

Dean Sousanis Origin of the Moon Theory, 1969 Paper

What follows is the original 1969 paper by Dean Sousanis detailing his theory on the origin of the moon, the ocean, and other moons in the solar system. We've also included retyped copies of the text-only pages at the end of this document.

It was supposed to be just a one-page report on any aspect of physical oceanography for my NSF Oregon State graduate class. Instead, during that summer of the moon landing, surrounded by dozens of books, I had an unforgettable 24 hours as a cascade of unstoppable thoughts resulted in a theory of the moon's origin, the ocean's origin, and the origin of most of the solar system moons. My professor seemed amazed and asked me to clean it up for publication. I never did... life got in the way.

Over the years, to this day, many predictions of this theory have been realized. On presenting this theory to my classes and others, folks would get excited over it: "why don't you publish it?" It was instructive to point out: "see how a theory can sound so good, yet could be all wrong?" Anyway, we never did find anything wrong with it.

This theory (Spray-Ring Theory) not only attempts to explain the origin of the moon and many of its characteristics, but also tries to explain the origins of the oceans and continents and their bimodal elevation distribution, interconnectedness and sizes, and goes on to explain the origin of most solar system moons.

Anyway, here is the original (rough as it is) 1969 paper. It still seems relevant and maybe something more will emerge from it. – Dean Sousanis, December 2019

Dean Sousanis is a multi-award-winning teacher, including AAPT's Physics Teacher of the Year, and he is in the Michigan Tennis Coaches' Hall of Fame. Sousanis's teaching career spans nearly 50 years, and over that time he's trained dozens of teachers and mentored numerous students who went on to obtain physics doctorates and become college and high school physics teachers. His passion to excite students about learning is unmatched. Reach him at dsousanis@gmail.com.

Nick Sousanis is his son and an Eisner Award-Winning cartoonist and professor of comics studies at San Francisco State University. He's the author of *Unflattering*, originally his doctoral dissertation drawn entirely in comics form. To make sure you reach Dean—please contact Nick and he'll forward on. nick@spinweaveandcut.com. Or contact him through his site www.spinweaveandcut.com.

If you have thoughts about this, we'd love to hear from you! Thanks—D&N

Constantine Sousanis

I. The Ocean Basins of the Earth

The comparison of ocean basins to lunar seas by Dietz⁽¹⁾ led me to speculate on the early origin of the ocean basins. My initial thinking and subsequent readings and analysis led to a tie-in to the moon's origin.

Here are some of the facts and ideas which Dietz included that were of subsequent interest to this analysis:

- (1) Unlike the mare, the universality, or interconnectedness, of our ocean basin is its major basic feature.
- (2) While the maria are on different levels, the ocean floor throughout the various oceans has a common level.
- (3) There is a bimodal distribution of the land levels of the earth. The continental level averages 500 meters, the ocean floor 4,120 meters. This is not the case on the moon.
- (4) Evidence of cosmic bombardment comparable to the moon's is missing on the earth. Many possible explanations can be offered to account for this. Included is one which the spray theory will require; the moon's pocked surface resulted from the sweeping up of bodies not in solar orbit but earth orbit, including a ring such as Saturn's.
- (5) The moon shows no crustal spreading, no surface structure like the earth's trench system, ridge system, cordilleras of folded mountains, of large transform faults.
- (6) The ocean floor is a realm of more active tectonism than the continents.
- (7) 3½ billion years ago the earth started to differentiate, unlike the moon which is thought to be homogenous. The core-forming event occurred when the iron sank as the heat generated by radioactive elements not being able to escape led to its present component layers-core, mantle, crust.
- (8) Dietz feels a critical question is whether the granitic crust ever formed an unbroken, completely encircling layer around the earth. He answers negatively as he feels that convection cells within the mantle led to one of two initial "rafts" of crust. "Continents are pertuberances above the true surface of the earth, instead of ocean basins being depressions within the earth's outer shell. His latter point I feel is a moot one, depending strictly on definitions. Concerning his first point, as I will later show, the earth may well have been covered with an early crust, but 3½ billion years ago the spray event occurred that led to (presently hypothesized by some geologists) super-continents Laurasia (North America and Eurasia) in the Northern hemisphere and Gondwana in the Southern hemisphere. If the total areas of each of these two super-continents are summed up, the two have practically identical areas of 100 million square kilometers each. Dietz feels this equivalency is understandable if both continents were born from the mantle in opposite hemispheres. This is too tautological to explain much. In the spray hypothesis it is a necessary result that there be initially to super-continents formed and that they be equal in area.

The early origin of the ocean basins is left an open question as Dietz concentrates on the geological dynamics of the last 200 million years. It is the purpose of this paper to ultimately relate a theory of the origin of the moon to the origin of the ocean basin on the earth.

II. The Present Theories of Moon Origin

There are three general theories relating to the genesis of the moon;

- (a) Capture
- (b) Formation alongside the earth
- (c) Fission of the earth

In part III of this paper my hypothesis

- (d) Spray-Ring,

which is somewhat related to the fission theory, will be developed. First, it will be appropriate to discuss some of the difficulties in each of the three prominent theories which hopefully the spray theory does not encounter.

A. That the moon is a captured body is admitted even by a main proponent, Dr. Urey, to be very possibly highly unlikely event.⁽⁷⁾ Ruskol is convinced, as I am, that the regular character (close radii, approximately circular orbits, closely equatorial inclinations,) of not only the orbit of the moon but most other orbits of satellites of the solar system's planets, is just too incompatible with the capture theory, leaving only the possibility that the few "irregular" satellites which are usually remote and of negligible mass are the only captured moons.⁽⁵⁾ O'Keefe points out the celestial mechanical difficulties of capture; (1) Only very close encounter would have allowed capture; (2) its orbit would have then had to become more and more eccentric.⁽⁴⁾ Urey suggested the capture theory in that the density of the moon (3.4) resembled the density of the lightest chondritic meteorites (3.8.) But this still is a significant difference, which then requires postulation of further lighter materials present such as water or graphite. At any rate, the chemical composition of the moon should be quite different from that of the earth if Dr. Urey is right.

(B.) If the earth and moon formed the same way alongside each other, they should have formed from the same materials and resulted in similar densities-not at all the case. So far data keeps reaffirming that the earth's core is iron, not pressurized mantle material. The present earth-moon mass ratio of 81:1 can not be predicted from a mathematical model of a condensing swarm of particles. Ruskol does try to account for the discrepancy by postulating that the moon only began to form when the earth had completed .3-.5 of its mass accumulation. But he totally ignores the density problem.

(C.) According to the third theory, fission of the moon from the earth would allow the proper densities if it took place after the core was formed. The difficulty of this theory, which the spray theory can hopefully reconcile, is that the present angular momentum of the earth-moon system fails to account for the needed angular momentum allowing fission by a factor of, at the extreme, of four. There is some speculation of mechanisms between the earth-moon system and other planets which have perhaps soaked up some of this angular momentum.

All three theories can not account for a crisis which must have occurred to the moon 2 billion years ago as indicated when the rate of change of the moon's distance is extrapolated back in time. Further, the earth's geological record shows no trace of such a cataclismic crisis. MacDonald postulates the formation of the moon by the mutual capture of satellites in orbit around the earth. The genesis of these satellites encounters the same difficulties as the genesis of the moon theories, but it is an intrinsic part of the spray theory. The spray theory will have to further conform with Opik's thesis that bombardment could

not have come early in the moon's history because at that time when it was close to the earth the tidal bulge would have had such an extent that the future settle shape of today would have found the moon with elliptically shaped craters.

O'Keefe feels that most thoughts on moon origin can be summed up into two threads: (1) it is captured, dead, different from the earth; (2) it is closely related to the earth. The recent lunar landing seems to indicate the latter possibility to be more likely with the finding of what appears to be igneous rock at this early stage, and adds credence to the following spray-ring hypothesis.

III. The Spray-Ring Theory

Somehow the earth formed. (Possibly it occurred in a mass swarm, but the origin of the planets is not to be my concern at this time, as it is not essential to the following arguments.) At first the earth was characterized by a homogenous composition as the distribution of the material in the swarm was most likely random and accumulated randomly. But as heat built up, (radio-active decay of thorium, potassium, uranium, collisions, adiabatic effects, greater heat absorption from the sun due to atmosphere build-up, heat of fusion during solidifications, differentiation suddenly occurred on the molten earth, possibly $3\frac{1}{2}$ billion years ago as Dietz suggests. At that point the iron sinking was the main event.

(A.) In order to conserve the earth's angular momentum, the perhaps already fast spinning earth began to suddenly spin faster as the iron sank to its center.

(B.) This fast spin coupled with the high thermal speeds of the outer surface materials led to a spraying off of the earth into sub-orbit, orbit, and escape, of the material on the molecular level. (Figure 1.) This orbiting spray is possible due to the additional thermal motion even when the earth's angular momentum is lower than that required for a fission of a large mass.

(C.) As this spray of light material would be girdling the earth around the region of the equator, (even as high as 45° N. and S. the centrifugal accelerations would only be reduced to 71% of that at the equator, assuming bulge can be neglected,) (Figure 2,) the returning elliptical particles could be colliding with the exiting particles and on the average their resulting paths might be parallel to the earth's surface. (Figure 3.) A circular orbiting cloud, or ring, of material could in such a manner form a certain distance away from the earth along its equatorial plane. This distance would be a function of the hot atmosphere's extent which was very likely greater than that of today. Depending on the size of the ring particles and the density of the outwardly thinning atmosphere, a critical point would begin to exist as we move away from the earth where the orbiting ring could begin to survive, perhaps the 5-10 earth radii suggested from the backward extrapolation of the moon's motions, with the heavier particles surviving first closest to the earth, though this is not an essential point of this theory. (Figure 4.)

(D.) This sprayed out ring becomes the basis for the accumulation and buildup of the moon, perhaps 2 billion years ago as MacDonald suggests. Many coalescing processes are possible; Perhaps accumulations started first from crystallizations, and then, inter-crystalline accretions; perhaps occasional meteorites became centers of accumulation. (Figures 5-6.)

At any rate, accumulation probably proceeded slowly and no crisis need have been recorded on the earth. The process could have stayed relatively cool, also. Perhaps

as this material accreted and fell together into bigger and bigger pieces, the heavier pieces came together sooner and began to effectively sweep up the lighter pieces further out. Perhaps this accounts for the almost complete heavy bombardment on the backside of the moon. It could certainly account for the hits seeming to look as if they had been made by vertically falling objects. Only if they had been lunar orbiting objects could they have done this to such an extent. Also, there are some intriguing linear arrangements of craters that the ring hypothesis can explain. If the earlier heavy accumulations are still facing us today they may be the explanation of the mascons.

(E.) On the earth we have after the spray has died down, due perhaps to cooling, a large belt around the earth where considerable mass is missing. Two crustal "caps" remain at the poles; the geologists' hypothetical early super-continent (Fig. 7) of Laurasia and Gondwana. If before the spray the early crust was roughly uniformly distributed around the earth, after the spray practically equal areas would be left at the poles in direct agreement with the area calculations of the geologists. Also after the spray, significant flows of the crusts could have occurred equatorward. Perhaps, the momentum of these flows carried them far past the equator as perhaps in the well defined plume of Africa which may have run into a perhaps slower moving plume of North America. Perhaps the flow passages were along depressions that resulted from differential heating processes that occurred during the spray period. Also the distended upper mantle could have elastic-like transport back to the poles from where it was distorted. These two processes may account for the present land-form arrangements, and though considerably diminished and deflected with time, may still be influencing present drift and other dynamic tendencies. (Figure 8.) It is interesting that the lower mantle is not thought to be undergoing as marked evolution as the upper.

At any rate, the universality of the ocean basin, its common level, the earth's bimodal land distribution, no evidence of cosmic bombardment, are all accounted for by the spray-ring theory.

(F.) An interesting calculation to make is how much world we have to peel the earth to get enough mass to form the moon? A strip about 50 miles deep around the equator covering about 80% of the earth's area will suffice. After $3\frac{1}{2}$ billion years of adjusting, the present 5 mile average range of the bimodal distribution is most plausible with the extreme range of crust and ocean basin being about 15 miles presently. And it is probably most likely that dynamical changes to preserve the spherical geo-potential of the earth were taking place most rapidly during the period of the spray, so that 50 miles is an extreme number.

(G.) The spray-ring hypothesis to be any good should account for the formation of other moons in the solar system. This it does so dramatically that part IV has been devoted to this subject.

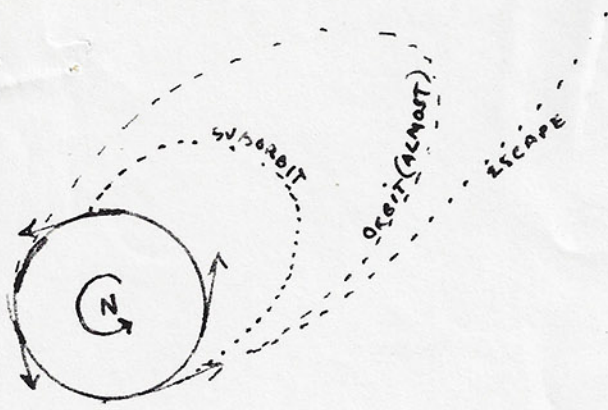


FIG. 1 Possible SPRAY Velocities AND THEIR PROJECTILE PATHS OFF THE EARTH.

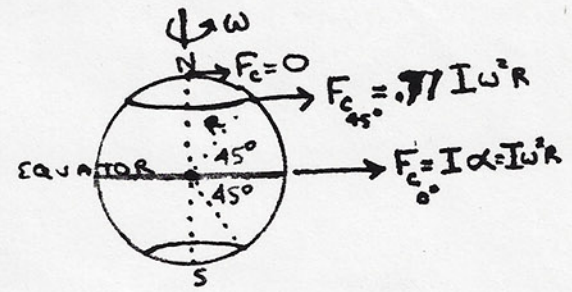


FIG. 2 MOST OF THE EARTH'S SURFACE EXPERIENCES CLOSE TO THE MAXIMUM CENTRIFUGAL FORCE. ONLY NEAR THE POLES DOES IT DIMINISH SIGNIFICANTLY

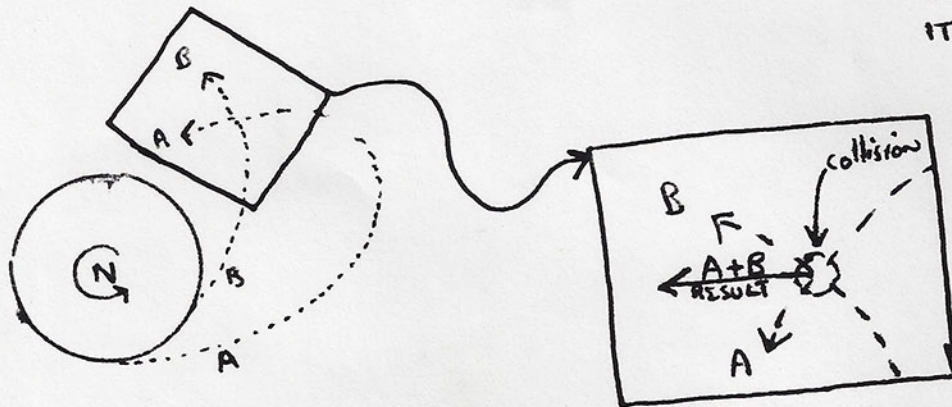
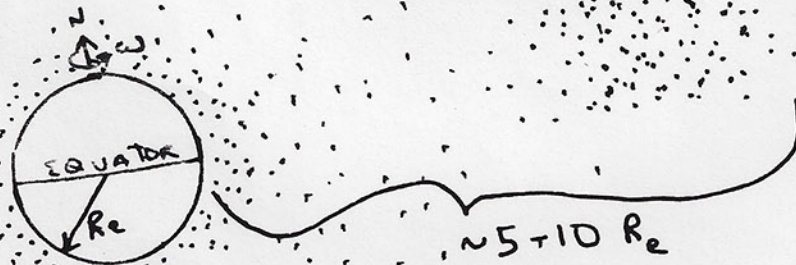


FIGURE 3: Collision of IN-COMING (A) PARTICLE WITH OUT-GOING (B) PARTICLE MAY RESULT IN MOTION PARALLEL TO EARTH'S SURFACE.



2 DIMENSIONAL CROSSSECTION

FIGURE 4: EARTH AND ITS ATMOSPHERE (HOT) IN EARLY TIMES. (NOT TO SCALE) INNER BAND OF HEAVIER RING MATERIAL OUTER BAND OF LIGHTER RING MATERIAL

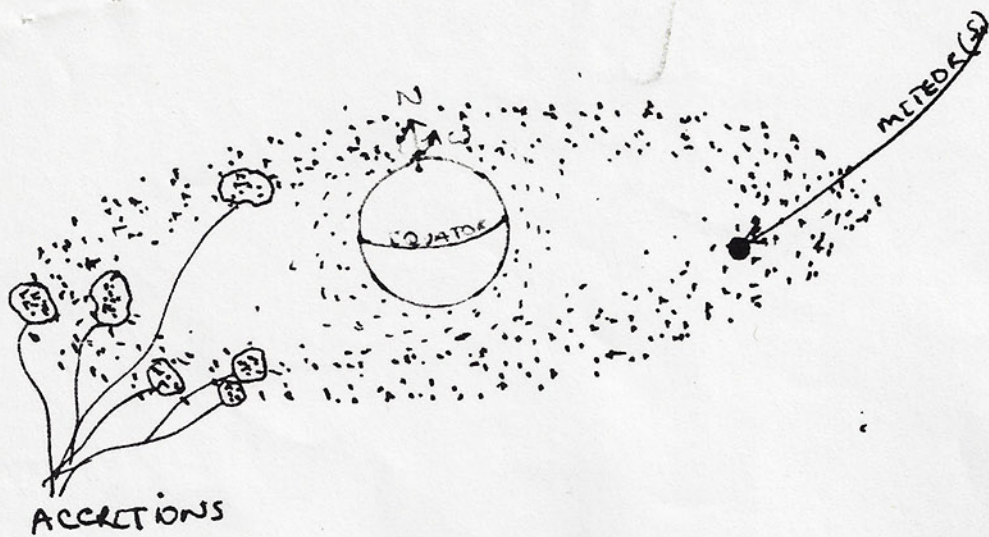


FIG. 5: ACCRETIONS OR METEORITES COULD START THE SNOWBALL EFFECT LEADING TO ACCUMULATION OF THE RINGS INTO A MOON.

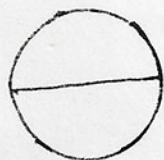
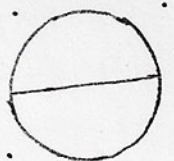
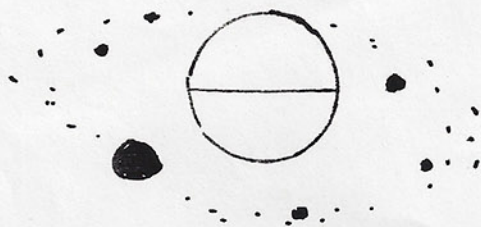
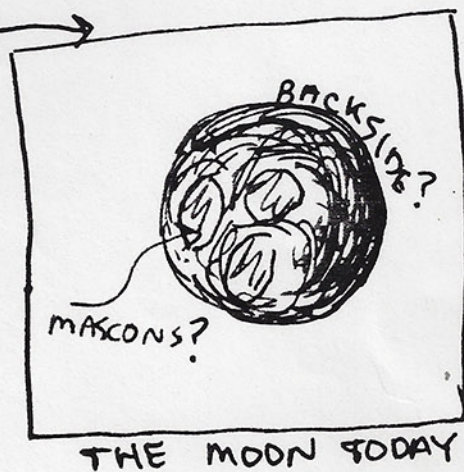


FIGURE 6

A ROUGH PICTORIAL REPRESENTATION OF THE PROGRESSION OF ACCRETION IN STAGES LEADING TO THE MOON AS IT IS TODAY.



THE MOON TODAY

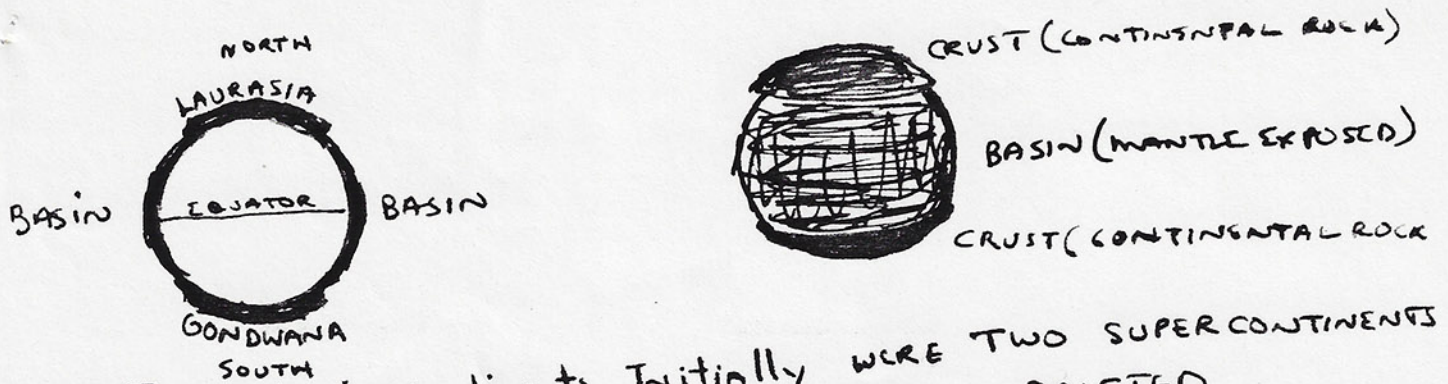


FIGURE 7: Today's continents initially were two supercontinents Laurasia and Gondwana, which have drifted over the years equatorward. Today's ocean basins are interconnected and have a common depth because their origin was the common basin which was formed when the moon was "sprayed" out, and is largely free of continental rock. The present bimodal land distribution is completely accounted for by this theory.

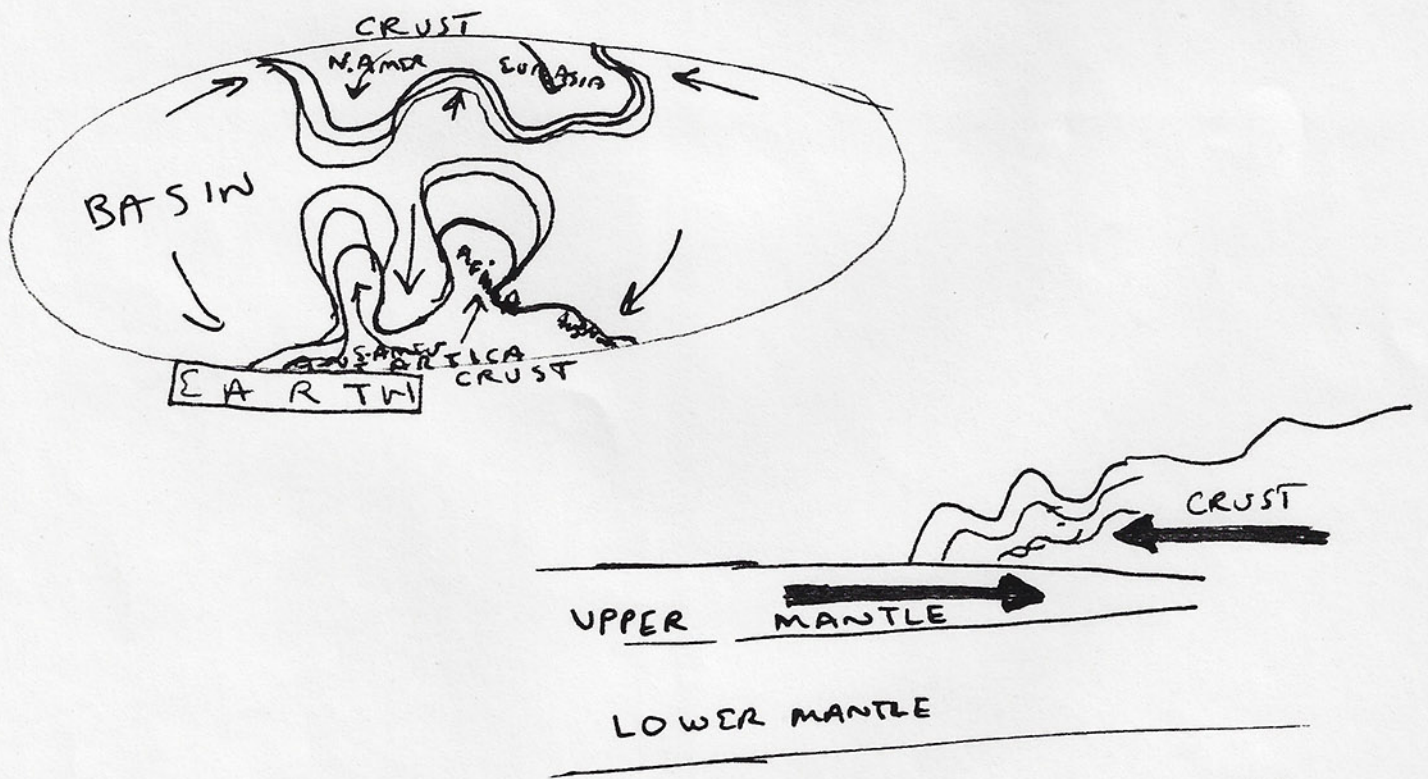


FIGURE 8: Possible crustal and mantle movements leading to present topography.

IV. Generalization of the Spray-Ring Hypothesis to Explain the Origin of the Moons of the Planets of the Solar System

Using the data from Chart I if we correlate the number of moons to the mass of each planet, we get at the most only a very gross correlation to the mass; certainly little predictive value is found here. (Figure 9) Now, according to the spray-ring theory formation of any moon would be a function of the outward-throwing forces in relation to the in-ward holding forces. More specifically, out-wardly we have the centrifugal acceleration, $\omega^2 R$. If we correlate just the angular acceleration to the number of moons of each planet, we get an astounding fit. (Figure 10.) If we next correlate the number of moons to the ratio of the out-ward centrifugal acceleration to the inward gravity of the planet, $\frac{\omega^2 R}{g}$, we again get an excellent fit. (Figures 11 and 12.) Finally, the Spray Probability (S_p) will most specifically be a function of the ratio of the outward centrifugal acceleration to the velocity needed to orbit the particular planet, \sqrt{gR} . Setting the Spray Probability of the earth arbitrarily to equal one, the formulation of S_p becomes:

$$S_p = \frac{\omega^2 R}{\sqrt{gR}} + 1$$

Figure 13 correlates the number of moons to the spray factor. While the fit is excellent, beyond expectations, if we consider possible error and limit our theory to only being able to account for 85% of the explanation for the moons, (as indicated by the 15% brackets on the graph) the fit becomes even better. Further, if we make some logical, arbitrary though intuitively accurate changes to the final graph, we get a nearly perfect fit;

- (1) Mars, though with two moons, has actually very little total lunar mass. This drops Mars down into appropriate fit. Of course, it may be appropriate to correlate the spray factor of all the planets to their total lunar masses, but this data is not available yet.
- (2) Earth at the time of moon formation had a much greater spin, but in time the excessive tidal drag of the moon has slowed, unlike Mars. This correction would shift earth to the right on the graph as shown, again achieving near perfect fit.
- (3) Finally only Jupiter remains perhaps a little off though it does fit if you consider a 15% variation as reasonable for the spray factor. At any rate, perhaps mass does indeed have a gross effect on the function of the Number of moons which would then certainly bring Jupiter into line. Or even, perhaps the exceptionally small density of Saturn is the factor which allowed it to have ~~more~~ ^{AS MANY AS} moons than Saturn—certainly spray is easier in a less dense planet.

Saturn's ring is certainly intriguing as it may be the only remaining spray-ring. One would expect that the last spray ring of a planet would be the closest orbiting body of that planet. Such is the case. It is also interesting that the latest moon to be discovered on Saturn is very small, travelling along the ring—is this the beginning of the accumulation process of the ring?

One final speculation. What process occurred in time to spew out one ring after another on the less dense planets? Perhaps early tremendous solar flare-ups, of which today our record is the moons around these large, thin planets. How the moons vary in age and composition will be an interesting question for future planetary exploration to undertake to answer.

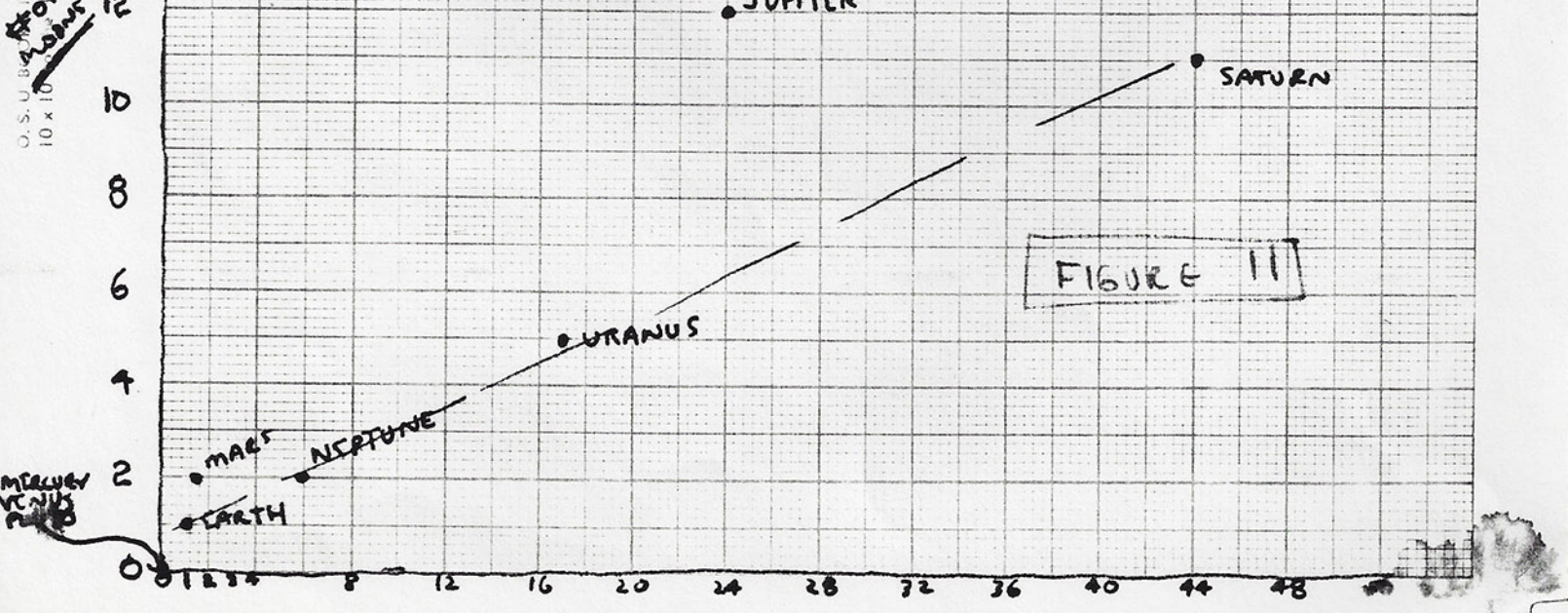
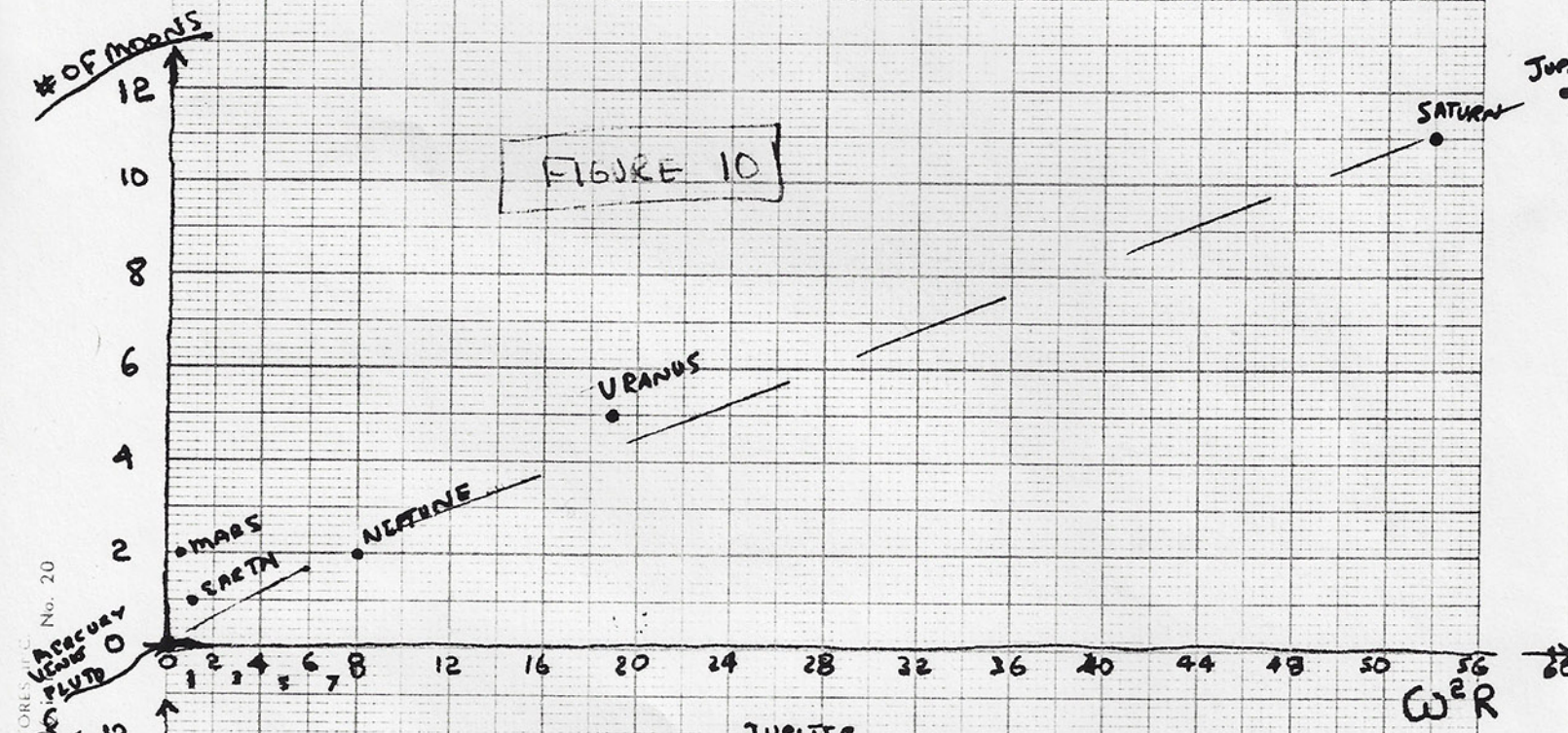
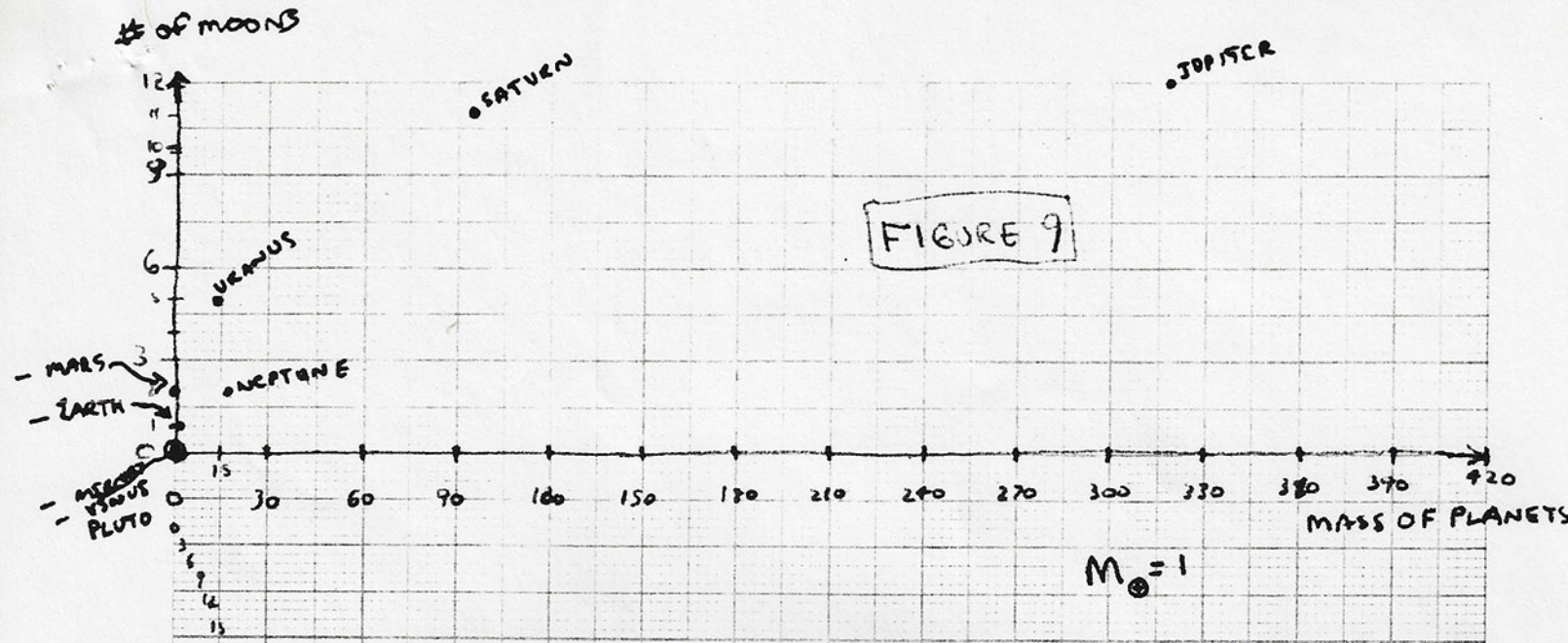
In Conclusion, this remarkably simple theory seems to account excellently for three major phenomena;

- (1) land forms of the earth
- (2) land forms of the moon
- (3) the origin of most moons

Is this one of those extraordinary coincidences of a theory being able to explain numerous phenomena but yet have a fatal flaw? Or is this simple process the fundamental process behind these phenomena?. As its explanations are specific, specific research questions and data will be easily generated and related to it.

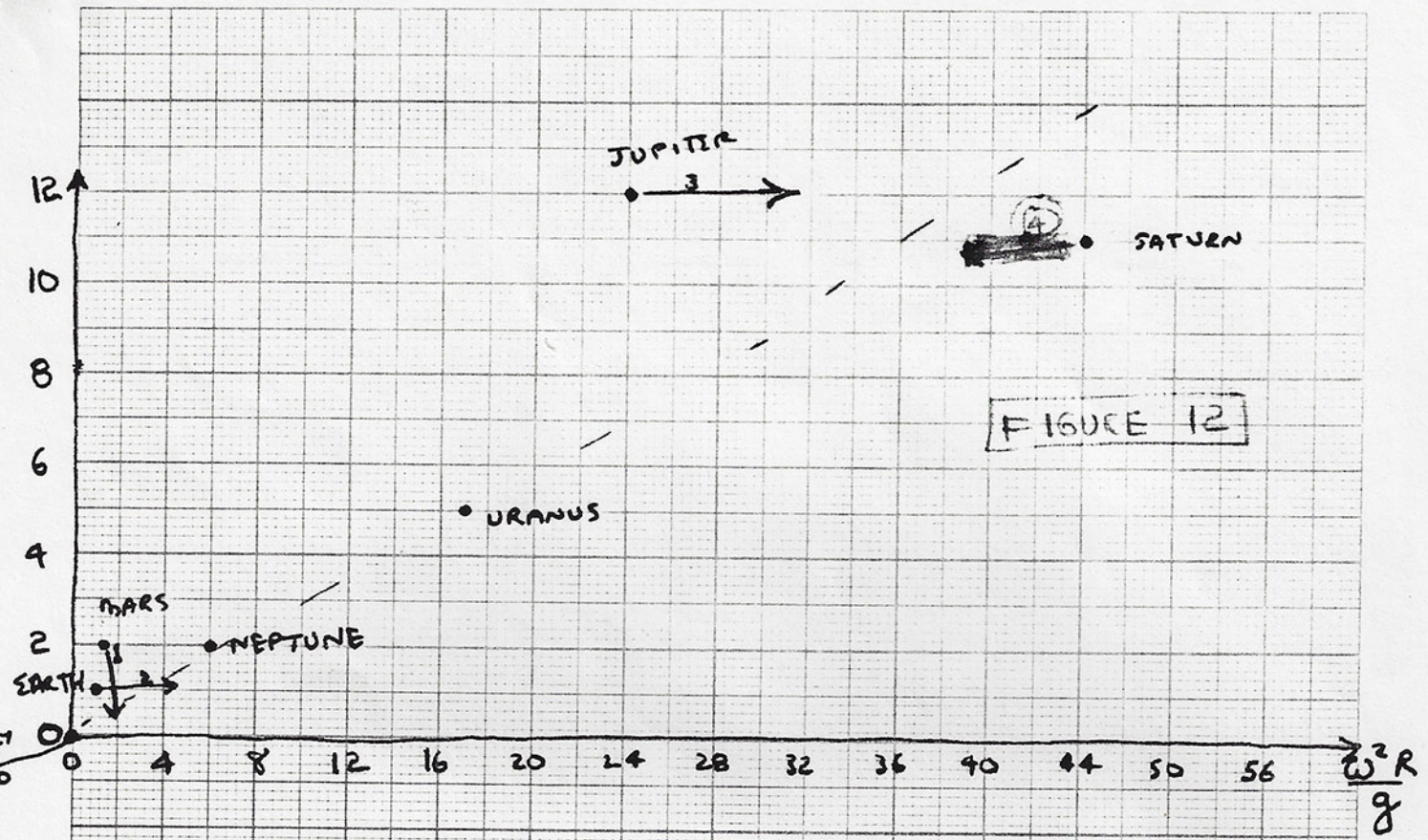
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3 INTUITIVE GRAPHICAL CHANGES: (in blue)

- ① MARS while having 2 moons, they are so little in mass that it would be perhaps more accurate to represent the "amount of moon" MARS HAS BELOW EARTH'S.
 - ② EARTH due to tidal drag of its large moon has lost considerable $\omega^2 R$ since the moon first formed. Thus as this graph is trying to explain moon origin it would be more accurate for EARTH to have an $\omega^2 R$ about 4-5 times larger.
 - ③ Jupiter could be shifted to the right some to take into account the gross effect of large mass as its mass is over three times larger than Saturn's and 318 times larger than Earth's.
-  Saturn's very small overall density (0.714 g/cm³) may account for its being perhaps the last planet to have formed a ring.

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CORRELATION BETWEEN # of MOONS and SPIN FACTOR: $S_p = \frac{\omega^2 R}{\nu g} + 1$

OF MOONS

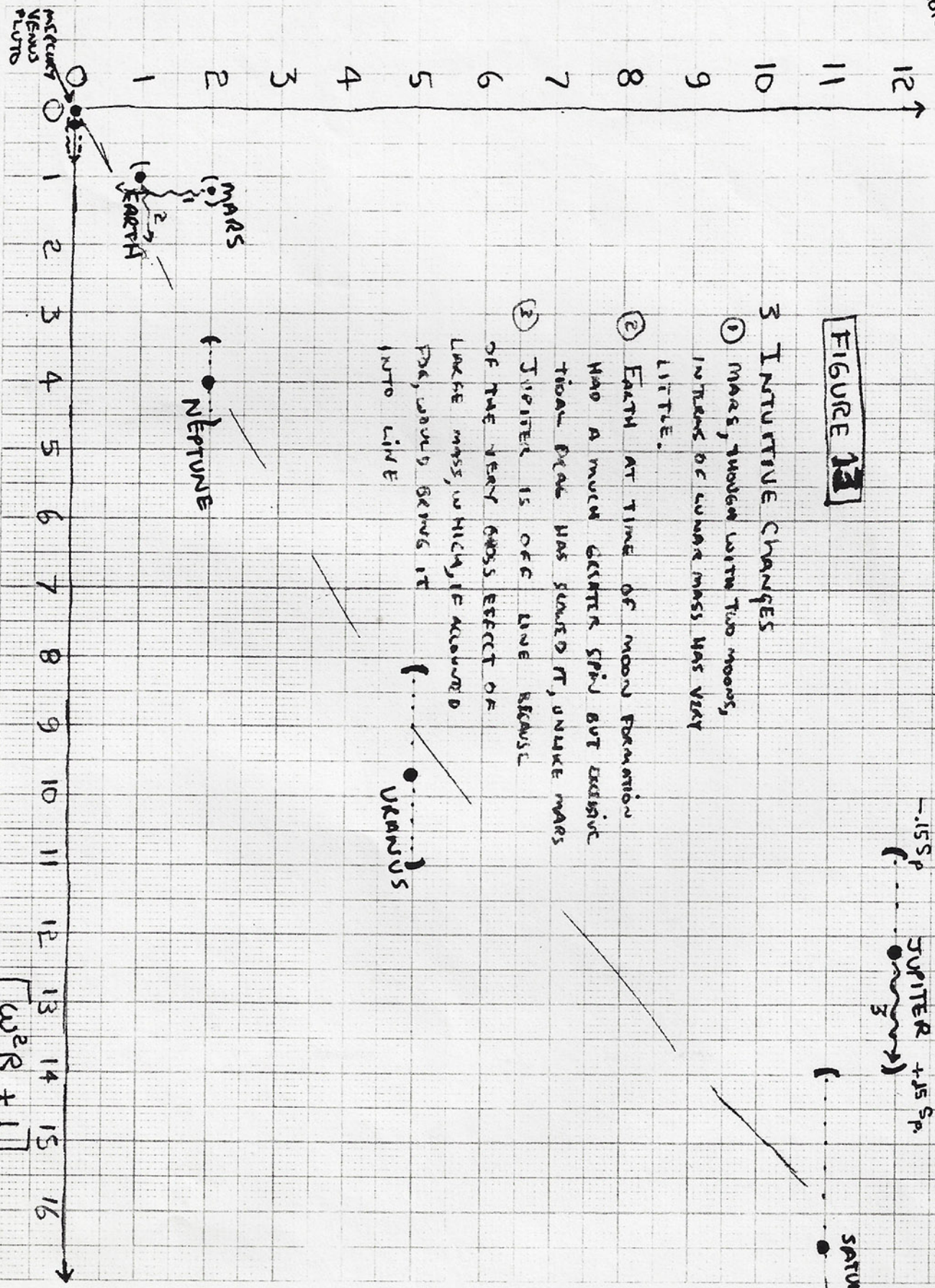


FIGURE 13

3 INTUITIVE CHANGES

- ① MARS, JUPITER WITH TWO MOONS, INSTEAD OF LUNAR MASS WAS VERY LITTLE.
- ② EARTH AT TIME OF MOON FORMATION HAD A MUCH GREATER SPIN BUT EXCESSIVE TIDAL BRAK HAS SLOWED IT, UNLIKE MARS
- ③ JUPITER IS OFF LINE BECAUSE OF THE VEY GRASS EFFECT OF LIKE MASS, WHICH, IF ACQUIRED FOR, WOULD BEING IT INTO LINE

-15 Sp
JUPITER +15 Sp

$$\left[\frac{\omega^2 R}{\nu g} + 1 \right] \text{ Spin Factor}$$

	# OF MOONS	$\frac{W_R}{S_P} + 1$ NEG $S_P = 1.0$	MASS OF PLANET $M_{\oplus} = 1.0$	DENSITY OF PLANET $\rho_{\oplus} = 1.0$	RADIUS OF PLANET $R_{\oplus} = 1$	SPIN RATE OF PLANET $\omega_{\oplus} = 1$	ACCELERATION OF GRAVITY	CENTRIFUGAL ACCELERATION $\omega^2 R$	$\frac{\omega^2 R}{g}$
JUPITER	12	12.2	318.4	.24	10.97	2.40	2.65	63.3	23.9
SATURN	10 + Rings	16.5	95.3	.13*	9.03	2.40	1.17	51.7	44.2
URANUS	5	9.7	14.5	.28	3.72	2.24	1.10	18.7	17.0
NEPTUNE	2	4.0	17.2	.40	3.50	1.53	1.41	8.2	5.8
MARS	2	1.2	.11	.71	.52	.98	.40	.50	1.25
EARTH: \oplus	1	1.0	1.0	1.00	1.00	1.00	1.00	1.00	1.00
PLUTO	0	.4	.2	.36?	.45?	.16	.16?	.05?	.07?
MERCURY	0	.2	.05	.92	.39	.45	.36	.08	.22
VENUS	0	.1	.81	.89	.97	.09	.86	.01	.01

CHART I (2)

* NOTE EXTREMELY SMALL DENSITY, WHICH MAY BE RESPONSIBLE FOR SATURN'S TO HAVE ALMOST AS MANY MOONS AS THE MUCH LARGER JUPITER, IF MASS HAS ANY GROSS EFFECT.

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Constantine Sousanis

1. The Ocean Basins of the Earth

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- (5) The moon shows no crustal spreading, no surface structure like the earth's trench system, ridge system, cordilleras of folded mountains, of large transform faults.
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- (8) Dietz feels a critical question is whether the granitic crust ever formed an unbroken, completely encircling layer around the earth. He answers negatively as he feels that convection cells within the mantle led to one of two initial "rafts" of crust. "Continents are protuberances above the true surface of the earth, instead of ocean basins being depressions within the earth's outer shell. His latter point I feel is a moot one, depending strictly on definitions. Concerning his first point, as I will later show, the earth may well have been covered with an early crust, but 3 ½ billion years ago the spray event occurred that led to (presently hypothesized by some geologists) super-continents Laurasia (North America and Eurasia) in the Northern Hemisphere and Gondwana in the Southern Hemisphere. If the total areas of each of these two super-continents are summed up, the two have practically identical areas of 100 million square kilometers each. Dietz feels this equivalency is understandable if both continents were born from the mantle in opposite hemispheres. This is too tautological to explain much. In the spray hypothesis it is a necessary result that there be initially two super-continents formed and that they be equal in area.

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- (a) Capture
- (b) Formation alongside the earth
- (c) Fission of the earth

In part III of this paper my hypothesis

- (d) Spray-Ring,

which is somewhat related to the fission theory, will be developed. First, it will be appropriate to discuss some of the difficulties in each of the three prominent theories which hopefully the spray theory does not encounter.

- A. That the moon is a captured body is admitted even by a main proponent, Dr. Urey, to be very possibly a highly unlikely event. (7) Ruskol is convinced, as I am, that the regular character (close radii, approximately circular orbits, closely equatorial inclinations,) of not only the orbit of the moon but most other orbits of satellites of the solar system's planets, is just too incompatible with the capture theory, leaving only the possibility that the few "irregular" satellites which are usually remote and of negligible mass are the only captured moons (5). O'Keefe points out the celestial mechanical difficulties of capture: (1) Only very close encounter would have allowed capture; (2) its orbit would have then had to become more and more eccentric (4). Urey suggested the capture theory in that the density of the moon (3.4) resembled the density of the lightest chondritic meteorites (3.8). But this still is a significant difference, which then requires postulation of further lighter materials present such as water or graphite. At any rate, the chemical composition of the moon should be quite different from that of the earth if Dr. Urey is right.
- B. If the earth and moon formed the same way alongside each other, they should have formed from the same materials and resulted in similar densities – not at all the case. So far data keeps reaffirming that the earth's core is iron, not pressurized mantle material. The present earth to moon mass ratio of 81:1 can not be predicted from a mathematical model of a condensing swarm of particles. Ruskol does try to account for the discrepancy by postulating that the moon only began to form when the earth had completed .3-.5 of its mass accumulation. But he totally ignores the density problem.
- C. According to the third theory, fission of the moon from the earth would allow the proper densities if it took place after the core was formed. The difficulty of this theory, which the spray theory can hopefully reconcile, is that the present angular momentum of the earth-moon system fails to account for the needed angular momentum allowing fission by a factor, at the extreme, of four. There is some speculation of mechanisms between the earth-moon system and other planets which have perhaps soaked up some of this angular momentum.

All three theories can not account for a crisis which must have occurred to the moon 2 billion years ago as indicated when the rate of change of the moon's distance is extrapolated back in time. Further, the earth's geological record shows no such trace of such a cataclysmic crisis. MacDonald postulates the formation of the moon by the mutual capture of satellites in orbit around the earth. The genesis of these satellites encounters the same difficulties as the genesis of the moon theories, but it is an intrinsic part of the spray theory. The spray theory will have to further conform with Opik's thesis that bombardment could not have come early in the moon's history because at that time when it was close to the earth the tidal bulge would have had such an extent that the future settled shape of today would have found the moon with elliptically-shaped craters.

O'Keefe feels that most thoughts on the moon origin can be summed up into two threads:

- (1) it is captured, dead, different from the earth; (2) it is closely related to the earth. The recent lunar landing seems to indicate the latter possibility to be more likely with the finding of what appears to be igneous rock at this early stage, and adds credence to the following spray-ring hypothesis.

III. The Spray-Ring Theory

Somehow the earth formed. (Possibly it occurred in a mass swarm, but the origin of the planets is not to be my concern at this time as it is not essential to the following arguments.) At first the earth was characterized by a homogenous composition as the distribution of the material in the swarm was most likely random and accumulated randomly. But as heat built up, (radio-active decay of thorium, potassium, uranium, collisions, adiabatic effects, greater heat absorption from the sun due to atmosphere build-up, heat of fusion during solidifications), differentiation suddenly occurred on the molten earth, possibly 3 ½ billion years ago as Dietz suggests. At that point the iron sinking was the main event.

- A. In order to conserve the earth's angular momentum, the perhaps already fast spinning earth began to suddenly spin faster as the iron sank to its center.
- B. This fast spin coupled with the high thermal speeds of the outer surface materials led to a spraying off of the earth into sub-orbit, orbit, and escape, of the material on the molecular level. **(Figure 1)** This orbiting spray is possible due to the additional thermal motion even when the earth's angular momentum is lower than that required for a fission of a large mass.
- C. As this spray of light material would be girdling the earth around the region of the equator (even as high as 45° degrees North and South the centrifugal accelerations would only be reduced to 71% of that at the equator, assuming bulge can be neglected), **(Figure 2)**, the returning elliptical particles could be colliding with the exiting particles and, on the average, their resulting paths might be parallel to the earth's surface. **(Figure 3)** A circular orbiting cloud, or ring, of material could in such a manner form a certain distance away from the earth along its equatorial plane. This distance would be a function of the hot atmosphere's extent which was very likely greater than that of today. Depending on the size of the ring particles and the density of the outwardly thinning atmosphere, a critical point would begin to exist as we move away from the earth where the orbiting ring could begin to survive, perhaps the 5 – 10 earth radii suggested from the backward extrapolation of the moon's motions, with the heavier particles surviving first closest to the earth, though this is not an essential point of this theory. **(Figure 4)**
- D. This sprayed out ring becomes the basis for the accumulation and buildup of the moon, perhaps 2 billion years ago as MacDonald suggests. Many coalescing processes are possible: perhaps accumulations started first from crystallizations, and then, inter-crystalline accretions; perhaps occasional meteorites became centers of accumulation. **(Figures 5 and 6)**

At any rate, accumulation probably proceeded slowly and no crisis need have been recorded on the earth. The process could have stayed relatively cool also. Perhaps as this material accreted and fell together into bigger and bigger pieces, the heavier pieces came together sooner and began to effectively sweep up the lighter pieces further out. Perhaps this accounts for the almost complete heavy bombardment on the backside of the moon. It could certainly account for the hits seeming to look as if they had been made by vertically falling objects.

Only if they had been lunar orbiting objects could they have done this to such an extent. Also, there are some intriguing linear arrangements of craters that the ring hypothesis can explain. If the earlier heavy accumulations are still facing us today they may be the explanation of the mascons.

- E. On the earth we have after the spray has died down, due perhaps to cooling, a large belt around the earth where considerable mass is missing. Two crustal “caps” remain at the poles: the geologists’ hypothetical early super-continents of Laurasia and Gondwana. **(Figure 7)** If before the spray the early crust was roughly uniformly distributed around the earth, after the spray practically equal areas would be left at the poles in direct agreement with the area calculations of the geologists. Also after the spray, significant flows of the crusts could have occurred equator-ward. Perhaps the momentum of these flows carried them far past the equator as perhaps in the well defined plume of Africa which may have run into a perhaps slower moving plume of North America. Perhaps the flow passages are along depressions that resulted from differential heating processes that occurred during the spray period. Also the distended upper mantle could have elastic-like transport back to the poles from where it was distorted. These two processes may account for the present land-form arrangements, and though considerably diminished and deflected with time, may still be influencing present drift and other dynamic tendencies. **(Figure 8)** It is interesting that the lower mantle is not thought to be undergoing as marked evolution as the upper.

At any rate, the universality of the ocean basin, its common level, the earth’s bimodal land distribution, no evidence of cosmic bombardment, are all accounted for by the spray-ring theory.

- F. An interesting calculation to make is how much would we have to peel the earth to get enough mass to form the moon? A strip about 50 miles deep around the equator covering about 80% of the earth’s area will suffice. After 3 ½ billion years of adjusting, the present 5 mile average range of the bimodal distribution is most plausible with the extreme range of crust and ocean basin being about 15 miles presently. And it is probably most likely that dynamical changes to preserve the spherical geo-potential of the earth were taking place most rapidly during the period of the spray, so that 50 miles is an extreme number.
- G. The spray-ring hypothesis to be any good should account for the formation of other moons in the solar system. This it does so dramatically that part IV has been devoted to this subject.

IV. Generalization of the Spray-Ring Hypothesis to Explain the Origin of the Moons of the Planets of the Solar System

Using the data from Chart I, if we correlate the number of moons to the mass of each planet, we get at the most only a very gross correlation to the mass; certainly little predictive value is found here. **(Figure 9)** Now, according to the spray-ring theory, formation of any moon would be a function of the outward-throwing forces in relation to the in-ward holding forces. More specifically, outwardly we have the centrifugal acceleration, $\omega^2 R$. If we correlate just the angular acceleration to the number of moons of each planet, we get an astounding fit. **(Figure 10)** If we next correlate the number of moons to the ratio of the outward centrifugal acceleration to the inward gravity of the planet, $\omega^2 R/g$, we again get an excellent fit. **(Figures 11 and 12)** Finally, the Spray Probability (S_p) will most specifically be a function of the ratio of the outward

centrifugal acceleration to the velocity needed to orbit the particular planet \sqrt{gr} . Setting the Spray Probability of the earth arbitrarily to equal one, the formulation of S_p becomes: $S_p = \omega^2 R / \sqrt{gR} + 1$

$$S_p = \frac{\omega^2 R}{\sqrt{gR}} + 1$$

Figure 13 correlates the number of moons to the spray factor. While the fit is excellent, beyond expectations, if we consider possible error and limit our theory to only being able to account for 85% of the explanation for the moons (as indicated by the 15% brackets on the graph), the fit becomes even better. Further, if we make some logical, arbitrary though intuitively accurate changes to the final graph, we get a nearly perfect fit:

- (1) Mars, though with two moons, has actually very little total lunar mass. This drops Mars down into appropriate fit. Of course, it may be appropriate to correlate the spray factor of all the planets to their total lunar masses, but this data is not available yet.
- (2) Earth at the time of moon formation had a much greater spin, but in time the excessive tidal drag of the moon has slowed, unlike Mars. This correction would shift earth to the right on the graph as shown, again achieving near perfect fit.
- (3) Finally only Jupiter remains perhaps a little off though it does fit if you consider a 15% variation as reasonable for the spray factor. At any rate, perhaps mass does indeed have a gross effect on the function of the number of moons which would then certainly bring Jupiter into line. Or even, perhaps the exceptionally small density of Saturn is the factor which allowed it to have almost as many moons as Jupiter – certainly spray is easier in a less dense planet.

Saturn's ring is certainly intriguing as it may be the only remaining spray-ring. One would expect that the last spray ring of a planet would be the closest orbiting body of the planet. Such is the case. It is also interesting that the latest moon to be discovered on Saturn is very small, travelling along the ring – is this the beginning of the accumulation process of the ring?

One final speculation: What process occurred in time to spew out one ring after another on the less dense planets? Perhaps early tremendous solar flare-ups, of which today our record is the moons around these large, thin planets. How the moons vary in age and composition will be an interesting question for future planetary exploration to undertake to answer.

In Conclusion, this remarkably simple theory seems to account excellently for three major phenomena:

- (1) land forms of the earth
- (2) land forms of the moon
- (3) the origin of most moons

Is this one of these extraordinary coincidences of a theory being able to explain numerous phenomena but yet have a fatal flaw? Or is this simple process the fundamental process behind these phenomena? As its explanations are specific, specific research questions and data will be easily generated and related to it.

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