grand Canyon and its incredible history beginning with the formation of the mile-thick layer of sediments all the way through the more recent carving action of the Colorado River. Such tour guides will explain this history in terms of millions of years, something many Christians feel immediately uncomfortable with. But now such Christians have another option. It is possible to arrange special guided tours from "creation science" experts who will give a very different story, one that seems to be more biblical. It will even sound very scientific as tourists will be flooded with information and facts on how the Grand Canyon is actually a tribute to the immense impact of Noah's flood [18]. All of the features that appear to reveal vast ages can be explained away as vestiges of one catastrophic event just a few thousand years ago. There are answers for why there appears to be many so many distinct layers of sediment in the Canyon. There are answers for why there is metamorphic rock and igneous rock near the bottom. There are answers for why certain fossils only appear in certain layers. And, of course, there will be explanations denouncing the reliability of geologic and radiometric dating methods. Above all, you will enjoy the scenery so much that you probably won't care what the tour guide is rambling on about anyway. But the sense of security is important to many Christians wishing to have a "safe" tour, free of any evolutionary dogma. It's your choice, but if you are really interested in learning some geology, I would highly recommend the National Park's tour. Let me explain a few reasons why.

Catastrophes: Local versus Global

The basis for "Flood Geology", as introduced in chapter 1, comes from an understanding of the Scriptural account of Noah's flood as a global catastrophe. Many scientific evidences have been presented in various publications (e.g. [19]) as support for this conclusion. However, all of the catastrophe evidences fall short of verifying a one-time global catastrophe. Indeed the history of the physical earth is filled with many regional catastrophic events. There is no denying this by modern geologists, who agree that both gradual processes and catastrophic ones are responsible for shaping the earth's landscape. In the last few decades we have witnessed the 1980 eruption of Mt. St. Helens in Washington State, various earthquakes of magnitude 8 or higher, massive floods inundating communities such as the 1993 flooding of the Mississippi River and other various catastrophes. Catastrophes have been important factors in the geologic record. But to find evidence for a one-time global flood, one must look for basic evidences of global significance. These include the existence of a water supply sufficient to flood the entire earth, a comparison of the layers of sediments throughout the world, the distributions of life forms on earth, the fossil record, and above all a remnant universal record of a clear impact on the earth's environments with a consistent date and nature of the same catastrophic event. Does such an investigation show that a single global flood occurred on the earth just a few thousand years ago? Let us examine the evidence.

A Dearth of Water

The first thing we should look for in locating evidence for a global flood is the source of water. In a local flood a region of land is inundated with water originating from outside of that region.

The normal hydrologic cycle can sometimes dump an inordinate amount of water in a region that cannot drain the water fast enough. But a global flood would require quite a different scenario. The supply of liquid water on Earth is very impressive, covering 70% of the globe with ocean water. The oceans contain 97.5% of the total supply of water, while 1.8% is frozen in glaciers. Fresh water reservoirs account for only 0.8% of the total water on earth [20]. The obvious question is how could there have been enough water to cover the entire earth? Enough water to flood all of the highest mountains on earth would require over 3 times as much water as is presently known to exist on earth. Where did this floodwater come from? And where did it go?

Could it have been in the atmosphere? The atmosphere normally holds about 0.001% of the earth's water. Increasing this amount quickly reaches a natural limit, when the air becomes saturated with water vapor and liquid drops begin to form. The so-called "canopy theory" [19] proposes the pre-flood atmosphere held a vast supply of water in vapor form. But saturation is reached with not much more water than we normally have in our atmosphere, so it cannot work. Could such a supply of water be hidden underground somehow? Although aquifers are known to exist deep underground there is a natural limit. That limit arises from the increasing hardness of rock with increasing depth. The pressure of only a few hundred feet of the earth's crust is usually sufficient to reach rock that is impermeable to water. Fossil aquifers exist where there is water-saturated rock, trapped several hundred feet underground. However, the low density of water relative to rock ensures that water will not be found much deeper than this. The pressures increase dramatically with depth until water saturation is no longer physically possible. There simply isn't any place on earth to hide enough water to flood all of the earth's present geography.

A Dearth of Evidence for a Quick Rearrangement

But that doesn't settle the issue for some. Creation scientists are quick to point out that since the mountains have been changing over time, that it may have been possible for the present level of water on earth to cover the highest mountains if the ocean depths were shallower and all of the mountain ranges were significantly lower. While this might seem reasonable, such drastic changes to the earth would have left many clear indications. For one, all of the high mountain ranges on earth should appear very young, since such radical uplift in the terrain would completely reshape the mountain peaks. A mere few thousand years would not be long enough to leave some ranges highly eroded, while others remain sharp and craggy in appearance. But as we have discussed previously, mountain ranges are seen in all different stages of appearance, some highly eroded and smooth, some showing the action of significant weathering and erosion, to some still in the formative stages devoid of significant erosion. The differing appearance of ages in mountain ranges is a huge strike against any appeal to drastic upheavals in the geology of the earth in recent history.

On a more practical level, appealing to drastic changes in the contours of the earth during a global flood does not give any survivors much of a chance. Such sudden and drastic changes in the earth would certainly be accompanied by massive earthquakes. Enormous tsunamis unlike any we've ever witnessed on earth would have resulted from earthquakes with magnitudes greater than 9 on the Richter scale. Such waves would have completely destroyed any vessel made to weather the flood. We must conclude that such a rearrangement of the earth's terrain is not a reasonable suggestion. It is more reasonable to insist on a miraculous appearance of a vast supply of water, followed by a miraculous disappearance of it. But, as we will discuss in the

next chapter, the Bible does not indicate such a scenario. In fact, the Bible points to existing supplies of water and a natural means of abating the floodwater.

A Dearth of Flood Deposits, An Abundance of Fine Layering

Let us leave the difficult issue of the source of water for now and look at other expectations of evidence from a global flood. One of the most important evidences for a global flood should be seen in the layers of sediment throughout the world. Flood deposited sediments have characteristics that are easily recognized by geologists. Called “pluvial” deposits, they can be distinguished from other layers of sediments due to the intense mixing effects of a flood, interleaving fine grains of particles throughout the soil. This mixing effect produces a fairly continuous layer of clay-textured sediments, allowing geologists to identify flood deposits up to several thousands of years old. Although a global flood would deposit varying layers of sediment throughout the world, we would expect continuity in such a layer throughout the world. It would be continuous not only vertically, but also horizontally, unless more recent geologic activity has since produced unconformities. We would not expect to see distinct transitions in the layers of sediment laid down by such a flood, due to the intense mixing that occurs. How do these expectations match up with what we actually see?

Almost any place such as a roadside rock exposure will reveal distinct layers that seem to run along the entire structure. Upon closer inspection the layers of rock can be seen to have many fine transitions in layer upon layer. Such transitions in the layers are expected if indeed the sediments have been laid down slowly, year by year, while climatic changes altered the appearance of the sediments. But where is the huge continuous pluvial layer from a global flood? Such a layer cannot be found in the layers of sediment around the world. Nearly all rock layers bear the tale-tell impressions of slow sedimentation, showing many fine transitions expected by such a process. The Grand Canyon shows a remarkably long history of numerous distinct changes in the sedimentation. Different rock layers such as sandstone and limestone alternate down through a mile-thick exposure of sediments. These are clear indications of climatic changes between periods of sedimentation. To attribute all such layers to one flood is to ignore the evidence entirely.

An Abundance of Fossils, Limestone, and Sharp Divisions

What else is to be expected from a global flood? First of all, flood-deposited sediments are usually not the optimal conditions for fossil formation. Fossils can only form in anaerobic environments, in which the bones can survive deterioration long enough to allow the slow-acting process of cell-by-cell tissue replacement by minerals from the surrounding soil. Pluvial sediments usually include well-mixed aerobic soil, making poor conditions for fossilization. But we see fossils of various kinds throughout layers of the Grand Canyon. Assuming these could have somehow formed during a global flood, what else could we expect? It would be natural to expect a global flood to mix marine and fresh-water fauna together with terrestrial fauna. There should not be sharp divisions of sediments; neither should there be sharp divisions of marine versus fresh-water or even aquatic versus terrestrial fossils. But that is precisely what we do see, throughout all of the many layers of the Grand Canyon. The limestone layers show clearly only aquatic marine fossils, indicating formation during a period in which this part of the crust was submerged in a salt-water ocean. The layers of sandstone reveal terrestrial fossils and wind-blown scratched sand grains, indicating a period of dry desert-like conditions. Again, to ignore

these sharp divisions is to throw out overwhelming evidence against the idea that a global flood deposited these sediments.

Even more telling are the distinct changes in fossil types in succeeding layers. For instance, trilobites are observed only in rock layers geologists attribute to the Paleozoic era. If they had perished in one global flood responsible for all the sediments laid down, we would expect to find them mixed in with other layers of sediment and alongside fossils of all the various marine fauna that perished in the same event. But they are only found in the layers of rock attributed to periods Cambrian through Permian. Furthermore, in Cambrian rock layers only certain marine fossils are consistently found, some of which are not found in any other layers of rock. Indeed, in Cambrian rock there are fossil forms that do not even fit into any modern recognizable groups [21]. Such rock can be found in all of the continents of the earth, having the same characteristic fossils. Radiometric dating has confirmed that this layer of rock is from 570 to 500 million years old [22]. These same fossils are not found in the abundant Pre-Cambrian rock strata, or in the fossil rich layers of subsequent rock strata through recent Earth history. Geologists interpret these findings to the appearance and subsequent extinction of several Cambrian era marine fauna, deciphered from the record made possible by the slow accumulation and preservation of fossil-rich limestone sediments. The thick layers of limestone are attributed to the decay of marine life, settling and accumulating over millions of years. Consequently, the sheer volume of marine life necessary to form such a layer represents millions of times more than the earth could possibly sustain all at once. Although we could continue with these evidences, the testimony they bear should already be very clear. Our expectations from a recent global flood have not fared well with regard to any of these evidences.

Surviving Fresh-Water Fauna

Another note of practicality is in order here. Fresh-water fauna can seldom survive long in salt-water and likewise, most salt-water fauna cannot survive long in fresh-water. A global flood should have mixed the oceanic salt-water with fresh-water, destroying fresh-water fauna in the process. And we note that Noah did not take two of each kind of fresh-water fish and clam aboard the ark. It is interesting that studies of the Black Sea reveal that it was once a fresh-water lake, as evidenced by the fossil shells dating prior to 7600 years ago [5]. Upon a breakthrough of an earlier Bosporus Strait land bridge, a massive inundation of salt-water from the Mediterranean Sea immediately destroyed all fresh-water fauna. The cooler salt-water pouring in from the Mediterranean created a special condition of anaerobic water at depths greater than a few hundred feet. Since that time only marine fauna can be found living around the shores of the Black Sea, even though it has a lower level of salinity than the Mediterranean Sea. Salt-water simply spells doom for most fresh-water species. Likewise, a global flood should have destroyed fresh-water fauna. It obviously didn't. Even most coastal marine life and plant life should have perished, since these depend on sunlight. Again, such is not the case. A global flood has many unavoidable consequences that we do not observe.

Geographical Distributions of Life Forms

For the sake of the stubborn, let us continue. What about expectations of the present varieties of life forms throughout the earth? If a global flood destroyed all land life, which has been subsequently repopulated by the surviving members aboard Noah's ark, we can expect to find certain connections between all forms of land life on all continents of the earth. From the

millions of species of life on earth today and the many varieties within species, we quickly run into a dilemma when considering what species of life were actually taken aboard Noah's ark. If all present breeds of dogs stem from a pair just a few thousand years ago, one must then speculate an extremely rapid sequence of genetic variation not witnessed today, something not even the staunchest Darwinist would insist on. We also run into severe difficulties when considering how some species could have possibly survived a subsequent migration from where the ark landed to where they are found today. But perhaps the biggest difficulty lies in explaining the distributions of life forms on earth today. While nothing is impossible for God, we should at least understand that miracles beyond the scope of science are needed to account for all of these observations, if indeed all terrestrial life on earth today stems from the populations aboard Noah's ark.

While life forms appear to be similar between some continents, we also find characteristics that differ dramatically from one continent or island to another. Two of the more interesting cases are the life forms found on Australia and Madagascar. Here we find such unique life forms that bear little resemblance to creatures from anywhere else in the world. They appear to be well adapted to their environments, and the evidence strongly suggests that they have been isolated for quite a long period of time from other continents. There may well be other places on earth where they could thrive, but they are not found elsewhere. For example, nowhere else do we find any monkeys even closely resembling the lemurs of Madagascar [23]. The distribution of life forms on earth presents an interesting dilemma for the explanation that they all came from Noah's ark a mere few thousands of years ago. Why should the life forms of Australia and Madagascar be so radically different from creatures elsewhere in the world? We could suggest that all of the oddballs banded together to move off Noah's ark and away to these isolated regions. Even so, we might expect to find a significant number of such creatures that bear strong resemblance to creatures from other continents, being separated by a migration only a few thousand years ago. The evidence from the varieties of life forms and the fossil records strongly suggest that these regions have been isolated from other continents for a considerably long time. Indeed, the geologic evidence reveals that Madagascar was separated from the African continent 165 million years ago, while Australia has been separated from Antarctica for even longer. The premise that all terrestrial life has been repopulated since a recent global flood finds no support from these considerations.

Numerous Flood Myths

In the face of so much evidence to the contrary, what is it that continues to drive the appeal of "flood geology" within the Christian churches? In lieu of scientific support, another possibility is the existence of flood myths found in various people groups throughout the world, an amazing total of 61 myths having been compiled by James E. Strickling, Jr. [24]. These have been examined by scholars for the possibility that they all stem from the same global event. While it is clear that Sumerian and Accadian and a few other Middle Eastern flood traditions bear strong resemblance to the biblical Noah's flood story, similarities with most other flood traditions are lacking, leaving scholars divided over the possibility of their common origin. It may be a better explanation to note that nearly all ancient civilizations located predominantly along water sources and were subject to the risk of floods, occasionally resulting in devastating consequences. Survivors of such regional floods and their descendants would naturally pass along traditions of tremendous devastation. It appears that we cannot appeal to the widespread existence of flood myths as convincing evidence for a global flood.

The Crux of the Matter: Understanding Scripture

We finally come to the crux of the matter. What is the true driving force for the wide acceptance of a global flood amongst Christians? As we have discussed, the scientific support for a global flood is lacking. Other scientists have carefully analyzed the evidence and find no support for a recent global flood [23,25]. It would be a great mistake to suggest that the scientists, myself included, have conspired to deny all of the evidences for a global flood just a few thousand years ago. Such evidence simply does not exist. When looking at the global consequences such a catastrophe should reveal, we find no convincing support for it. Why then does such a poorly supported position continue to find such widespread acceptance? We must conclude that it is simply an understanding of the scriptural account given in Genesis 6-9. Believing that the Scriptures do not permit anything other than a global flood just a few thousand years ago, well-intentioned “creation scientists” have valiantly searched for confirming evidence to support it. But no convincing evidence has come forth. How should we respond to this dilemma? I believe it is long overdue that we ask ourselves whether such an understanding of Scripture is really justified. Let us examine the Scriptures together and see.

Chapter 4

Scriptural Understanding of the Earth

When a person today, born in the western world, and educated in our modern scientific culture, examines the Old Testament Scriptures, written in Hebrew over 2000 years ago, from the perspective of a person from a completely different culture, there are bound to be difficulties in understanding what was intended by the original author. The ancient Hebrews understood that the Scriptures were given by God, written by the hand of men, and applicable to all generations. Modern believers accept this as well. But where we often run into difficulties is in trying to apply our modern scientific mind-set in attempting to understand expressions in ancient Hebrew, often resulting in absurd conclusions. This can be avoided if we can learn to appreciate the distinctions in style and expressions used by the ancient Hebrew writers. Unfortunately, even Bible scholars have fallen into the same pitfalls, because it is very difficult for us to admit that our mind-set is very different from that of the ancient Hebrew writers. We combine our modern view of the world with Scripture and we reach conclusions that the original authors would be appalled at. If they could speak to us they would reiterate Proverbs 30:5-6 “Every word of God is tested; He is a shield to those who take refuge in Him. Do not add to His words lest He reprove you, and you be proved a liar.”

The Value of π

A classic example of where we tend to reach the wrong conclusion is the Old Testament value for π , the numerical value for the circumference of a circle divided by its diameter. We know that this is an irrational number, impossible to write exactly as a ratio of any two integers. Some amazing individuals can recite π to hundreds of significant figures. Computer programs can calculate it to any accuracy you want. Normally, it's sufficient to round it off to 3.14. When I worked in a collaboration active at the Superconducting Super Collider, a high energy physics facility since closed due to funding cancellations, I had to know π to six digits of accuracy to gain entrance to the main building. The rationale behind this was that we were all physicists who should know it or easily find it. But the ancient Hebrew authors had no such reason to know it, as evidenced by the passage in I Kings 7:23 “Now he made the sea of cast metal ten cubits from brim to brim ... and thirty cubits in circumference.” What are we to make of this? Shall we conclude that the biblical value for π is 3.0? Shall we conclude that these ancient Hebrews didn't display very good math skills? That would be the natural conclusion of the literalist interpreter today, one who doesn't consider the distinctions in style and expressions often used by the Hebrews.

Just a little bit of perusing the Old Testament Scriptures reveals that such a conclusion would be extracting the wrong message from the passage. Look at the census taken of the Israelite warriors following their exodus from Egypt in the first three chapters of the book of Numbers. Of all the numbers given for the warriors in each tribe, without exception the last digit is 0, zero. It would be statistically very improbable that each of these numbers just happened to be a multiple of 10 (1 out of 10^{12}). It would be even more statistically improbable that each of these numbers would be a multiple of 50 (1 out of 50^{12}). But that is what the text says. Were these the EXACT numbers? If they were, this would represent the most accurate census ever taken as well as an extremely improbable statistical occurrence. Before we conclude such a thing let us continue to examine the Old Testament usage of numbers. In Judges 7, Gideon sends 22,000

warriors home because they were afraid, leaving 10,000. Of those he selects only 300, so that Israel would not think their own power gives them victory. Do you see the pattern? Does it make for errors in the Bible when round numbers are used? It does so only if we demand exact numbers from the text. But giving us exact numbers was certainly not the intent of the author. Likewise there are many other examples where something we may be interested in knowing is not a message included in the text.

The strict Bible scholar who wishes to follow the advice given by Solomon in Ecclesiastes 11:2 finds himself in a quandary. It says, “Divide your portion to seven, or even to eight, for you do not know what misfortune may occur on the earth.” He wants to cry out “which is it, seven or eight?” He finds the same difficulty when reading Proverbs 30. No less than four times in the chapter does it first claim to describe three things, then changes it to four. In verse 15 we find “There are three things that will not be satisfied, four that will not say ‘Enough’.” We might go back and erase the three if we were writing it, but the ancient Hebrew author did not. He left it that way for a purpose. His style gave additional emphasis to each example in this way. But the literary style is unusual to us. We want to counter, “Either it’s three or it’s four!” We see the same pattern in the book of Amos. No less than eight times Amos uses the pattern “For three transgressions of (nation to be judged) and for four, I will not revoke its punishment.” What should we do? Should we go back and translate the Bible not only into English, but also translate the style and mind-set? Perhaps a better proposal is for us to learn to appreciate the differences in style and how that can affect our interpretation of the text.

The Hebrew word for Earth

This difficulty is also encountered in the biblical expressions concerning the earth. The first distinction we must appreciate is in the Hebrew word for “earth”. They used the same word, pronounced “erets” to mean either “earth”, “land”, “ground”, “country”, or even “field” [1]. Often the context in which it is used makes the meaning clear, but sometimes it is difficult to know how to interpret what is meant. The problem is compounded by our modern image of the earth as a round sphere, 70% covered by water and 30% by continents and islands. This stands in stark contrast to the usage in Genesis 1:10 “And God called the dry land earth.” We seldom use the word earth to mean a regional area of land as the ancient Hebrews did. The second important distinction we must make concerns the perspective of the Hebrew writer. It isn’t necessary for the Hebrew writer to have had a modern scientific view of the earth in order for the Scriptures to be completely true. Rather, we must be cautious concerning what the author was intending to describe. Otherwise we easily reach the wrong conclusions.

One example comes from a description of the famine, predicted by God through Joseph in Genesis 41. The Hebrew writer describes the extent of the famine in verses 54 and again in 56 and 57. Verse 54 is translated “and the seven years of famine began to come, just as Joseph had said, then there was famine in all the lands (erets).” Verses 56 and 57 tell us “When the famine was spread over all the face of the earth (erets)...” and “And the people of all the earth came to Egypt to buy grain from Joseph, because the famine was severe in all the earth (erets).” Are we to interpret this to mean that the famine existed throughout all continents of the earth as we know it today? Are we to infer that the American Eskimos and Indians, the Australian Aborigines, the Chinese and Far East Islanders all came to Egypt to buy food? Not many Bible scholars would insist on this. The key is in accepting that lands, known countries, and the earth were all the same word “erets”. Indeed, the expressions “all the lands”, “all the earth” and “all the face of the

“earth” are completely consistent with all lands known to the ancient Hebrews. Thus the most reasonable conclusion is that the famine was widespread around the region of the Middle East. Should the Scriptures have made a distinction for the sake of us in the Western hemisphere that it was only referring to the lands surrounding the Middle East? That would have been somewhat silly to a reader long ago, to whom the Middle East was “all the face of the earth”. Isn’t it a little more reasonable for us to appreciate how the Hebrew writer used this expression?

Need more examples? There are plenty in the Scriptures. Consider several other such usages of the word “earth” given in the Old Testament. In I Samuel 30:16 we find that the Amalekites who had raided David’s camp were now “spread all over the land (erets).” Yet David and his 400 warriors were able to wipe them out within 24 hours. The prophet Zephaniah warned that the coming day of the Lord would be one of judgment in which “all the earth will be devoured in the fire of His jealousy, for He will make a complete end, indeed a terrifying one, of all the inhabitants of the earth.” The context is clarified earlier as a judgment against Judah for its sins, and the prophecy was fulfilled when Jerusalem fell to the Babylonians in 586 B.C. Again, in II Chronicles 36:23, King Cyrus of Persia declares: “The Lord, the God of heaven, has given me all the kingdoms of the earth”. Yet we know that the kingdom of Persia was limited to the Middle East. The New Testament also has several similar examples. According to Luke Jesus was born during a census taken by Caesar Augustus “of all the inhabited earth.” This, of course, was referring to the entire Roman Empire, a vast region of the Middle East. We find that in Acts 2, on the day of Pentecost, Peter addresses “devout men from every nation under heaven.” Then Luke elaborates more specifically what this means: peoples from fifteen different regions of the Roman Empire are listed. Once again, the geography is limited to the Middle East.

Are the claims exaggerated? They are only if we take the wrong meaning from the text in each case. But if we can appreciate the style of the expressions used, the claims are not exaggerated. They are true descriptions. The Hebrew expressions of “all” and “every” were often used in this manner and understood not to be an exaggeration, but rather a commonly accepted manner of indicating all or every from a recognized and known area [26]. Since this was understood to the Hebrews, we should not insist on interpretations based entirely on the wording of our modern translations and our modern Western mind-set. Though the true meaning of such expressions may not be obvious to us, we can learn to recognize how such expressions are used throughout Scripture and appreciate the different style and mind-set of the ancient Hebrew writers. Most importantly, we must learn to accept that certain aspects of the narrative are not always clearly specified. Such is the case with Noah’s flood.

Noah’s Flood

The story of Noah’s flood has intrigued modern Bible readers perhaps more than any other. For God to have destroyed “all flesh” from the earth because of the wickedness of man is indeed a frightening image. It is a foreshadowing of what is prophesied to take place in the end times, when God will judge all who have lived and the heavens and earth will be replaced with new ones. To dismiss Noah’s flood as being mythical, a story fabricated to teach us a moral lesson, leads naturally to dismissing the prophecies of the final judgment as described in Revelation. Indeed Christ also referred to Noah’s flood as an historical fact, likening his surprise second coming to the surprise of those swept away by the flood. It appears that the factual occurrence of Noah’s flood is tied to many crucial Bible messages. Christians who consider this part of the Bible just a mythological story borrowed and adapted from other cultures fail to appreciate the

consequences. Noah's flood is portrayed not as a fable or parable, rather as an historical account.

But modern science reveals no evidence for a global flood in the past several thousand years. Is the validity of the Bible at stake? We could reject the findings of modern science and claim we are standing on God's Word. But this would only serve to remove us from relevance to a world that takes science seriously. Claims of "creation scientists" supporting a recent global flood require setting common sense aside as discussed in the previous chapter, while serving to distort the role of science in understanding the earth. Calling upon believers to reject the underlying principles of geology simply because they lead to a history of the earth differing from a scriptural understanding is nothing but a cult practice. Let us rather search for answers that don't require a rejection of common sense and reality. What about our understanding of the Scriptures? Could we have overlooked indications in the Bible itself that the flood was not a global one? Let us take a closer look.

Regardless of how well we would like to know the details of the flood story, many questions remain difficult to answer. Who were the sons of God and the daughters of men, who had children together? Who were the Nephilim, "the mighty men of renown", who "were on the earth in those days, and also afterwards"? The Nephilim are referred to later in the book of Numbers as inhabitants of great size occupying the land of Canaan when the Israelites left Egypt. The fact that they are referred to before the flood and after the flood presents an interesting problem. Wasn't Noah, his wife, his sons and their wives the only survivors of the flood? Dogmatically insisting on particular answers to these questions is a grievous mistake. The Scriptures do not permit such certainty. Attempting to sort through all of it requires speculation on our part. But there are some clues regarding the extent of the flood.

Many scholars believe that the sons of God were certain descendants of Adam, ones who inherited a covenant relationship and should have known the Lord. But they chose to intermarry with other people groups who did not, and the resulting union produced a people who were not devoted to the Lord. What is made clear to us is that the wickedness of mankind was increasing and the righteousness of Noah stood out in stark contrast. The very people God chose to destroy from the face of the earth were the ones who should have known the Lord and His ways, the covenant descendants of Adam. From the descriptions given in Genesis the descendants of Adam are believed to have been located in present-day Iraq, near the Tigris and Euphrates Rivers. Although God had given the command to "fill the earth", just how spread out Adam's descendants were is questionable. Most of them chose to remain in the basin area of the Euphrates. In fact, their close proximity may have contributed to the growing sinfulness for which they were to be judged and destroyed. The first indication from the Scriptures that they began to disperse on the earth is after the flood (see Genesis 10:32). This gives us our first clue that the flood was localized to a certain geographical region. There was simply no reason for God to flood the entire world, when His very purpose was to remove the wickedness of man.

Now examine how the flood is described by God to Noah. Noah was commanded to build an ark capable of sustaining animal life as well. God speaks to Noah "And behold, I, even I am bringing the flood of water upon the earth, to destroy all flesh in which is the breath of life, from under heaven; everything that is on the earth shall perish." This may appear to be describing the destruction of all land life on earth. But as we have noted before, such an expression in Hebrew probably refers to the living creatures in all the land known and recognized by the survivors of

the flood. Why then save a pair of each animal? Wouldn't a regional flood leave surviving members of the species? Not necessarily and certainly not accessible members. In the flat, arid region of the Tigris and Euphrates, all such life there would be confined close enough to the rivers such that a sudden titanic flood would destroy all of it. So it was necessary for their survival and accessibility for Noah to preserve members of each.

The next clue we find by returning to Genesis 6:4, "The Nephilim were on the earth in those days, and also afterward". Even if it isn't clear who the Nephilim were, the Scriptures clearly state that they were on the earth before and after the flood. Didn't the flood destroy all people on earth outside of Noah's immediate family? Apparently not! Recall that expressions such as "the face of the earth (erets)" need not be referring to a global event, but rather one encompassing the known region of the earth. Likewise "everything that is on the earth" need not refer to all life on the earth as we understand it. Our image of the earth is certainly quite different from what the ancient Hebrew author envisioned and recognized as the earth. To him, "the face of the earth" may well have meant the land as far as the eye can see. While this may have been an enormous region of land surrounding the Tigris and Euphrates Rivers, it would not necessarily have included regions beyond that. We are led to the conclusion that the Nephilim, who occupied the land of Canaan by the time Israel was led out of Egypt by Moses, were not wiped out by Noah's flood simply because the flood never reached the land of Canaan. This conclusion is supported by the absence of any archeological evidence for flood deposits in present-day Palestine corresponding to the flood deposits found by C.L. Woolley in present-day Iraq [7]. Furthermore, archeological evidence has been found revealing continuous human occupation of Palestine since 4500 B.C. or earlier, which may antedate the flood [27]. This also implies that other people groups beyond the Tigris-Euphrates region would have survived the flood as well.

One sticky point concerns the description of how the mountains were covered. We read in verse 19-20, "And the water prevailed more and more upon the earth, so that all the high mountains everywhere under the heavens were covered. The water prevailed fifteen cubits higher, and the mountains were covered." This certainly sounds like a global flood. But once again, we must learn to appreciate the Hebrew word usages. The word for mountains, "har", was also used to describe hills [27]. We also note that hills surrounded the Tigris and Euphrates basin. A measurement of fifteen cubits, which may have been a little over 20 feet, suggests that the survivors of the flood took measurements. Would they have been able to measure the depth of mountaintops far beyond where they began? This isn't likely. Since the Hebrew word for hills was identical to that for mountains, it is far more likely that they were able to measure how deep nearby surrounding hills were submerged by the floodwater. Again, in chapter 8 we read that the ark came to rest "upon the mountains of Ararat". Although some have taken this to imply that the landing place of the ark was the 17,000 ft. high Mt. Ararat, the Bible does not support such a conclusion. Ararat represented a province, not a particular mountain. Geologist Carol Hill gives several persuasive reasons for concluding that the actual location where the ark came to rest is near present day Cizre, Turkey, in the hills near the source of the Tigris River [27]. The biblical description of olive trees and vineyards strongly suggests such a mild hill country northeast of the arid plains of the Tigris-Euphrates basin.

The final clue that indicates the flood was local is found in how the floodwater subsided. There is no indication of the floodwater receding until, according to Genesis 8:1, "God caused a wind to pass over the earth, and the water subsided." Simply from the fact that a wind helps the water to recede we ascertain that the flood was localized in a region of land and eventually made its

way out to sea. A wind blowing on floodwater covering the entire globe would not help much to clear the water away. But since the basin of the Tigris and Euphrates Rivers has such a small grade, less than 1 foot of elevation per mile along their meandering way to the Persian Gulf for the vast majority of their courses [28], the normal rate of water flow is actually very low. A strong wind would aid greatly in removing the floodwater. But once again, the actual volume and extent of the floodwaters remains speculative.

Note that all of the clues given here suggesting the flood was a local one, come from the Bible itself and not from modern science. And although modern science indicates that the flood must have been a local phenomenon, we don't have to "bend" the Scriptures to agree with it. Rather, the key is in learning to appreciate the style and expressions of the ancient Hebrew writer, which differ sharply in some cases to our modern Western mind-set. More importantly, it is necessary for us to distinguish between the clear messages given by the text as opposed to the more speculative ones. As of this time, we really cannot precisely specify the extent of Noah's flood, where exactly the ark ended up, or the full effects of the flood on the earth. The Scriptures do not give us enough information to be certain. But the clues do suggest a massive local flood in the Middle East, an event that is supported by archeological evidence and modern geology. There are many important messages given by the story of Noah's flood, but we will not delve into them since the purpose of our examination is completed. Accepting the validity of Noah's flood does not require rejecting modern geology. What about the rest of the Bible? What does it say that has relevance to plate tectonics?

A Scriptural History of the Physical Earth

The very first chapter of the Bible describes the creation of the heavens and the earth. Genesis 1 tells us that God "spoke" all things into existence, uttering "Let there be..." The meaning of this expression is difficult to fully understand, but the important point is that the creation of the earth came about because God willed it. The imagery given during the first three "days" of creation is one in which God first speaks something into existence, then He performs a separation. First light is separated from darkness, waters above the expanse from the waters below the expanse, then dry land is formed when the waters below the expanse are gathered together. A sense of meticulous care in the creation process is given. Indeed the first three days of creation describe the preparation of the abodes to be populated in the next three days of creation. Here is a summary of it:

<u>Day</u>	<u>Separation</u>	<u>Day</u>	<u>Population</u>
1	Light from darkness	4	Sun, Moon & Stars
2	Waters above & below	5	Sea creatures & birds
3	Dry Land from the water	6	Land creatures

This is clearly not a scientific account of creation. It is poetic in structure and it has some profound messages concerning the Creator and His creation. Creation is not an accident, rather a well planned process. The outcome is described seven times as being good. The claim that the universe and the earth were created, having a definite beginning, is in excellent agreement with the scientific record. That the earth was meticulously prepared by God to be inhabited is becoming increasing supported by the scientific evidence that the earth is a "rare" planet in its properties allowing it to support life. It is just as spoken through the prophet Isaiah, "For thus says the Lord, who created the heavens (He is the God who formed the earth and made it, He

established it and did not create it a waste place, but formed it to be inhabited), ‘I am the Lord, and there is none else’.”

The only places we can find any potential conflicts between this account and a modern scientific view of the origin of the earth are precisely those in which it is necessary to interpret the Hebrew expressions used. These include the meaning of the creation “days” and the order of creation events. An examination of the creation days is given in the booklet *A Christian Physicist Examines the Age of the Earth* [2]. The main point is that we cannot use these days to determine the time frame of creation, since the “days” probably do not refer to a time period at all. The phrase “And there was evening and there was morning, the first day”, is used similarly for each of the first six days. Nowhere else in Scripture is such a description given for a day, and rightly so. It appears to be symbolic of what is taking place, a transformation from darkness and chaos into light and order.

We encounter a similar problem when evaluating the sequence of creation. While many scholars have analyzed whether this sequence is compatible with the fossil record, the comparison may be a moot point. Because the days may not refer to a time period, the creation account may not have been intended as a chronology to begin with. In fact, it may simply be a coincidence that the order given in Genesis 1 of the populations listed roughly agrees with a chronology of the fossil record of life on earth, since the creation account was not necessarily intended to convey a chronological order, but rather God’s actions of transforming order from the chaos. But one idea that seems difficult to avoid in the account is the idea that the earth was at first covered by a great ocean prior to the formation of the continents. Since the dry land does not exist until God gathers all of the “waters below” into one place indicates that the earth was at one time covered with a great ocean. As discussed in chapter 2, modern science has only recently reached this same conclusion, as we have begun to understand the origin of the continents on the basis of the same forces driving Plate Tectonic movement today.

Other references in the Scriptures appear to allude to Plate Tectonic movement. Isaiah, the Old Testament prophet twice refers to how the Lord created the heavens and the earth. Isaiah 44:24 has the Lord speaking “I the Lord, am the maker of all things, stretching out the heavens by Myself, and spreading out the earth all alone.” Again, in Isaiah 42:5 we read “Thus says God the Lord, Who created the heavens and stretched them out, Who spread out the earth and its offspring.” The Psalmist also uses such an expression in Psalm 136:6, “To Him who spread out the earth above the waters”. In Job 38:18 the Lord asks Job, “Have you understood the expanse of the earth”. We find numerous references to the creation activities of God, the stretching out of the heavens and the spreading out of the earth. As described in the booklet *A Christian Physicist Examines the Big Bang Theory* [29], the repeated references to the Lord stretching out the heavens may be alluding to the expansion of the universe we observe today. The repeated expression “spreading out the earth” may be alluding to the plate tectonic movement that formed the continents of the earth and continues to drive continental drift.

Additional Scriptures refer to how the Lord “laid the foundations of the earth”. Psalm 24:1-2 tells us “The earth is the Lord’s, and all it contains, the world, and those who dwell in it. For He has founded it upon the seas.” Psalm 104:5 gives a similar description, “He established the earth upon its foundations, so that it will not totter forever and ever.” Zechariah 12:1 also refers to the acts of creation, “Thus declares the Lord who stretches out the heavens, lays the foundation of the earth, and forms the spirit of man within him”. Modern geology has revealed the earth’s

extraordinary foundation to consist of a dense iron core, surrounded by a rocky mantle, the upper part of which has a low enough viscosity to support slow convective action and the resulting plate tectonic movement of the crust and plates above it. Scriptures from the Old Testament give compatible descriptions in a much simpler language.

The biblical writers certainly did not have special scientific insight nearly 3000 years ahead of their time. They had something better. They had divine inspiration, guiding them to pen words that perhaps they did not fully comprehend, but serves to convey God's message to man even today. Why would God choose to do this? Isaiah gives us a reason for this. In Isaiah 43:9-10 we read

Who among them can declare this and proclaim to us the former things? ... "You are my witnesses," declares the Lord, "and my servant whom I have chosen, in order that you may know and believe Me, and understand that I am He. Before Me there was no God formed, and there will be none after Me.

We see that God has revealed insights from His Word to the former things that have taken place long before us, that we might recognize that He alone is the Lord, the creator of these things. Modern science is confirming the biblical descriptions of how God "stretched out the heavens" and "spread out the earth." This gives us strong reason to trust God's Word, that it is valid for our lives today.

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