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The Scriptural Accounts of the Creation: A Scientific Perspective

The purpose of this paper is to examine the scriptural accounts of the Creation from a scientific point of view with particular emphasis on physics and astronomy, although of necessity I will also have to deal to some extent with biology, chemistry, and geology. The views expressed here are my own and are not meant to represent the views of The Church of Jesus Christ of Latter-day Saints or Brigham Young University. They are a distillation of my thoughts and conclusions over two decades of teaching and research.

BASIC PRINCIPLES

As we deal with the Creation, I suggest that there are some basic principles that we need to follow in our quest for truth. Both science and religion have as a major purpose the search for truth. But what is truth? I believe that the best definition comes from the Doctrine and Covenants: "Truth is knowledge of things as they are, and as they were, and as they are to come" (93:24). Truth, then, is knowledge of things as they really are—past, present, and future. Although the methodology of science and religion differ, both are ways of learning about truth. Brigham Young stated, "The idea that the religion of Christ is one thing,

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and science is another, is a mistaken idea, for there is no true religion without true science, and consequently there is no true science without true religion."[1] The emphasis, of course, must be on *true* science and *true* religion. When seeming conflicts arise, either the scientific principle is wrong or our understanding of the revealed religious concept is mistaken or incomplete. When discrepancies do arise, the revealed word of God must take precedence. As President Harold B. Lee said, "In all your learning, measure it and test it by the white light of truth revealed to the prophets of God and you will never be led astray."[2] We must, however, also be careful in our interpretation of revealed truth. We must not "wrest" the scriptures, as Peter warns (see 2 Peter 3:16), trying to draw conclusions from them that are not warranted. We need to develop a humble recognition of the limitations of our understanding of and our ability to interpret both scripture and science. Dogmatism, pride, and prejudice can cloud our judgment and mislead us.

Elder Bruce R. McConkie made a critically important observation: "Our knowledge about the creation is limited. We do not know the how and why and when of all things. Our finite limitations are such that we could not comprehend them if they were revealed to us in all their glory, fullness, and perfection. What has been revealed is that portion of the Lord's eternal word which we must believe and understand if we are to envision the truth about the Fall and the Atonement and thus become heirs of salvation."[3] Our knowledge, both scriptural and scientific, is limited. We need to keep that constantly in mind.

Elder James E. Talmage gave this vital insight:

> Discrepancies that trouble us now will diminish as our knowledge of pertinent facts is extended. The Creator has made a record in the rocks for man to decipher; but He has also spoken directly regarding the main stages of progress by which the earth has been brought to be what it is. The accounts cannot be fundamentally opposed; one cannot

> contradict the other; though man's interpretation of either may be seriously at fault. . . .
>
> Let us not try to wrest the scriptures in an attempt to explain away what we cannot explain. The opening chapters of *Genesis*, and scriptures related thereto, were never intended as a textbook of geology, archeology, earth-science or man-science. Holy Scripture will endure, while the conceptions of men change with new discoveries. We do not show reverence for the scriptures when we misapply them through faulty interpretation.[4]

We may become frustrated that the Lord has not revealed more to us—there are so many details we simply do not have any information on, but President Boyd K. Packer explains, "If all things were known, man's creativity would be stifled. There could be no further discovery, no growth, nothing to decide—no agency. All things not only *are not* known but *must not* be so convincingly clear as to eliminate the need for faith. That would nullify agency and defeat the purpose of the plan of salvation."[5] Because of our limited knowledge and understanding, differences of opinion will inevitably arise, but in the words of President Gordon B. Hinckley, "we can disagree without being disagreeable."[6]

For believing Latter-day Saints, another important concept is God's intimate involvement in the Creation. The scriptural accounts make it clear that the Creation was not simply a mechanistic unfolding of events driven by natural law. Each scriptural account shows God playing a direct, integral, and continuous part in the Creation; he did not just wind the clock at the beginning and then stand back and let things develop on their own. Abraham's account of the Creation is perhaps clearest in emphasizing this. For example:

> And then the Lord said: Let us go down. And they went down at the beginning, and they, that is the Gods, organized and formed the heavens and the earth. . . .

> And the Gods ordered, saying: Let the waters under the heaven be gathered together unto one place, and let the earth come up dry. . . .
>
> And the Gods saw that they were obeyed. . . .
>
> And the Gods watched those things which they had ordered until they obeyed. . . .
>
> And the Gods said: Let us prepare the waters to bring forth abundantly the moving creatures that have life. . . .
>
> And the Gods saw that they would be obeyed. . . .
>
> And the Gods prepared the earth to bring forth the living creature after his kind. (4:1, 4–5, 9–10, 18, 21, 24)

All these passages indicate that God was carefully involved in all aspects of the Creation, observing what took place and intervening to ensure that all things worked out in accordance with his plan.

Elder McConkie emphasized this point:

> All created things, this earth and all that is thereon—all things were and are made, not by man's power, not by some undirected forces of nature or of the universe. There was no happenstance in creation, no chance creation of life in the primordial swamps, on development up from one species to another by evolutionary processes. The creation was planned, organized, and controlled. It came by God's power—by faith! It came by a power that does not appear and is not seen and understood by the carnal mind or the scientific intellect. The creation is God's doing. Things came into being by forces which do not appear to man and can in fact be known only by revelation. And as God created all things by faith, even so his created handiwork can be known and understood only by that same power, the power which is faith.[7]

God is intimately involved in and is the moving and directing power behind the Creation. Moreover, many aspects of the Creation can only be understood through revelation—logic,

scholarship, and scientific experimentation cannot bring us to a full understanding of it. We need the inspiration and guidance of the Holy Ghost. As Moroni said, by the power of the Holy Ghost we can know the truth of all things (see Moroni 10:5).

Summing up these basic principles:

- The *truths* of revealed religion will agree with the *truths* of science.
- The emphasis must be on *true* religion and *true* science.
- We must recognize our very limited knowledge of the Creation from both a scientific and a scriptural standpoint and humbly recognize that in this mortal sphere we will never come to a complete understanding.
- Revelation has priority over scientific knowledge.
- We should be extremely cautious in attempting to interpret the scriptural accounts of the Creation from a scientific standpoint, since these accounts are not meant to be a scientific treatise on the subject. We need to be very careful not to "wrest the scriptures" through misapplication or faulty interpretation of them.
- We must avoid contention—we can disagree without being disagreeable.
- God is intimately involved in and is the moving and directing power behind the Creation.
- The Creation can only be fully understood through revelation.

QUESTIONS ABOUT THE CREATION

In trying to understand the Creation accounts in the context of science, numerous questions arise. Some of these are:

- How long was each of the creative periods?
- What is the actual age of the earth?
- Was there death among plant and animal life before the Fall of Adam?
- What are all these fossils of strange plants and animals that are no longer found on the earth?

- What about these manlike creatures that lived on the earth thousands or even millions of years ago?
- What about evolution?

Let's examine each of these in turn.

Length of the creative periods. As Elder John A. Widtsoe once pointed out, within the Church there are at least three prevailing positions on the length of the creative periods: (1) each day of the Creation was twenty-four hours, (2) each day of the Creation was actually a thousand years, and (3) the Creation of the earth extended over very long periods, the duration of which we do not yet accurately know.[8] Of these three, the one that seems to agree best with present scientific evidence is "very long periods." A related question is whether each of the creative periods is of the same length. Elder Bruce R. McConkie suggested that "each day [of the Creation] . . . has the duration needed for its purposes. . . . There is no revealed recitation specifying that each of the 'six days' involved in the creation was of the same duration."[9] The scriptural description of separate days or times may well be a way of drawing attention to various aspects of the creative process, which was almost certainly not a series of different, unrelated events but a continuous process in which several different things were happening at the same time.

Those familiar with the temple account of the Creation will recognize that it differs from the scriptural account both in sequence of events as well as what is done on each day. As Elder McConkie stated, "The temple account [of the Creation], for reasons that are apparent to those familiar with its teachings, has a different division of events. It seems clear that the 'six days' are one continuing period and that there is no one place where the dividing lines between the successive events must of necessity be placed."[10]

As I see it, the creative periods extended over vast periods of time—millions or even billions of years in duration. Moreover, these periods were not necessarily separate, successive

periods, but a continuous process with many things going on simultaneously.

The age of the earth. This issue is, of course, related to the length of the creative periods. The traditional chronology of the Irish Anglican archbishop James Ussher (1581–1656) places the Fall at 4004 BC. To arrive at this number, Ussher worked back from known dates using the data for births and deaths given for the various patriarchs in the book of Genesis. Unfortunately, these numbers are not consistent in the various manuscripts and versions of the Bible, and we have no way of knowing which, if any, of those are accurate, except as they may occasionally appear in modern scripture (see D&C 107:42–53). A statement of the prophet Nephi, son of Helaman, speaking around 20 BC, suggests that the Fall may have occurred considerably earlier than 4000 BC. Nephi says, "There were many before the days of Abraham who were called by the order of God; yea, even after the order of his Son; and this that it should be shown unto the people, *a great many thousand years before his coming*, that even redemption should come unto them" (Helaman 8:18; emphasis added). Only four thousand years before the coming of Christ does not seem to qualify as "a great many thousand years."

William W. Phelps, who worked as a scribe for Joseph Smith in his translation of the Book of Abraham, made this interesting statement in a letter to William Smith, the prophet's brother: "Eternity, agreeably to the records found in the catacombs of Egypt, has been going on in this system, (not this world) almost two thousand five hundred and fifty five millions of years."[11] An age of 2,555,000,000 years is within an order of magnitude of present scientific estimates of the age of the solar system (around 4.6 billion years).

Scientists have attempted to determine the age the earth and the solar system using a variety of radiometric dating techniques. Radioactive isotopes of elements such as uranium, thorium, potassium, and carbon are unstable. Their radioactivity is the result of their nuclei giving off subatomic particles—protons and neutrons. As a given nucleus emits

a particle, it decays, changing into another element or isotope. Ultimately the nucleus reaches a point where it is stable and no longer decays. Uranium, for example, ultimately becomes lead. This radioactive decay occurs at a very predictable rate. The term *half-life* is used to describe this rate. It is the amount of time it takes half of all the atoms of a radioactive substance to decay. This varies considerably from element to element. For uranium-238 the half-life is 4.5 billion years, whereas carbon-14 has a half-life of only 5,730 years. Taking a sample of rock, a scientist can compare the ratio of the radioactive element to its nonradioactive end product in that rock and then calculate its age. The process is, of course, more complex than this—one has to determine how much, if any, of the end-product was present at the beginning, and whether there was some intrusion of material in the intervening time period—but that is the basic idea. Using such techniques, the oldest terrestrial rocks are estimated to be about 3.8 billion years old.[12] Since the earth is very active geologically and is subject to weathering, rocks from its earliest period are not likely to have survived. The oldest rocks found by the Apollo astronauts on the moon, which is not geologically active, and which has no weathering, are around 4.2 billion years old. Radioactive dating of meteorites gives ages of 4.5 to 4.7 billion years old.[13] All of this evidence taken together seems to point to the formation of the solar system and this earth around 4.6 billion years ago.

Death before the Fall. This is an issue that has generated much discussion within the Church, with strong opinions held on both sides. In the late 1920s and early 1930s, Elder Brigham H. Roberts, senior president of the First Council of Seventy, wrote and spoke extensively about his beliefs concerning pre-Adamites and death among plant and animal life before the Fall. His views were strongly opposed by Elder Joseph Fielding Smith of the Quorum of the Twelve. Elder Smith's arguments centered on the passage from 2 Nephi 2:22 that if Adam had not fallen, "all things which were created must have remained in the same state in which they were after they were created;

and they must have remained forever, and had no end." Each attempted to have his views confirmed by the Church. Both Elder Roberts and Elder Smith formally presented their views to the First Presidency and the Quorum of the Twelve. Then after careful consideration, the First Presidency, in a report dated April 5, 1931, addressed to the Council of the Twelve, the First Council of the Seventy, and the Presiding Bishopric, stated, "Neither side of the controversy has been accepted as doctrine at all."[14] Thus the First Presidency made it clear that the Church has no official stand concerning the existence of pre-Adamites or death among plants and animals before the Fall.

Soon after this, Elder Talmage, who was a geologist called to the Quorum of the Twelve, was invited by the First Presidency to give a talk on the issue. The talk, entitled "The Earth and Man," was given in the Tabernacle on August 9, 1931. In this talk Elder Talmage stated that the earth was extremely ancient. He also confirmed that life and death occurred on the earth long before the coming of man: "But this we know, for both revealed and discovered truth, that is to say, both scripture and science, so affirm—that plant life antedated animal existence, and that animals preceded man on earth. . . . These [plants and animals] lived and died, age after age, while the earth was yet unfit for human habitation."[15]

In November of that same year, 1931, the First Presidency approved the publication of this speech with slight changes, and it appeared in the Church section of the *Deseret News* on November 17.[16] It was subsequently made available as a Church pamphlet and was republished in the *Instructor*.[17]

It is important here to stress that although there may have been death among plants and animals before the Fall, this does not apply to Adam and Eve. The scriptures and the teaching of the Brethren make it absolutely clear that in the Garden of Eden before the Fall, Adam and Eve were not yet subject to death, and it was only by partaking of the forbidden fruit that they became mortal.

Elder Talmage certainly supported the view that among plants and animals there was death before the Fall. If there were

no death before the Fall, it would be very difficult to account for all the fossilized remains of now-extinct flora and fauna located in geologic strata all over the earth. In addition, fossils of animals show signs of tumors, rheumatic disorders, arthritis, abscesses, and breakage, and fossils of plants show spot fungi, burls, and insect galls.[18] All these seem to indicate that death and disease were part of living things millions of years ago.

Fossils. Some have tried to account for fossilized remains by suggesting that the earth was formed from parts of other planets and that these fossils are plants and animals from these other worlds. For support, they refer to a quote from Joseph Smith that "this earth was organized or formed out of other planets which were broken up and remodeled and made into the one on which we live."[19] This is not, however, a direct quote from Joseph Smith, but comes from an entry in William Clayton's journal.[20] William McIntire was at the same sermon and recorded what Joseph said somewhat differently: "this Earth has been organized out of portions of other Globes that has ben [*sic*] Disorganized."[21] Here McIntire uses "globes" rather than "planets," which could refer to any celestial bodies—planets, comets, asteroids, or stars. All the elements out of which this earth is formed, with the exception of hydrogen and some helium, were formed inside stars. The elements from helium to iron were formed in the various stages of fusion a star goes through during its lifetime. Elements heavier than iron are formed primarily in supernova explosions and are then dispersed throughout the galaxy by those explosions. Thus the elements of this earth did indeed come from other "globes" that were disorganized—a supernova is a fairly substantial disorganization! Moreover, it is reasonable to assume that our own earth is typical of what God does in preparing other worlds for his children. Therefore, after an inhabited world has passed through its mortal state, it is not disorganized and thrown into a junk pile for reuse in forming other worlds but is rather resurrected and celestialized.

Another telling argument against fossils being the remains of plants and animals from fragments of other worlds is the

sequential way in which they are preserved—in strata or layers. Fossilized plants and animals found at great distances from each other all over the earth are found in equivalent strata, and in the same order within these strata. Were this earth formed from bits and pieces of other planets, this would likely not be the case.

Fossils are simply the remains of life-forms that were once here on the earth and have become extinct. Extinction is a process we are familiar with; we see plants and animals becoming extinct all the time.

Fossils of manlike creatures. What about these manlike creatures that evidently lived on the earth thousands or even millions of years ago? The scriptures do not mention them. What are they? What is our relationship to them? They are certainly creations of our Father in Heaven, but he has not revealed to us their purpose in his plans. In any event, whatever they are, they are not our ancestors, as the First Presidency statement on the origin of man made clear in 1909:

> It is held by some that Adam was not the first man upon the earth, and that the original human being was a development from lower orders of the animal creation. These, however, are the theories of men. The word of the Lord declares that Adam was "the first man of all men" (Moses 1:34), and we are therefore duty bound to regard him as the primal parent of our race. It was shown to the brother of Jared that all men were created in the beginning after the image of God; and whether we take this to mean the spirit or the body, or both, it commits us to the same conclusion: Man began life as a human being, in the likeness of our heavenly Father.[22]

There is no doubt that in the past there were manlike creatures on the earth. But they are not related to us. Hugh Nibley said it well:

> Do not begrudge existence to creatures that looked like men long, long ago, nor deny them a place in God's

> affection or even a right to exaltation—for our scriptures allow them such. Nor am I overly concerned as to just when they might have lived, for their world is not our world. They have all gone away long before our people ever appeared. God assigned them their proper times and functions, as he has given me mine—a full-time job that admonishes me to remember his words to the overly eager Moses: "For mine own purpose have I made these things. Here is wisdom and it remaineth in me" (Moses 1:31). It is Adam as my own parent who concerns me.[23]

Organic evolution. The scriptural accounts of the Creation do not give the particulars of the process by which life originated on this earth. But they do make it clear that God was the source and author of all life and was intimately and continuously involved in bringing it forth on this earth. It was not and indeed *cannot* have been, as some scientists maintain, the result of "nothing but a set of individually mindless steps succeeding each other without the help of any intelligent supervision."[24] The details of how God accomplished the placing of life on this earth are not explicitly stated in the scriptures, but his intimate involvement is made absolutely clear. Moreover, he has endowed living organisms with a remarkable degree of adaptability to take advantage of a wide range of environments so they can "fill the earth" as God commanded. Some of the mechanisms described in evolutionary theory may well be the means by which this is accomplished.

In connection with this, we need to recognize what life really is. Life is not simply a self-replicating machine. The scriptures teach us that every living thing consists of both a physical body and a spirit. "And every plant of the field before it was in the earth, and every herb of the field before it grew. For I, the Lord God, created all things, of which I have spoken, spiritually, before they were naturally upon the face of the earth. . . . All things were before created; but spiritually were they created and made according to my word" (Moses 3:5, 7). Indeed it is the process of placing a preexistent spirit into a physical

body that produces a living soul. "I, the Lord God, formed man from the dust of the ground, and breathed into his nostrils the breath of life; and man became a living soul" (Moses 3:7). This is true not only for man but for animals and plants: "And out of the ground I, the Lord God, formed every beast of the field, and every fowl of the air . . . and they were also living souls; for I, God, breathed into them the breath of life" (Moses 3:19); "And out of the ground made I, the Lord God, to grow every tree, naturally, that is pleasant to the sight of man; and man could behold it. And it became also a living soul" (Moses 3:9).

THE ETERNAL NATURE OF MATTER AND INTELLIGENCE

Latter-day Saints view creation differently than the standard Judeo-Christian doctrine of creation ex nihilo, or out of nothing. The scriptures teach us important and fundamental truths about the universe in which we live. First of all, we learn that "The elements are eternal" (D&C 93:33). God did not create them; they have always existed and will always continue to exist. From a scientific point of view, we might say that matter and energy are eternal, since matter and energy are interchangeable—one can be converted to the other, but neither can be destroyed, as Einstein's famous equation $E = mc^2$ illustrates. Also, "all spirit is matter, but it is more fine or pure" (D&C 131:7). Physical matter and spirit matter are not fundamentally different—spirit matter is simply more refined. Finally, intelligences "have no beginning; they existed before, they shall have no end, they shall exist after, for they are gnolaum, or eternal" (Abraham 3:18), and "intelligence, or the light of truth, was not created or made, neither indeed can be" (D&C 93:29). Intelligence, the ultimate individual identity of every living thing, is also eternal and uncreated.

God's creative work, then, does not produce something out of nothing. It is a process of organizing three eternally existing components—physical matter or energy, spirit matter, and intelligence—utilizing eternal laws that govern this process. "We will go down, for there is space there, and we will take of

these materials, and we will make an earth whereon these may dwell" (Abraham 3:24). By so doing, God fulfills his purpose of bringing to pass "the immortality and eternal life of man" (Moses 1:39).

CREATION PLANNED BEFOREHAND

The Abrahamic account reveals another important piece of information about the Creation. It describes a council in heaven where the plans for the Creation were discussed and worked out (see Abraham 5:1–3). President Spencer W. Kimball explained:

> A plan was presented in the great council. Before this earth was created the Lord made a blueprint, as any great contractor will do before constructing. He drew up the plans, wrote the specifications, and presented them. He outlined it and we were associated with him. . . . Our Father called us all together as explained in the scripture, and plans were perfected now for forming an earth. In his own words: "And there stood one among them that was like unto God, and he said unto those who were with him: We will go down, for there is space there, and we will take of these materials, and we will make an earth whereon these may dwell. . . ." (Abraham 3:24) That assemblage included us all. The gods would make land, water, and atmosphere and then the animal kingdom, and give dominion over it all to man. That was the plan. . . . God was the Master-worker, and he created us and brought us into existence.[25]

THE SEVEN CREATIVE PERIODS

The three scriptural accounts all agree that "in the beginning" God created the heavens and the earth. But this is not the beginning of the entire universe, as the account in Moses makes clear: "Behold, I reveal unto you concerning *this* heaven, and *this* earth" (Moses 2:1; emphasis added). This earth is but one of innumerable worlds that our Father in Heaven has created as places of mortal probation for his

children, where they learn to develop the divine potential within them to become like him (see Moses 1:35–39; Abraham 3:24–26). Thus the scriptural creation accounts do not describe the creation of the universe, but only the organization of the earth and its surrounding environment—perhaps what we would call the solar system. The universe with its myriad stars, planets, galaxies, and so forth was already there.

Another important point is that Abraham and Moses described the visions they saw of the Creation using language that lacked the specialized scientific vocabulary we now have. Nuclear fusion, gravitation, genetic code, greenhouse effect, atoms, molecules, chemical reactions, and so forth are all part of the creation, but ancient languages lacked terms for these concepts. Much of the challenge of correlating the scriptural accounts of the Creation with scientific knowledge lies in "translating" the language Abraham and Moses used into modern, scientific terminology.

In what follows, I attempt to correlate the events of the Creation as described in scripture with the latest scientific evidence and theories of the formation of the earth and our solar system. The dates I give are not to be considered the last word but rather the best present estimates based on a variety of scientific techniques, especially those derived from the measurement of radioactive decay. At the end of the paper is a chart showing the six creative periods, the events occurring in each, and the estimated dates.

The first period: formation of the solar system (Genesis 1:1–5; Moses 2:1–5; Abraham 4:1–5). We begin with God indicating a region of space where there was sufficient preexisting unorganized matter to organize and form this earth and solar system: "There is space there, and we will take of these materials, and we will make an earth" (Abraham 3:24). The next step in the process was to cause "darkness to come upon the face of the deep" (Moses 2:2), which implies that there was light previous to this—presumably the light of all the myriad stars and galaxies of the universe. Then light was produced: "Let there be light" (Genesis 1:3; Moses 2:3; Abraham 4:3).

And "the earth, after it was formed, was empty and desolate" (Abraham 4:2). We can summarize the events of the first period as follows:

- There was a region of preexistent matter from which God organized this solar system.
- The first step was to cause darkness.
- Then light was produced.
- The earth in its initial state was empty and desolate.

Let us now compare this description with the generally accepted theory of the formation of the solar system. Around 4.7 billion years ago, there was a large cloud of gas and dust with some intrinsic rotation. This cloud, perhaps under the influence of a shock wave from a nearby supernova, began to collapse upon itself due to the mutual gravitational attraction of the constituent gas molecules and dust particles. Since about 75 percent of all the matter in the universe is hydrogen, it was a major component of the cloud. Abraham and Moses perhaps used the term *waters* or *deep* to describe this cloud consisting predominantly of hydrogen. Water, H_2O, is made up of two molecules of hydrogen and one of oxygen. The word *hydrogen* means "water producer" in Greek. As this cloud of gas and dust began to collapse, it became denser and began to block out light; hence the darkness.

As this cloud continued to collapse, the gravitational potential energy of the individual molecules and particles was converted into heat, and eventually in the center of this cloud the density and temperature became high enough to sustain nuclear fusion of hydrogen into helium.[26] There are regions in our galaxy where we see such dark clouds—the Horsehead Nebula in Orion is perhaps the best known—and infrared observations of these clouds show that stars are forming within them.[27]

Regions of higher density within the cloud eventually collapsed to form the planets, asteroids, comets, and other parts of the solar system. Close to the sun, the temperature was higher, which allowed only small, rocky planets like the

earth to form. Further out, the temperature was lower, allowing larger, gaseous planets like Jupiter and Saturn to form.[28]

Once fusion started in the core of the protosun, light pressure began to drive out the remaining gas and dust. Stars in this stage of development, i.e. pre–main sequence stars surrounded by dark clouds of gas and dust, have been observed and are called T-Tauri stars.[29] Naked T-Tauri stars are the next stage, in which the cloud has mostly been dispersed.[30] Thus the creation of light seems to refer to the start of nuclear fusion in the core of the sun. It is not, however, until the fourth period that the various "lights" in the heavens become visible, because it took some time for the light pressure of the sun to disperse the dark cloud in which the solar system was formed.

The earth also was formed in this cloud of gas and dust by the accretion of rocky bodies produced within the cloud. This accretion as well as the decay of radioactive elements produced a rapid internal heating, which drove off the initial atmosphere of hydrogen and inert gases and melted the planet. Lighter materials rose to the surface to ultimately form the crust of the earth, and the denser material sank to form the molten nickel-iron core. The earth began to cool, and by about 3.7 billion years ago, the first continents appeared and plate tectonics began.[31]

The events of the first period took place roughly between 4.6 and 3.6 billion years ago, according to the most recent scientific dating techniques.

Second period: formation of the atmosphere (Genesis 1:6–8; Moses 2:6–8; Abraham 4:6–8). In the second period God formed an "expanse" in the midst of the "waters" to separate the waters above from the waters below (Abraham 4:6). This seems to describe the formation of the earth's atmosphere. About 4 billion years ago, volcanic activity caused by interior heating in the earth's crust produced a second atmosphere, containing outgassed water, methane, ammonia, sulfur dioxide, and carbon dioxide.[32] This was also a period of massive bombardment by large meteors and asteroids, which fractured the earth's crust.[33] The scars of this bombardment have

mostly been weathered away on the earth, but are still clearly visible on the moon, Mercury, and, to a lesser extent, Mars. After the earth had cooled enough, the earth's ocean basins, which were formed by the combined effect of these bombardments and plate tectonic movement, began to fill with rain that condensed out of the atmosphere.[34]

Beginning about 3.5 billion years ago, photosynthesis by cyanobacteria (primitive one-celled organisms without a distinct nucleus) began to release oxygen into the atmosphere.[35] However, prior to 2 billion years ago, it remained a reducing atmosphere with little free oxygen. Large deposits of reduced minerals such as banded iron chert, detrital pyrite, and uranite could not have formed if even 0.1 percent of the atmosphere had been oxygen. Sometime between 2 and 1.5 billion years ago, levels of oxygen increased to the point that no more reduced minerals formed. From that point on, oxidized minerals are found in the geological record.[36] About 1.5 million years ago, green algae, the first eukaryotes (organisms with nuclei in their cells), began to appear. Green algae are much more efficient photosynthesizers than cyanobacteria, and they began to add more oxygen to the atmosphere until, around 800 million years ago, the oxygen level reached about 5 percent of the present value.[37]

Another important component of the atmosphere was also formed during this period—the ozone layer. Energetic ultraviolet photons began to dissociate water molecules in the atmosphere. The light hydrogen atoms escaped into space while the heavier oxygen atoms remained behind. The oxygen atoms in turn combined to form oxygen molecules (O_2). As O_2 accumulated in the upper atmosphere, it was again dissociated into free oxygen atoms, which in turn combined with other O_2 molecules to form ozone (O_3). The dissociation-association process eventually stabilized, forming the ozone layer. This filtered out harmful ultraviolet light, which not only prevented any further dissociation of water but also allowed life to flourish,[38] since high levels of ultraviolet light are lethal to most living organisms.

The proper mixture of gases in the atmosphere is critically important for sustaining life on the earth. For example, although carbon dioxide and water vapor make up only a very small part of the atmosphere, without them the average temperature of the earth would be about –40° Celsius.[39] It is clear that at various stages of the creative process God carefully arranged for modifications in the earth's atmosphere that would ultimately provide one suited to the animal and plant life now found here.

The earth's magnetic field, produced by its rotating liquid nickel-iron outer core, also helps protect life on the earth's surface. This field deflects the potentially harmful stream of charged particles coming from the sun, called the solar wind, and forms the well-known Van Allen radiation belts.[40]

The events of the second period, in which the present atmosphere of the earth was formed, seemed to have occurred between 4 billion and 600 million years ago, thus overlapping with both the first and the third periods.

Third period: oceans and continents, plant life (Genesis 1:9–13; Moses 2:9–13; Abraham 4:9–13). During the third creative period, the seas were formed and dry land appeared. As indicated above, the water that forms the seas and other bodies of water on the earth came from volcanic outgassing of water vapor, which condensed as rain and began to fill the low-lying areas. Also with the cooling of the crust of the earth around 3.7 billion years ago, the major continental plates formed and the process known as plate tectonics began.[41] As the various continental plates collided with each other, mountain ranges began to form, a process that continues to the present time. The weathering of the earth by rain and wind also caused major changes over time.

Next God prepared the earth for plant life. When it was first formed, the earth was far from being a favorable environment for life. It had an atmosphere of carbon dioxide, hydrogen, sulfur dioxide, methane, and other compounds, but lacked any free oxygen. Plants would thus necessarily be the first living organisms to be placed on the earth because of their

ability to convert carbon dioxide into oxygen, which is essential for animal life. The earliest fossil remains in the rocks of the earth, called stromatolites, were formed by cyanobacteria and date back to around 3.5 billion years ago. These remained the dominant form of life until about 1.5 billion years ago,[42] although in Precambrian rocks found in South Africa there are fossil remains of tiny rod-shaped forms that resemble living bacteria in their cell-wall structure.[43] There is some genetic evidence that perhaps archaebacteria preceded the cyanobacteria, but there is no fossil evidence to support this.[44] This means that life appeared on the earth very soon after the crust cooled and solidified.

It is interesting that some scientists have proposed terraforming the planet Venus, converting it to an earthlike environment, by seeding its clouds with cyanobacteria, which would convert the predominantly carbon dioxide atmosphere to oxygen. The reduction of carbon dioxide would in turn reduce the greenhouse effect, and the temperature would drop. Eventually, water vapor in the atmosphere (which contains enough water to cover the entire surface of Venus with 100 inches of water) would condense and fall as rain. Over time the average surface temperature of Venus would drop to around 70 to 80 degrees Fahrenheit, with oceans forming in the depressions.[45] This is, in essence, the process God seems to have used in preparing our earth for more advanced forms of life.

Land plants appeared much later during the Middle Silurian period, some 420 million years ago, and did not become common until near the end of the Devonian, about 360 million years ago.[46] The first appearance of flowering plants (angiosperms) was not until about 120 million years ago.[47] Grasses are not found until around 57 million years ago.[48]

The progressive appearance of plant life[49] on the earth thus stretched over an enormous period of time—from about 3.5 billion years to 57 million years ago, when the variety of plant life was much like what we now have on the earth.

Fourth period: appearance of the sun, moon, and stars (Genesis 1:14–19; Moses 2:14–19; Abraham 4:14–19). During this phase

of the Creation, God organized the various "lights" in the heavens—the sun, moon, and stars. As explained in the section on the first period, once hydrogen fusion had started in the sun, light pressure would have progressively ejected the remaining gas and dust of the original cloud out of which the solar system formed, thus progressively making these various heavenly bodies visible. This dispersal of the gas and dust occurred within a few million years after fusion started in the protosun.

Organizing the lights for seasons, days, and years seems to refer to the setting of the orbital and rotational periods of the earth and moon. A year is the time it takes for one orbit of the earth around the sun. A month was originally measured as the time period from one new moon to the next, which is based on the orbital period of the moon around the earth. A day is the time it takes the earth to rotate once on its axis. The seasons can also be determined by which constellations are visible at a given period during the year. Moreover, the various seasons are the result of the tilt of the earth's axis with respect to its orbital plane, as well as the eccentricity of its orbit about the sun. All these various aspects of the motions of the earth and the moon had to be fine-tuned to produce the times and seasons we now have.

Fifth period: sea animals and birds (Genesis 1:20–23; Moses 2:20–23; Abraham 4:20–23). God's preparation of the waters to support animal life included providing the proper proportions of dissolved salt and other minerals and ensuring that there would be sources of oxygen and food (plants). In agreement with the scriptural accounts of creation, both plant and animal life appeared first in the oceans. Only in rocks less than 1.5 billion years old are microfossils of eukaryotic cellular organisms found, which are much more complicated than prokaryotic organisms like cyanobacteria.[50] It was only when oxygen levels reached about 5 percent of the present value, some 800 million years ago, that more complex multicellular (metazoan) life began to appear.[51]

About 600 million years ago, at the beginning of the Cambrian period, there was a rapid increase in the variety of

higher life forms, called the Cambrian explosion.[52] Around 490 million years ago, exoskeletal animals such as trilobites, brachiopods, and shelled mollusks appeared. By 550 million years ago, the first vertebrates, such as jawless fish and graptolites, appeared.[53]

It was not until 145 million years ago that birds first appeared, and they are, of course, land animals. Why birds are included with sea animals rather than land animals is not clear, but as stated earlier, the separation of the events of the creation into periods is in a sense artificial, since the whole process was a continuous one.

After creating life, God caused the living things "to be fruitful and multiply, and fill the waters . . . and . . . to multiply in the earth" (Abraham 4:22). This refers to the prolific capability God designed into all life to adapt itself to an incredible variety of environmental conditions and fill every ecological niche.

Sixth period: land animals and man (Genesis 1:24–31; Moses 2:24–31; Abraham 4:24–31). In the sixth and final period of creation, God prepared the land to be an environment conducive to life. This included the weathering of rocks to produce soil, the establishment of land plants to provide food and oxygen for land animals, and so on. As this process progressed, more complex forms of animal life could be supported. The fossil records show that about 370 million years ago, amphibians first appeared. By 340 million years ago the earliest reptiles (cotylosaurs) were present, and by 320 million years ago mammal-like reptiles (pelycosaurs) were found. Winged insects appeared around 310 million years ago, and dinosaurs came on the scene about 240 million years ago. By 220 million years ago, there was a large variety of mammal-like reptiles, but it was not until about 90 million years ago that marsupials (animals with pouches like a kangaroo) and placentals (animals in which the young develop in a womb with a placenta) appeared.[54]

Around 65 million years ago, at the end of the Cretaceous period, there was a period of mass extinctions, in which dinosaurs and many other kinds of life disappeared. This may have been caused by a giant asteroid impact.[55] The fossil record

also shows other major extinction events such as the Permian around 250 million years ago.[56]

The first primates appeared 62 million years ago, and by 60 million years ago there was a great diversity of mammal types. Rodents first arrived on the scene about 45 million years ago, and hominids (manlike creatures) about 19 million years ago.[57]

The first appearance of *Homo sapiens sapiens* (human beings) and *Homo sapiens neanderthalensis* (Neanderthals) seems to have been about 125,000 years ago, when fossils of both are found. This was at about the temperature maximum of the last interglacial period. Around 30,000 years ago, Neanderthals seem to have become extinct. By 18,000 years ago, the last ice age reached its maximum, with glaciers covering large areas of northern Europe and North America.[58] About 11,600 years ago, there was a rapid warming, and the ice sheets melted, producing catastrophic flooding of the Mississippi Valley and other places.[59] Could this have been the biblical flood?

This final stage of the creation seems to have covered a period from about 370 million years ago to the point when Adam and Eve were first placed on the earth.

Seventh period: Sabbath (Genesis 2:1–3; Moses 3:1–3; Abraham 5:1–3). The seventh period is actually not part of the creation, but is the rest period after the work was done. We have no information as to how long it lasted.

CONCLUSION

This paper is certainly not meant to be the final word on the incredibly complex subject of the Creation from both a scriptural and scientific perspective. Advances in science and new revelation could alter some, or even many, of the conclusions made here. What is clear, however, is that there are no insurmountable areas of disagreement between the scriptural accounts of the Creation and our present scientific understanding. When looked at from the proper perspective, there is, in fact, a remarkable degree of agreement. Indeed, *true* religion and *true* science will always be in harmony.

Possible Chronology of the Events of Creation

Period	Activity	Details	Years before present
First	Formation of solar system	Earliest meteoroids formed	4.7 billion
		Solar system formed	4.6 billion
		Oldest lunar rocks	4.2 billion
		Oldest terrestrial rocks	3.8 billion
Second	Formation of atmosphere	First (original) atmosphere	4.0 billion
		Volcanic activity formed second atmosphere	4.0 billion
		Blue-green algae begin to produce O_2 in atmosphere	3.5 billion
		Oxygen level reaches 5 percent of present value	800 million
Third	Formation of continents and ocean	Plate tectonics begins	3.7 billion
		Cyanobacteria (blue-green algae)	3.5 billion
	Plant life	Green algae	1.5 billion
		Land plants	420 million
		Flowering plants	120 million
		Grasses	57 million
Fourth	Appearance of sun, moon, and stars	Light pressure from the sun clears out residual gas and dust	4.5 to 4.4 billion
Fifth	Sea animals and birds	Cambrian explosion of complex life forms	600 million
		Exoskeleton animals	590 million
		Vertebrates	550 million
		Birds	150 million
Sixth	Land animals	Amphibians	370 million
		Reptiles	340 million
		Mammal-like reptiles	320 million
		Marsupials and placentals	90 million
		Primates	62 million
		Rodents	45 million
		Hominids	19 million

NOTES

This chapter is modified from Michael D. Rhodes and J. Ward Moody, "Astronomy and the Creation in the Book of Abraham," in *Astronomy, Papyrus, and Covenant*, ed. John Gee and Brian M. Hauglid (Provo, UT: Institute for the Study and Preservation of Ancient Religious Texts, 2005), 17–36.

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32. Zeilik, Gregory, and Smith, "Interstellar Medium," 76.
33. Zeilik, Gregory, and Smith, "Interstellar Medium," 76.
34. Zeilik, Gregory, and Smith, "Interstellar Medium," 76.
35. Shu, *Physical Universe*, 494.
36. Rich and others, *Fossil Book*, 79.
37. Emiliani, *Scientific Companion*, 156.
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42. Emiliani, *Scientific Companion*, 151.
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44. Emiliani, *Scientific Companion*, 151.
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