

Evaluating The Day Four Cratering Hypothesis

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Abstract

The hypothesis that impact craters took place in the solar system on the fourth day of creation is evaluated. Both biblical and scientific aspects are considered. After seriously considering Faulkner's proposal I am acknowledging the fourth day impacts hypothesis as a valid option for creationists. I am prepared to adjust my view of impact cratering to allow 1) for impacts before Noah's Flood, 2) to allow for God protecting earth from impacts, and to allow 3) that God could have used impacts to form and shape solar system objects. Furthermore, this view has advantages over secular planetary science in explaining elemental abundances in the solar system.

Keywords: Impacts, craters, solar system, Creation account

Creationists have recently considered impact cratering in the solar system occurring during the fourth day of the Creation Week. This was discussed in a forum conducted at the Seventh International Conference on Creationism. Then recently Faulkner put forward this proposal in an *Answers Research Journal* paper (Faulkner 2014). Young-age creationists have debated the question of when impact cratering took place in the solar system and on earth (Faulkner 1999, 2000; Froede 2002; Froede and DeYoung 1996; Oard 2009, 2012, 2013; Samec 2008; Spencer 1994, 1998, 1999, 2002, 2008, 2013). Cratering is ubiquitous throughout the solar system, except for certain objects such as the gaseous planets, or objects that have evidence of being resurfaced. Yet earth seems to stand apart in having much fewer known identifiable impact sites than other solar system objects, including our moon. Using the Moon to estimate the number of impacts on Earth would seem a logical approach, but after considering this, I would say it is not clear how to scale the cumulative number of craters from one object to another. Oard (2009, 2012) and Spencer (2013) have both addressed this problem. The inevitable conclusion implies tens of thousands of sizable impacts on earth (perhaps as high as 58,000 from Spencer [2013]), in scaling from the Moon to the Earth based on gravitational cross section and surface area. To have so many impacts on earth, generating craters 30km (18.6mi) diameter and larger, seems unrealistic and hard to reconcile with the number of identifiable earth crater sites. Yet there is clear evidence for impact craters throughout the geologic column and in rocks that most creationists agree would have formed in Noah's Flood (Spencer 1998). The key questions then become, "When did the bulk of the impacts occur?" and "How many occurred on earth?"

Creationists are now considering impacts during the Creation Week, and Faulkner (1999, 2014) proposes some helpful ideas on applying this hypothesis. On the one hand, we must hold to a literal six day view of Genesis 1 and be true to Scripture; on the other hand there is a need for an approach to dealing with the observational evidence in the solar system regarding impacts. In an old-age naturalistic (evolutionary) view cratering is seen as being especially intense in the period from 4.6 to 3.8 billion years ago when the planets and other objects in our solar system were forming. Planetary scientists split this period loosely into two periods called the Early Heavy Bombardment and the Late Heavy Bombardment. These were referenced by Faulkner (2014). Roughly the same period is referenced by geologists as the Hadean period. Since that early period the understanding is that cratering has been essentially random and of a roughly constant rate. Furthermore, in the secular scientific community, earth is treated as just another planet in our solar system. That is, secular scientists assume it was subjected to impacts as were other planets, in its formation. Planetary scientists would argue that earth accreted from many planetesimals (similar to asteroids) in the early solar system. In this process earth was bombarded by planetesimals, just as other planets (and other objects) were. It is understood that earth's active geological processes, including plate tectonics, have reworked earth's surface and destroyed evidence of many of the early earth's craters.

I have suggested a view that impacts began at approximately the beginning of Noah's Flood and continued for some time after the Flood (Spencer 1998). This view associated impacts with God's judgment in the Flood and held that impacts did

not occur at the time of Creation or the Fall. Unless the number of impacts on earth were dramatically fewer than the estimates by Oard (2009) and Spencer (2013), this does not seem plausible because of the severe effects this could have during Noah's Flood. Oard uses a factor of 18.9 for the ratio of the number of earth impacts to the number of lunar impacts, considering surface area and gravitational cross section. Scaling estimates such as this suggest there should be tens of thousands of significant impacts on earth. Thus the fourth day cratering hypothesis is worthy of consideration. Even if one assumed the number of impacts on Earth were comparable to the number of observable craters on the Moon considered in the crater statistics referred to by Spencer (2013), this would imply on the order of 3000 impacts on Earth (see Spencer 2013 for a similar lunar crater number). This is assuming no scaling effects from earth's greater surface area and gravity. This would be an unrealistically small number considering how much larger the Earth is than the Moon. Yet we find much fewer than this in known earth impact sites. Spencer (2013) references one list of earth impact sites containing 184 sites likely to be craters. Though Noah's Flood could destroy many crater structures, a question remains as to whether the Flood is the entire answer. I have approached the issue of cratering with an assumption that I now find may be incorrect. This assumption has been that there was no supernatural intervention by God to protect earth from impacts. This seemed an appropriate assumption. But, whether we place impacts in the Creation Week or at some other time, it seems inescapable that some unknown factor reduced the effects of impacts on the earth. Some sort of intelligently directed bombardment that limited object trajectories could also be a possibility, but this is very close to Faulkner's hypothesis also. It is very difficult to imagine any natural physical effect that would so dramatically reduce the number of impacts on earth. Thus some degree of supernatural protection of earth from impacts seems to be a necessity, regardless of when they took place. If supernatural protection of earth is a possibility, this in turn opens up the possibility of impacts in the solar system at some time prior to the Flood.

Creationists have generally held to a view of Genesis chapter 1 which interprets the Moon to have been formed on the fourth day, not that it was formed on the first day and was merely made visible on the fourth day. Kulikovsky (2009) argues persuasively for this from the Hebrew, for example. This seems to rule out impacts on the first three days of the Creation Week. The Moon must exist and have a surface before impacts can form on its surface. If impacts took place on earth on the fourth day of

creation this would have very negative effects on life, even without directly killing animals. This is because of plants being made on the third day of Creation. Plants must be present for food on the fifth and sixth days. Thus if impacts take place on the fourth, fifth, or sixth days of Creation, it seems they could not happen on earth. Faulkner stresses that Earth was formed first, then other solar system objects are inferred to have formed on the fourth day along with the Sun and Moon. Solar system objects outside earth were not created for living things and they were made at a later time than the earth's formation. Earth itself as a planet was essentially "finished" over a period of three days, then populated with animals on the fifth and sixth days. We are given no details about how planets, moons, or other small bodies in the solar system were created. We know from Scripture that everything was completed in the Creation Week.

A biblical consideration regarding the fourth day cratering concept is in assuming that God created matter on the first day of Creation Week that was later re-formed into other materials and objects. I believe this is possible from considering the language of Genesis 1, though it is not the only possibility. Since we do not have a detailed description in Scripture of the formation of the Moon or planets, the question to consider is whether Scripture rules out the Day Four cratering hypothesis. In my opinion, there is no way to show definitively from Scripture that matter was present before the formation of solar system bodies like planets, but neither does it rule it out. Fields (1976) argues that the initial statement of Genesis 1:1, "In the beginning God created the heavens and the earth" (NIV) is not merely a summary of the Creation account, but is the first creative action. Kulikovsky (2009) implies a similar view. We do not know all that may have been included in this initial creative action but it seems matter and energy, as well as space and time were initiated in this action. Earth's initial incomplete state is then described in Genesis 1:2 as covered with water and "formless and empty" (NIV). There is no description of what may have existed away from the earth after this initial action. Thus it seems possible matter could have been created in some form before Day Two. But even if there was no rocky material outside earth until Day Four this would not necessarily negate the possibility of the Moon being supernaturally assembled on the fourth day from smaller objects, as Faulkner suggests. It is also possible the small bodies were actually created on the fourth day, then used to assemble solar system objects. So the fourth day impacts hypothesis does not necessarily depend on solid objects being created on the first day, though this is Faulkner's proposal.

We know the Sun and Moon were created on the fourth day of creation and the stars are also listed as created on the same day. It seems reasonable to infer that objects in our solar system outside earth were also created on the fourth day, though this is not stated in Genesis. There are various statements in Genesis 1 saying “Let there be ...” or similar and these “Let there be ...” statements are often followed by a statement like “and it was so.” For example Genesis 1:3 follows this very obviously regarding the creation of light. Then in verse 6 (NIV 1984), it says “Let there be an expanse...” and this follows in verse 7 by the statement, “And it was so.” Verse 24 is similar but it says “Let the land produce living creatures ...” followed by “And it was so” at the end of the verse. Some might object to the Day Four cratering hypothesis arguing that Scripture teaches God spoke things into existence by fiat command. The “let there be...” and “and it was so...” statements above seem to describe God’s creative command followed by a confirmation that it was finished and that it happened immediately because of His command. But it may not be necessary to take “and it was so” as implying something instantaneous. The essential points are that we understand the authority of God’s word caused the events to happen and it was completed in less than a day. God can speak things into existence instantaneously if he chooses but from the language in Genesis 1 it is not clear what would have been created instantaneously. Whether the Moon was created in 2 microseconds or 2 hours makes little difference, since either agrees with the Creation account and either would be supernatural. Either of these would be something only God could do. Genesis 1 indicates God commanded and then various creations came about in less than a day, complete and fully functional for their intended purpose. Thus there are multiple possibilities for how the Moon may have formed on the fourth day.

Other statements in the Old Testament may give some insight regarding God commanding things into existence. For example Psalm 33:6–9 describes the stars being created by God’s command. Verse 6 states in the NIV (1984), “By the word of the LORD were the heavens made, their starry host by the breath of his mouth.” This verse could be taken to imply that the stars were spoken into existence instantaneously. Psalm 33:9 states in the NIV, “For he spoke, and it came to be....” Even this statement may not necessarily demand an instantaneous process; rapid, yes, but not necessarily instantaneous. The Moon is not mentioned in this passage though there is the expression “all their host.” Two passages with expressions similar to “all their host” would be Nehemiah 9:6 and Isaiah 45:12. These passages seem to refer to the stars and again the Moon is not mentioned. It may be that the expression “all their host” in the passages above refer to objects

like stars that are not near earth. This is suggested in the context by the fact that earth is mentioned separately. So earth is contrasted with everything far away from earth. The Sun and Moon seem to get more attention in the Creation account than stars in the rest of the universe, presumably because they directly affect life on Earth. Thus, Faulkner’s proposal, that some sort of “raw materials” were created on the first day of Creation Week which were reorganized into the Sun and Moon (and presumably other objects) on the fourth day is not ruled out by Scripture. Samec (2013) suggested a similar process which he referred to as “in-place formation.” In Samec’s “in-place formation” concept objects, possibly including stars, could have formed from matter that was nearby, such as nebulae.

A further assumption made in the Day Four cratering hypothesis is that there were solid rocky or icy objects “left over” in the solar system after the formation of the Moon and planets that caused impacts in the Creation Week. Though not mentioned in Scripture, I would agree this is a possibility if you can accept that impacts could have been a physical process used to shape the appearance of the surfaces of solar system objects. However it raises a question as to whether impacts occurring in the Creation Week are something “good,” “bad,” or “neutral.” In other words, are impacts in the Creation Week something “very good” as described in Genesis 1:31? Faulkner argues that outside of earth impacts can be considered “neutral” since they would not affect life. I am now willing to concede this as a possibility. Faulkner does not seem clear if this early impact bombardment ended on the fourth day or whether it continued for some time in the solar system. But Faulkner maintains this early bombardment (which he refers to as the EHB, for Early Heavy Bombardment) did not affect Earth at all, though it did affect our Moon. Faulkner then adds that another event took place at the time of the Flood which caused a limited number of impacts on earth as part of the Flood event.

Faulkner stresses in recent papers (Faulkner 2013a, 2013b, 2013c) how assumptions Christians make about how God would have created can become stumbling blocks to understanding. We have a great tendency to assume God would have done his creative work a certain way, even though it may be an arbitrary assumption we are making and not something indicated in Scripture. We should hold to what Scripture reveals without compromise but yet not expect Scripture to explain all the details of how God created. This is why we can explore various possibilities logically and scientifically to see where they lead us. Therefore I would like to acknowledge that Faulkner’s proposal is a possibility but I would offer some additional cautions on applying the Day Four cratering concept.

- We should be cautious about assuming all objects in the solar system were formed in the same manner. Some objects could have been created differentiated and some not, for example. Every planet and moon in the solar system has its own unique characteristics that are from creation.
- Rapid assembly of planets and moons from smaller objects raises the question of whether objects were initially molten. I would suggest that creationists should not assume objects were initially molten unless it is somehow an advantage in explaining the geology of that body. If planets and moons were initially molten, it may be necessary to suppose the cooling of surfaces was somehow accelerated or was supernatural. This is due to the natural cooling time of molten objects or molten surfaces. It could be that planets and moons were created with solid surfaces and then impacts occurred on them on the fourth day.
- Small bodies left over after creation may imply orbital changes took place after the Creation Week that could have caused impacts in the solar system before the Flood. (This need not necessarily include impacts on earth.) This is due to the time scale of orbital perturbations and chaotic motion effects of the asteroids and some comets. Some asteroid and comet orbits can change on timescales of tens to a few hundred years (when not near the Sun). This raises the question of how stable were the orbits of these “left over” bodies? Would impacts before the Flood be an occasional possibility or was earth also miraculously protected between Creation and the Flood?
- If the Moon and other objects were formed by a kind of miraculous assembly from smaller bodies as Faulkner suggests, this implies the process was intelligently directed and that differentiation of planets and other objects into interior layers was part of the process. This would have been necessary in order for the process to be completed on the fourth day.
- The geology of various planet and moon surfaces needs to be considered regarding the timing of impacts. For example, on Mars the Tharsis surface bulge which has three very large volcanoes on it is roughly antipodal to the Hellas impact crater. Does this imply the volcanoes formed after the impact, or were the volcanoes present before the impact? If the impact contributed to the formation of the volcanoes, how long did formation of the volcanoes take and when did it occur? Volcanism and other geological processes could give clues regarding the time frame over which impacts took place in some cases.

Bulk Composition in the Solar System

The bulk composition of planets, moons, asteroids, comets, and the Sun can be related to Faulkner’s fourth day impact hypothesis. This may support solar system objects being “assembled” from smaller bodies. The secular view of the origin of the solar system holds that all objects in our solar system formed from the same nebula, referred to as the “solar nebula,” or sometimes as the “solar disk.” An argument that planetary scientists consider to be in favor of this is that for many elements the bulk proportions in various solar system objects are remarkably similar, with the exception of hydrogen and helium. The Sun has a very high proportion of hydrogen and some helium, but it also has other elements. Considering the relative abundances of the elements in the Sun versus other objects such as planets, moons, and various small bodies the abundances are often roughly similar if you do not consider hydrogen or helium (Wood 2011). The bulk composition of planets and moons in the solar system are often compared to that of the various classes of asteroids or the classes of meteorites. Asteroids and meteorites are compared in turn to the solar element abundances (Palme, Lodders, and Jones 2014). Meteorites of the CI chondrite type are considered to be closest to solar abundances. The cases where elemental abundances do not follow “solar proportions” are believed to often relate to the temperature as a function of distance from the Sun in the solar nebula at formation. In addition to this, planetary scientists try to explain some isotope anomalies that don’t fit this pattern by proposing some isotopes came from outside the solar system, or that nuclear processes due to cosmic rays or solar radiation have affected isotope ratios. Though there are some naturalistic assumptions in the methods of comparing element abundances, there are undoubtedly composition similarities across the solar system.

In Faulkner’s fourth day impacts hypothesis, the similar element abundances of various solar system objects could naturally relate to God having assembled them from a similar “stock” of asteroid-like objects. On the other hand, secular planetary science has difficulty explaining a number of anomalies that don’t fit the general pattern. Since in a creation view the assembly of planets, moons, and other bodies was supernatural and directed by intelligent design, there could be unique element or isotope proportions in particular objects. The various objects in the solar system were created to exhibit uniqueness. Thus there is a common compositional pattern that is the general rule, but there are also compositional exceptions to the rule that do not easily fit naturalistic theories. Thus the fourth day cratering hypothesis may have an advantage over

secular theories, because of the role of intelligent design in the process. Naturalistic theories often have difficulty with uniqueness.

An example of how this could be applied in understanding an interesting moon would be Jupiter's moon Io. To compare our Moon to Io, our Moon has a measured density of 3.34 g/cm^3 while Io's density is 3.53 g/cm^3 (Kuskov and Kronrod 2001). Volcanism on Io is extremely active, with a variety of lavas found on the surface, some of which have temperatures as high as 1000 to 1800 K (Keszthelyi et. al. 2004). This and other geophysical data implies Io has a large proportion of silicates and other dense minerals such as various forms of pyroxenes. Thus Io is actually very rocky, though its surface is largely covered with sulfur and sulfur dioxide. In bulk composition Io and Europa are not as different as they appear on the surface. Europa (bulk density 2.99 g/cm^3) is covered with water ice but Io is covered with various forms of sulfur. The bulk composition of Io can be compared to type LL and L chondrite meteorites in terms of the proportions of iron and silicon. This is also similar to our Moon. However, "building" Io from meteorite-like objects does not explain the amount of sulfur present on Io. There may well be some FeS in Io's core but large quantities of sulfur dioxide and elemental sulfur continually erupt onto the surface. Sulfur is extremely rare or nonexistent on the surfaces of all other moons in the solar system. This raises difficult questions for planetary scientists because in an old age view there would have to be some process to effectively recycle the sulfur on the surface down into the mantle and back onto the surface again. This seems unlikely due to how volatile sulfur compounds are. I have suggested a young age view of Io that may be more plausible (Spencer 2003). The sulfur and volcanism on Io points to created uniqueness, as well as similarity of composition across the solar system. Thus, natural processes alone are not sufficient, such as when planetary scientists argue all bodies in the solar system formed from a common source nebula. On the other hand, the fourth day impacts hypothesis suggests a more limited type of "common source" building blocks, but with allowance for the supernatural and intelligent design. The raw materials for creating planets and moons were likely created near where they were needed. This contrasts with the view from secular planetary science, which supposes a roughly uniform protosolar disk that solar system objects formed from. In secular planetary science, only natural processes are applied to explaining how various elements and minerals would come to exist at the locations where we observe them in the solar system. Supposing planets and other objects were supernaturally formed from other objects is an option that allows for similar

compositions of objects but yet allows for uniqueness as well. Thus the fourth day impacts concept is a more effective explanation than naturalistic theories from planetary science in my opinion.

Discussion

The fourth day impacts hypothesis of Faulkner has been considered and is a valid option for creationists. Faulkner suggests various small objects were present after the initial formation of various planets and other objects and these impacted with planets, moons, and possibly other objects on the fourth day of Creation. Faulkner avoids impacts being a threat to earth by the assertion that none of these fourth day impacts took place on earth. I agree this is necessary to make the fourth day impacts concept viable. To put impacts earlier in the Creation Week does not seem to interpret Genesis chapter one correctly. Impacts on earth at the Fall has also been considered by some creationists. I believe this would have the same issue as putting all impacts at the time of the Flood. If you have too many large impacts at the Fall, then life could be seriously threatened. The changes that took place at the Fall were pervasive in nature but catastrophic impacts do not seem to belong in Genesis chapter 3.

I would like to suggest another variation on the fourth day impacts hypothesis, that the impacts which began on the fourth day could have continued in a less frequent manner until Noah's Flood. It could be most of the impacts took place on the fourth day, but since there were "left over" small bodies present, there could have been occasional impacts in the solar system in the pre-Flood period, but probably in decreasing frequency. But, these pre-Flood impacts need not necessarily have affected earth. This would involve a longer event that could be easier to reconcile with the geology of various planets and moons. Then at the time of Noah's Flood, something separate happened to cause impacts on earth which were timed or designed to happen as part of God's judgment of earth. This approach could raise the possibility that God's supernatural protection of earth from impacts began in the Creation Week and continued until the Flood, and then the protection stopped when God judged the earth at the time of Noah. After the Flood, impacts naturally trailed off in frequency.

This approach, including solar system impacts in the pre-Flood period, leaves open the question of how many impacts on the Earth and Moon took place during Noah's Flood. The number of earth impacts was likely more than the number of currently known earth impact sites (which numbers about 184, see Spencer 2013). However, the number need not have been tens of thousands in this scenario. On the other

hand, the number of impacts on our Moon was in the thousands. The number of secondary craters, caused by ejecta from impacts, on the Moon remains unclear. Secondary craters on the Moon could be as many as the number of primary craters. Crater scaling considerations would imply that considering natural processes alone, whereas the Moon would have about 3100 craters from 30–300km (18.6–186.4mi) diameter, this would scale to possibly 58,000 similar sized craters on earth (Spencer 2013). I would now regard this as a valid estimate of what could have happened to earth if God had not intervened. It is only an estimate. It is also valid to question whether crater scaling from one solar system object to another is really even possible.

Another issue which may be brought up regarding earth impacts is the size-frequency crater distribution graphs. This is where the number of craters are graphed as a function of crater size. Relating this to the fourth day cratering concept requires further study. There are various assumptions and estimates used in preparing the size-frequency crater graphs. If the impacts on earth during Noah's Flood coincided with impacts across the inner solar system, this might produce a correlation in crater distributions. However, crater statistics for earth are difficult to compare to other solar system objects because the numbers of craters are so much less. If the number of impacts on the Earth and the Moon during the Flood were only in the hundreds, this may imply the crater distributions for objects outside Earth were not affected by it greatly.

I am now prepared to change my perspective regarding impacts on earth in a young-age creation view. Rather than assuming impacts began at approximately the beginning of Noah's Flood, I would suppose solar system impacts took place on the fourth day of Creation but not on earth. This is only possible due to God's intelligent supernatural intervention to protect earth. Noah's Flood is part of the reason earth has fewer identifiable impact craters than other solar system objects. But the Flood does not seem to be the entire answer. Earth was not spared all impacts; rather they were a contributor to God's judgment in Noah's Flood. It is true that Noah's Flood very likely wiped out evidence of earth impacts, but it now seems this in itself is not sufficient to explain the magnitude of the difference in the number of impacts between earth and other solar system objects. I suspect it is possible the fourth day impacts trailed off in the solar system during the pre-Flood period. Then a separate event led to some impacts on earth during Noah's Flood. Some impacts also trailed off into the post-Flood period and today impacts are rare. This scenario can explain why there are so many impacts in our solar system and yet the solar system gives

evidence of being less than 10,000 years old. The magnetic decay data from Humphreys (1984, 1990, 2008), the evidence from Io (Spencer 2003), as well as short period comets (Spencer 2014) all argue for a young solar system. Thus solar system cratering can be interpreted in a manner consistent with the biblical timescale. This view also gives us reason to thank God for his protection of earth.

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