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Solar System Formation's Timeline by NASA is Questioned

Removing Some Cherished Paradigms

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Introduction

The solar system's formation with its most important milestones is presented. The timelines come from various dating techniques that are considered accurate due to collaboration with more than one dating method and from computerized numerical simulations. Inconsistencies in the timelines shall be pointed out such as a milestone occurring before or after another that should be impossible within the realm of scientific logic. The basic accepted timeline for planet formation is given by NASA's website address: https://spacemath.gsfc.nasa.gov/Grade35/10Page6.pdf. Other insertions by this author are added to the timeline that includes some inconsistent reasoning and proposed plausible solutions.

Solar System Birth

1. The pre-solar nebula era is given a *time of zero* or 4.6 billion years ago when the collapse of a dust and ion cloud formed a flattened disk due to the forces of gravity processing an anomalous clump of matter. [1]

2. The asteroid era is estimated to have taken *3 million years*; this span is the formation of large asteroids up to 200 km across from end to end. These rocky objects are assumed to be held in various orbits due to centripetal force as the disk of matter of mostly hydrogen and helium spirals inward. Also assumed is that heavier volatiles such as nitrogen, carbon, silicon, and oxygen were already formed by previous stars that dispersed their star-making materials into interstellar space using supernovae. What is possibly incorrectly assumed is that the previously mentioned volatiles do not have the proper pressure and temperature regimes within interstellar space or inside a cold rotating disk to chemically form asteroid-making molecules such as silicon oxides, CO_2, CH_4, NH_4, H_2O, and the planetary core-making coalescence of materials such as nickel and iron. Also, the very short span of 3 million years for this material to gather in an extremely low-density region of interstellar space is very optimistic.[2 3 4 5]

3. The gas giant era is the rapid formation of Jupiter and Saturn that supposedly ended after about *10 million years*. This is difficult to imagine since the density of the nebula disk should be thinner at the outer edge where the gas giant planets reside. And in this region of the disk, the extreme cold and lowest density parameters cause difficulties in providing the conditions for rocky materials and planetary core elements to form centers of matter and to begin gravitationally collecting the lightest gases such as H, He, and ices of H_2O, CO_2, NH_3, CH_4 from the forming nebula. NASA is forced into an early gas giant era hypothesis to remain congruent with predicted future events. NASA's idea

is probably that the ices formed small planet-sized bodies that then eventually and quickly formed into two huge planets. How these icy bodies collected into certain orbital distances without destroying each other is uncertain. Another enigma is how these planets had enough initial heat to become gaseous. Such problems within the last 10 years have created new thinking called the grand tack hypothesis probably urged forward by the discovery of 'hot Jupiters' closely orbiting exo-solar stars. This discovery produced the thought that maybe Jupiter was not always in its present orbit. [6 7 8]

4. The grand tack era that is hypothesized to *occur during the giant gas planet migrations* is added to NASA's list of eras to help explain how the gas giants possibly evolved so quickly and cleared the inner nebula disk of matter only allowing for the smaller terrestrial planets to be created. Planetary astronomers with their well-funded studies of numeric simulations have proposed that Jupiter formed at approximately 3.5 AU near the 'snow line', migrated inward to 1.5 AU, and then reversed its trajectory to eventually end at its current orbit of 5.2 AU. The reversal in its migration is likened to the path of a sailboat changing directions or tacking as it moves against the wind. This metaphoric wind is the gravity wave orbital resonances created together by Jupiter and Saturn. [9 10 11]

   This sweeping of Jupiter close to the inner nebula disk produced its immense size before migrating outward caused by Saturn also migrating inward and being captured in a 2 to 3 mean-motion resonance with Jupiter. Saturn partially cleared a gap in the inner disk reducing the rotating torque on Jupiter by the outer disk. [12 13] "The net torque on the planets then became positive, with the torques generated by the inner Lindblad resonances exceeding those from the outer disk, and the planets began to migrate outward." [14] Lindblad resonances occur when an inner resonance of the planet's orbital velocity is increased, moving the planet outwards, and decreased for an outer resonance causing inward movement. Resonances of this kind increase the object's orbital eccentricity and cause its periapsis to line up in phase with the forcing function of the protostar's gravity. [15 16 17]

   The grand tack enthusiasts mention numerous problems. Jupiter's inward migration drives planetesimals inward depriving material to coalesce to produce Mars. [18] Also, this migration crosses the asteroid belt two times scattering asteroids into the outer solar system and causing large eccentricities and inclinations which are not present today. [19] Icy asteroids may be scattered inward causing the possible delivery of water to the inner planets; but this delivery comes too early since the T-Tauri era that follows will drive the water away. Other experimentation with mean-motion resonances leads to large orbital eccentricities causing possible danger of large-planet scattering and reducing the supply of mass toward the inner disk for developing the inner planets. [20 21] Multiple hypotheses have been offered to fix different outcomes that do not agree with the current configuration of planets. Numeric simulations start at many different locations for the outer planets but have no ready explanation for why their embryos were birthed so early in these positions.

The basic objection to the dozens of grand tack proposals is their use of gravity-driven 3:2 and 2:1 mean motion resonances and the torques generated by Lindblad resonances that affect eccentricities, major elliptical axes, and inclinations. These same effects are always present even in today's solar system. The stability of this planetary system these past 3 billion years requires other factors besides just gravity. Such factors are the electromagnetic properties exhibited by the Sun and its planets that may maintain an equilibrium of orbital distances even though perturbed constantly by gravity-driven resonances. The electrical potentials between the planets, and the planets and the Sun may well preserve their inclinations and close concentricity of their orbits despite occasional perturbations, collisions, and close encounters. Presently, existing significant mean motion resonances are approximately 2:1 between Neptune and Uranus; 7:1 between Uranus and Jupiter; 3:1 between Mars and Venus; and 4:1 between Earth and Mercury. [22] Why don't these mean motion resonances cause instability in their orbits? Other factors besides just gravity may help their stability but are probably ignored in the present numerical simulations. Exploration of the planets reveals magnetospheres around most planets controlled by the solar winds and the interior magnetic field generation by most planets which are not included in most computerized experiments.

Astrophysicists should explore ideas beyond the standard accretionary paradigm. A binary model of parent stars and parent planets ejecting planets or moons from their equatorial regions into nearby orbits may also be a possibility that could explain many observed exo-solar nebular disks. Again, a reason for such heretical reasoning is electrical forces where the parent body over time acquires an unequal electrical charge that forces the parent body to violently launch a much smaller body into an orbit around itself. The solar winds then connect and communicate with these planets in a dark plasma mode like the outer planets communicating to their moons via their magnetospheres. This idea may also address why so many stars are binaries; again, the unequal balance of electrical charge could be the answer to a typical star spitting outward a secondary orbiting star.

Let it be known that there are numerous versions to choose from. Either apply the versions of the "dancing planets" quandary of the grand tack hypotheses and the jumping-Jupiter scenario (presented later) to create the current planetary configuration OR think outside the current box by using the proposed binary model with its equilibrium of orbits maintained by <u>both</u> gravity and electromagnetic forces. Apologies are given for spending so much time tacking back and forth in the inner solar system. Let's return to the next era of formation in NASA's timeline.

5. The star birth era begins *after about 50 million years* when the Sun's nuclear reactions start to produce energy in the core due to gravitational compression. Then the surrounding region of the star begins to rise in temperature to start melting any dust particles and begin their condensation and coalescing into larger particles. [23]

6. The planetesimal era ends after about *51 million years* with the formation of numerous small planet-sized bodies that have rocky, dry surfaces and are orbiting at similar velocities. The warmer conditions aid to melt, congeal, and collect the smaller particles into larger bodies with low-velocity collisions. [24]

7. The T-Tauri era begins *after about 80 million years* when the young Sun is trying to reach equilibrium and emits a lot of radiation in the form of solar winds that sweep through the inner solar system and boil off any primordial atmospheres of lighter volatiles that degassed to the surface of the small planet-sized bodies. From Exo-solar studies, the surrounding vaporization temperatures probably reached more than 400 K. as far as 1.5 AU, the distance of the Martian orbit. [25] [26] [27] Also, in Exo-solar planetary discoveries, the solar winds probably swept away the smaller dust particles remaining within the accretion disk after about 100 million years ending accretionary processes. This T-Tauri transition is considered the reason the inner planets are rocky compositions with little or no water and sparse atmosphere. [28] The recent grand tack hypothesis also gives reasons for the lack of lighter volatiles on the inner planets by the inward migration of Jupiter. [29] However, the embryonic births and formation of early gas giants within 10 million years beyond the 'snow line' in the outer solar system are ambiguous.

8. The ice giant era or the formation of the outer planets of Uranus and Neptune is considered to begin *after about 90 million years*. In the 1990's it was determined that these planets were made of frozen volatiles such as water, ammonia, and methane very different from the gas giants made mostly of hydrogen and helium. [30] Again, NASA is forced into this early-formation hypothesis to make future events more credible. Probably NASA's thinking is that the solar winds of the T-Tauri phase boiled away volatiles from the inner planets that then helped to form the ice giants. Why these boiled-away volatiles were not intercepted by the gas giants before they reached Uranus and Neptune is uncertain or why these ices went so far from the 'snow line' located at about 3 AU is suspicious. Why these planets accreted in such a short time on a broad expanse of about 30 to 40 AU radius from the Sun is questionable since computer simulations require more time. For NASA these planets need to be well-formed so that the timing of the popular Nice Theory of outer planet migrations and the Late Heavy Bombardment (LHB) make more sense.

However, the ice giant formation requires a collisional accumulation of planetesimals to form solid cores around 10 Earth masses for frozen envelopes to accrete. This idea is problematic due to small planetesimals at 20 or more AU having escape velocities from the solar system that are close to their relative velocities which would easily cause hyperbolic trajectories ejecting them from the solar system. [31] [32] These modeling challenges are met with the idea of the ice giant protoplanets forming firstly between Jupiter and Saturn before migrating outward. Another idea for modeling is 'disk instability' where short periods of gravitational instability within the outer nebular disk create a barrage of mass collection. This rapid accretion could create protoplanet cores in less than one million years. [33] Despite problems with ice giant formation NASA is encouraged with observing possibly such ice giant planets orbiting other stars since 2004. [34]

9. The <u>terrestrial planet era</u>, in the eyes of NASA, occurs *after 60 to 100 million years*. This is when the formation of the rocky planets occurs by the mergers of 50 to 100 smaller bodies. The difficulty is how these mergers occur without the crossing of their orbits to create low-velocity collisions causing coalescence. Elliptical crossing orbits have no explanation for their existence needed to sweep the various orbital regions clean and create single planets. [35]

   A recent isotopic study of Earth's and Mars' compositions, of carbonaceous chondrite (CC) meteorites from the outer solar system, and non-carbonaceous chondrite (NC) meteorites mostly from the inner solar system that includes the inner disk's unsampled meteorites during the original accretion reveals that the outer solar system contributed only a few percent by mass. This study disproves the idea of 'pebble accretion' coming from the outer solar system and helps to confirm the oligarchic growth through collisions. Furthermore, the results estimate that about as little as 4 % of CC material is on Earth and Mars which agrees with dynamic models showing CC asteroids scattering into the inner solar system. The barrier separating CC from NC materials was most likely the 'snow line' due to Jupiter's growth and reputed migrations. [36]

   This is also the same period for the asteroid belt to lose most of its mass, estimated at 99%, due to the proposal of perturbations created by Jupiter-making collisions too violent for fusing to take place. The belt's mass is only 4% of the Moon's with the four largest bodies in the belt equal to more than half. The inward scattering of these cold icy asteroids is suspected to bring a small amount of water and other lighter volatiles to Earth at this time, but hardly enough to complete Earth's water inventory. [37] [38] [39]

   Early forming Earth was very hot due to the T-Tauri era and continuing energetic collisions until the orbital region was cleared, and its important compounds required for life such as methane, carbon dioxide, water, and ammonia with low boiling points would be driven off quickly probably without any chance of condensing. But clearly, Earth has an abundance of volatile elements and compounds. Either the volatiles came from the planet's original accreted composition or were delivered later by asteroids after Earth cooled. But the scarcity and mismatch of certain isotopes of various elements in Earth's mantle compared to carbonaceous materials found in meteorites disprove that the mantle contained the necessary volatiles coming from the building blocks of smaller rocky bodies that then later degassed from the mergers to form an atmosphere. Hence, a possible delivery becomes necessary later after Earth had completed most of its accretion and sufficiently cooled. However, the conundrum is that the outer solar system could not have delivered ample water supplies since the oceans' isotope ratios are very different.

Scientists have studied in particular isotopes of krypton, a gaseous element physically similar to other lighter volatiles, that naturally differentiated and condensed with them. Assumed pockets of the ancient mantle have been raised to the surface in Iceland and the Galapagos Islands which avoided mixing and other general geological processes on the surface. Mantle krypton is different from that measured in air. These findings indicate that mantle krypton is not recycled atmospheric krypton and conversely, the degassing of the primordial mantle did not produce krypton in the air. In addition, this mantle krypton does not match the krypton of carbonaceous material found in meteorites which are suspected to have come from asteroids of a later period that are still striking Earth. This deficit of a certain isotope in krypton has been observed for other elements such as calcium, titanium, and nickel. The conclusions are that krypton and other volatiles came early, at the same time, and from the same source when Earth accreted its nonvolatile elements. [40]

Remnants of the protoplanetary disk or the present asteroids have not yet revealed any evidence of matching isotopes of krypton or other anomalous isotopic elements. The data for such analysis is admittedly sparse, and, hence, the mystery continues as to how Earth received its life-giving volatile elements and molecules. A possible version of a new proposed timeline can resolve the mystery. If Earth originally accreted near the "snow line" away from the protostar's searing corona, degassed a thick atmosphere enabling water to condense on a forming crust, then a new possible scenario is created. The formation of lighter volatiles on Earth can then be early, at the same time, and from the same source as the nonvolatile materials of the core and mantle. Much evidence is provided later to tell the story of Earth's displacement to a closer orbit to the Sun from near the "snow line" beyond Mars after the T-Tauri era and after most of the completion of the accretionary process.

10. The Moon-forming era is inserted into NASA's list to show that NASA's favored Giant Impact Hypothesis needs to occur in the same era as the terrestrial planets. The Moon's

first crust to solidify is dated from *90 to 290 million years from time zero* which means the Moon's-forming giant impact must occur during the same period as the terrestrial planet era. This impact and subsequent coalescing of debris would have melted all of the Moon's crust that then re-solidified to establish the date of the new crust. Hence, most of Earth's mass should already have accreted, but the earliest of Earth's rocks are younger than 3.9 billion years or 700 million years after the beginning of the solar system. How is it possible that the uncompleted Earth after the Giant Impact took an untenable more time to solidify than the Moon? An unlikely answer is that Earth's processes of tectonics, volcanism, and wind and water erosion erased older rocks from its active surface unlike that of the Moon. [41] Added to this answer, is that the larger Earth sustained more impactors than the Moon, but to completely melt all the original crust and erase all evidence of earlier molten rock is unrealistic.

Or another possibility is that the Moon formed like any other terrestrial planet in a separate orbit which then later began sharing its orbit with planet Earth in some unusual capture mode. The origin of a Moon-forming impactor to strike Earth in the Giant Impact Hypothesis is problematic due to - the Moon's comparable dehydration and lack of other volatiles compared with Earth, the unexplainable huge angular momentum of the Moon, the unmatching of the Moon's orbital plane with the Earth's equatorial plane, and the Moon's oxygen and titanium isotopic ratios that are so close to Earth's that little if any of the colliding body's mass could have been part of the Moon. [42] [43] [44]

11. The <u>Late Heavy Bombardment (LHB) era</u> is convincingly dated at *600 million years from time zero or 4.0 billion years ago.* NASA believes that the migration of Jupiter and possibly the other outer planets called the 'Nice' model disrupted the asteroid belt sending proposed large water-borne asteroids to impact planetary and satellite surfaces in the inner solar system after the T-Tauri hot phase. [45] The Nice model uses dynamic simulations of the Solar System to explain other historical events besides the LHB. The model supposedly helps to explain the formation and existence of other populations of smaller solar system bodies such as the Oort Cloud, the Kuiper Belt Objects (KBOs), the trojan asteroids of Neptune and Jupiter, and the trans-Neptunian objects. All these dynamic changes are postulated to occur after the protoplanetary disk material was dissipated and the protoplanets formed after about 80 million years from time zero. [46] [47] [48] [49] [50]

    The big issue is how the Main Belt asteroids originated. NASA with its most popular belief is that Jupiter and Saturn with their associated gravity-forming resonances prevented a planet from being successfully accreted in this region between Mars and Jupiter. [51] [52] [53] But recent space probes to the asteroids reveal these bodies resulted from collisions between planetesimals that already had formed crusts. The compositions of explored asteroids are like hydrated igneous rocks of previously crystallized crusts. And the resulting impact temperatures vaporized their surfaces and drove away most of the lighter volatiles including water. [54] [55] So how did these minor mature planets with youthful crusts and condensed water have enough time and disk density to develop and produce the observed properties of Main Belt asteroids? All the evidence leads to a major impact within the Main Belt. The necessary timeline with major collisions for the asteroid belt formation, and the derivation of Earth's water in sufficient quantity coming from the asteroids is incongruent with the facts. [56]

Recent and numerous computer simulations keep resulting in undesirable outcomes. The original 'Nice' model of smooth divergent migration of Jupiter and Saturn causes resonances to sweep through the Solar System leaving the inner planets' orbits too eccentric and the asteroid belt with too many highly inclined orbits. Hence, other simulations called the Jumping-Jupiter scenarios allowed these resonances to quickly cross the inner Solar System without altering orbits too much although confessedly the terrestrial planets remained sensitive to these jumping gas giants. [57] [58] [59] Other problems with the jumping Jupiter including Saturn's migration are significant and listed by astrophysicists. The amount of bombardment of the LHB is reduced; most of Jupiter's trojan asteroids and irregular satellites are captured; and without remorse by the astrophysicists and computer analysts, an additional ice giant is sometimes required to preserve the current orbits. This invention of the jumping planets although preserving the inner planets in computer simulations is perhaps disproven by these other factors. [60] [61] [62]

Better reasoning is suggesting that the LHB era indeed occurred but by an entirely new model that revisits an older model called the disruption theory. This model proposes that a sizable terrestrial planet was hit by a rogue planet that caused collisional debris creating the Main Belt of asteroids, the trojan asteroids, and the LHB that took place throughout the inner solar system. [63] [64] [65] The current asteroid belt is believed to contain only a small fraction of the mass of the original belt. Computer simulations indicate that the original belt contained a mass equal to the Earth. [66] The proposed struck planet was a watery primordial Earth that was displaced Sunward retaining much of the penetrating icy impactor's material. The Earth's falling spiraling trajectory created enough centripetal force to create a new orbit which began sharing with an already existing orbiting Moon. [67] The displaced Earth brought captured collisional debris that either fell back to Earth or was swept up by the Moon for millions of years.

12. The <u>ocean era</u> is reputed to have occurred during the LHB era or *4.0 to 3.9 billion years ago.* Supposedly the LHB caused by the migrating outer planets transported comets perhaps from the outer Kuiper Belt and asteroids from the Main Belt to Earth to form oceans. Exploration of comets thus far reveals dry rocky compositions and whatever

little water is analyzed has mostly different isotopic signatures compared to the Earth's Ocean water. Asteroids have a better match to the ocean's isotopic ratios, but their small size and water load require an unreasonable huge number of impacts. [68] However, the LHB did occur on Earth since the oldest cratons of the primordial crust are dated anywhere from 4.2 to 3.9 billion years ago which aligns with the LHB era. Hence, some of the primordial crust shows evidence that much of Earth's crust melted and re-solidified during the LHB era. But did the invaders from the LHB bring the water to fill Earth's oceans or had it already arrived?

13. The <u>liquid water era</u> is included to highlight its occurrence surprisingly only *after 100 million years from time zero or 4.5 million years ago*. Strong evidence of this water was found in a meteorite that contained the oldest carbonates in the solar system. The processes involved are labeled aqueous alteration, brecciation, and diversity of water-bearing parent bodies. [69] [70] No carbonate could exist when any of the pristine terrestrial planets' surfaces were still partially molten and swept clean of their forming atmosphere due to the T-Tauri era. These carbonates were created by CO2 in an atmosphere above a watery environment that is not possible on asteroid size bodies. So, the question arises as to where the location in the solar system 100 million years after time zero was this chemical reaction to take place. The only possible answer is one or more terrestrial-type planets near the 'snow line' which is most likely between Mars and Jupiter or in the region of the Main Belt of asteroids less than 100 million years from time zero. Liquid water can exist adjacent to the Sun's side of the 'snow line' and freezes if beyond that line. A planet in this region can quickly cool creating a crust that is then further cooled by the outgassing atmosphere of CO2 and other gases. Eventually, due to atmospheric pressures, the outgassing of water could then condense to form an ocean which could react with the CO2 to form carbonates. Certainly, these sequential processes take a great deal of time. Is there any other answer for this carbonate formation? So, how does a watery planet beyond Mars arrive at one AU to share an orbit with the Moon? Perhaps it was knocked inward toward the Sun by a huge impactor leaving behind the asteroid belt as collisional debris and causing the Late Heavy Bombardment (LHB).

14. The <u>Moon's bombardment era</u> is also an extra insertion into NASA's timeline. Data from the Apollo missions indicates that the Moon's mare regions remained molten from about *3.9 to 3.0 billion years ago* due to continued bombardment. [71] [72] [73] [74] [75] Why was the Moon singled out for this type of continued impact? A suggested possibility is that when the Earth was displaced from beyond Mars to begin sharing an orbit with the Moon, the planet brought along collisional debris that was swept away by the Moon for about 900 million years each time the Earth passed the slower Moon in its orbit. Eventually, the Earth matched the Moon's orbital velocity as the Moon moved farther away to exchange angular momentum. Also presumed, is that some collisional debris

also fell back to Earth during the same time. This idea can explain the identical isotopic ratios of oxygen and titanium for both the Moon and Earth.

15. The life era, NASA's terminology, occurs *after 800 million years, or 3.8 billion years ago*. The first traces of bacterial life forms emerged in Earth's fossil record. This milestone is expected since collisional debris fell to Earth that retarded life, stopped close to the time that the debris stopped falling on the Moon. More complicated life forms could then start undisturbed during the Archean geological era or the era of ancient life. [76] [77] [78] The oceans and atmosphere became re-established on Earth about 3.0 billion years ago causing the further expansion of complicated living organisms.

16. The Earth's deep intrusive granite era is inserted into NASA's timeline to emphasize a special period inside Earth's interior. It is suggested that the high energy of a Moon-size impact during the LHB period penetrated the mantle infusing and mixing with Earth's young, soft molten mantle. This frozen impactor added lighter volatiles to Earth's mantle that already had a watery environment on its surface. This humongous impact created the elevated surface inside the impact crater's perimeter which raised the Earth's pristine surface above ocean level for 1/5 to ¼ of its global area. This event caused the first super-continent which feature is not seen on other celestial bodies. The mixture of the two different mantle compositions created the continental granitic crust that still differs today from Earth's original basaltic oceanic crust. [79] [80] [81] [82] [83] However, the deeply embedded intrusive larger-grained granite beneath the smaller-grained quick-cooling granite on the surface is calculated to have taken about 2.6 billion years to cool, crystallize, and raise to the surface. This special rock cannot be re-created by the rock cycle and is difficult to make in laboratory experiments. Geologists call this the 'Granite Problem'. [84] [85] [86] [87] If this intrusive large-grained granite was created inside the Earth during the *huge impact of 4.1 to 3.9 billion years ago,* the age of this solid granite after *eventually crystallizing is about 1.5 to 1.3 billion years ago* which is about the time when plate tectonics and continental drift began accelerating.

17. The slow march of the supercontinent era starts the geological history that lasts from *3.9 to 0.65 billion years ago*. During this large span, the dating of the formation of an ocean and continental crust are established along with glaciation periods, active mountain ranges, the earliest multi-cellular organisms, and the rise of oxygen in the atmosphere. The supercontinent breaks apart and reassembles about four times. Life continues to advance with the first fauna and Ediacaran biota for feeding larger fauna. Also, during this time, a span of 0.9 billion years goes missing in the rock record called the Great Unconformity (GU). [88] [89] [90] Probably, a period of unusual glaciation covered the landmasses, and the deep melting ice eroded the adjacent softer sedimentary rock into low elevations under the ice or into the oceans leaving the newly crystallized intrusive granite on the surface. This deeper molten rock finally achieved its proper

pressure/temperature regime by rising to the surface due to continued wastage and plate tectonics.

18. The fast march of the last two supercontinents era started roughly with the formation of the ancient continent, Pannotia, about *0.65 billion years ago* and ended with the assembly and breakup of Pangaea that *continues to this day*. The cycling of several ice ages began and six significant mass extinctions were recorded with the last one occurring 11,500 years ago called the Holocene mass extinction. This event caused mammoths and other large fauna to disappear near the end of the Younger Dryas geological period. The layered Paleozoic rock layers above the Great Unconformity occurred and the famous Cambrian explosion of life peaked around *0.54 to 0.48 billion years ago*. During the Cambrian Period, mountain building increased due to accelerated plate tectonics caused by cooler, thicker, and stronger plates that thoroughly subducted more deeply without breaking and thoroughly mixed many molecules and minerals due to the ongoing rock cycle. This rock cycle was the result of the churning of sedimentary, metaphoric, and igneous rocks caused by the recycling and subduction of the crustal plates. A mixture of molecules and minerals encouraged many complicated life forms such as the dinosaurs that became extinct 65 million years ago. The periods of glaciation and mass extinctions are most likely caused by unknown celestial disturbances and/or fluctuating radiant energy from the Sun during the last 650 million years. [91] [92] [93]

Some Conclusions about NASA's Timeline

NASA's ideas: for the early formation of the outer planets in the first 10 to 90 million years using many inconclusive numeric simulations [94]; for the asteroid main belt due to gravitational resonances that do not explain well their origins or different compositional families [95] [96] [97] [98] ; for the accretionary process of forming terrestrial planets that require elliptical orbits for desired collisions [99] [100] ; for the disturbance of asteroids and Kuiper Belt objects due to outer planet migrations postulated in the Nice Theory with little explanation as to how these frozen bodies were formed [101] ; and for especially the Giant Impact hypothesis that reckons a moon-sized body struck Earth to emit materials beyond the Roche limit to then re-coalesce into the Earth's Moon that has numerous difficulties; [102] [103] [104] [105] [106] [107] [108] [109] --- are all seriously questioned.

1. A most recent study by the Subaru Telescope imaged a massive protoplanet embedded in a protoplanetary disk in the AB Auriga system. This far-away orbiting protoplanet labeled AB Aur b, is estimated at 9 times the mass of Jupiter and 93 AU from its parent star. This discovery provides direct evidence that Jupiter-like planets can form large distances from a star and most likely establishes that gravitationally unstable disks can fragment into dense clumps. [110] But there are no clear ideas whether this youthful forming planet will migrate inward or remain stable in its current position. However, this anomalous protoplanet brings into question the present models for outer planet

migrations in our solar system such as the 'Nice' theory, the grand tack, and jumping-Jupiter scenarios. Without a clear-cut planet migration, the late heavy bombardment (LBH) is difficult to explain unless a planetary disruption scenario within the Main Belt of asteroids is imposed. Sean Raymond, an astronomer at the Laboratoire d'Astrophysique de Bordeaux who leads the AB Auriga system study stated, "In the field of planet formation, we're not starved for ideas, but we're starved for actual constraints on the ideas."

2. NASA has no clear explanation for the age of the mares of frozen molten lava on the Moon that reflect continued bombardment for almost 600 to 900 million years. [111] [112]

3. NASA's enigma of Earth's water origins is still being determined. Isotopic differences between the water in the oceans differ from that of the meager water found and analyzed on asteroids and comets. [113] And the minerals discovered on comets and asteroids that require liquid water are not adequately explained. [114] The igneous rock nature and collisional properties of asteroids require an already existing large enough body with a hardened crust that can hold liquid water without sublimating into space. The simple answer is that such a body or bodies did exist, were impacted, and displaced from their orbits with the dispersal of smashed pieces of existing hydrated crusts and different mantles compositions that can easily describe the various compositional makeups and general locations of most of the existing asteroid categories. [115] [116] [117] [118]

4. The presently accepted Giant Impact hypothesis for forming the Moon has no consistent explanations for why the Moon is not hydrated and lacks sufficient iron [119] [120] ; for why both bodies have certain identical isotopic signatures which are virtually impossible if the Moon and Earth were originally two separate bodies [121]; and for why the necessary angular momentum of the Moon cannot be achieved with present computer modeling.[122]

5. The NASA and NOAA governmental agencies agreed that gravitational compression causes an almost symmetrical spherical solid for any large enough celestial body. Also, differentiation of lighter volatiles should outgas to form an almost evenly layered crust and atmosphere if not boiled away in its early formation. However, the enigma of Earth's first non-symmetrical supercontinent opposes the gravitational compression theory and is not explained except for the strangely unproven delay of large plumes of differentiated materials randomly rising from the core. [123] [124] The current journals lack the true origin of the first supercontinent and why Earth has a globally asymmetrical, continental granitic crust surrounded by an oceanic basaltic crust. The best current reason is that prominences and depressions of Earth's geoid caused a forming crust to break up on high points and assemble in low points that have no plausible supporting geophysics. Understandably, the scientific agencies may suffer from their established

paradigms and cannot easily move away from them. If geologists would explore novel answers for the mysterious 'Granite Problem', they may then imagine and find evidence for an icy body that penetrated Earth's mantle and infused a special rock via metasomatism into the basements of the continental crusts described as large-grained, slow cooling intrusive granite which could not have been produced by the rock cycle. [125] [126] [127] [128] Combining high temperature and pressure, not duplicated in laboratory experiments, caused such specialized metasomatism. Only a high-energy penetrating impact could have created such a deeply infused material never to be duplicated in the rock cycle.

Interesting Possible Substitutions for Our Consensus Science about the Solar System Timelines and its Formation

Any experimental new modeling by NASA hopefully will consider the following several replacements or new accompanying versions for their popular paradigms. Instead of the Nice Theory of outer planet migration causing the Late Heavy Bombardment (LHB) by disrupting existing asteroids and objects in the Kuiper Belt beyond Neptune, the LHB is created by a major collision between two large bodies in the Main Belt of asteroids. The missing major body in the collision is Earth which was displaced toward the Sun and formed a new orbit very close to an existing terrestrial planet now called the Moon. This model explains why Earth was able to bring its existing water closer to the Sun after the Sun's warm T-Tauri phase and after the Earth's accretionary period ended. None of the other terrestrial planets had this advantage after the T-Tauri era of retaining water and atmospheric gases except briefly for Mars closest to the 'snow line'. The Earth had time to capture and share its orbit with the Moon as the Earth slowed each orbital passing until their velocities became matched. The energy of slowing the Earth moved the Moon farther away by the exchange of angular momentum never explained conclusively by other ways. The isotopic similarities between the Moon and Earth are explained by collisional debris brought by Earth that was swept up by the Moon. This continued sweeping of the collisional debris lasting about 900 million years thusly created the presently unanswered long-lasting molten lava fields called mares and buried mass concentrations called mascons.

Additionally, this proposed collision in the asteroid belt explains the creation of Earth's first super-continent created by the immense impact basin. Many geological mysteries are then better explained such as the deeply embedded intrusive granite that further explains the 'granite problem' and the global Great Unconformity (GU). The humongous collision 4.0 to 3.9 billion years ago creates a raised crater covering about 1/5 of the surface that unbalances the crust on top of a resulting slippery Moho layer and geological hot spots caused by the trapped and infused melted volatiles. Through this process of mixing two mantles of the Earth and the impactor inside the crater perimeter, two different crusts are created known as the basaltic oceanic and the granitic continental crusts. The spinning crust attempts to seek equilibrium by breaking apart and starting plate tectonics and continental drift whose prominent features are found nowhere else in the solar system. Plate tectonics and its resulting subduction process create the rock cycle that thoroughly mixes the planet's minerals and enhances a life-giving brew that becomes accelerated during the Cambrian explosion of life about 540 million years ago. As the underlying continental crust continues to rise and cool via plate tectonics and subduction, the embedded intrusive granite now enters a pressure/temperature regime where it begins to crystallize and expose itself to the surface. Global glaciation periods provide a chance for the overlying rock layers from previous erosion to once again erode and expose this new intrusive granite rock.

The amazement of this model is how well it can address so many astrophysical and geophysical mysteries simultaneously almost like fitting together a jigsaw puzzle. Also, this model corroborates many of NASA's findings throughout the past decades. Perhaps adequate public funding or grants will begin to research parts of this proposed new version, not to necessarily replace the old versions, but to have the scientific community become more awakened to the possibility of other chronicles of our genesis.

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