Chapter 2: Seeing Purpose in lineaments

Abstract

The qualities of a meaningful pattern in nature are considered, and purpose, a meaning behind the pattern, is recognized as the most important. Several examples of partial occlusion of patterns are considered. Overlapping crater form such patterns, from Tsiolkovskiy and Fermi craters in the Fermi-Pavlov basin and their associated ghost craters on the farside of the moon to the Mabule, Kara, and Australian craters and their associated ghost craters on Earth. The purpose in these ring complexes is predicated on understanding the interruption of the patterns by other ghost rings. Being able to identify the source of interruption and their common pattern raises the confidence in the identification of a common genesis and of linears as parts of impact craters.

Introduction

Looking for meaningful patterns in nature is a human preoccupation, yet pattern recognition is often subjective and difficult (Zeller, 1964), and then recognizing a purposeful origin for them is even harder. O'Driscoll (1980) proposed the existence of a "Double Helix in global tectonics" to explain Earth's lineament patterns. His conclusion was simplistic, but his goal of finding a common cause behind lineaments remains important. Before lineaments can be interpreted, they must be identified. Some are obvious, most are not. How much must we see to define an inferred lineament? (An *inferred lineament* is one which is extrapolated beyond individual linears.) This is a problem in "partial occlusion" (Kellman and Shipley, 1991), only seeing a part, and interpreting it as if it were the whole. (Like seeing only your friend's head in a window, and recognizing that they still have their body attached, but not seen.) How much do we need to see to recognize the pattern? (One person may recognize your friend from just her face, but another may want to see what she is wearing.) One person may see a recognized face; another sees only another face in the crowd.

Clearly, training enhances that ability to see patterns, as demonstrated by those who professionally interpret satellite photographs, but others say we humans have a tendency to see patterns where none exist. (In a crowd, we recognize people's features that we are familiar with much quicker than random strangers.) If this field is so subjective is it a legitimate field of research? (The operating of a cyclotron is a mystery to me. Should I question if nuclear physics is a legitimate field of research because I have never trained in that field?)

This problem touches on human perception. Do these subjective or illusionary lines really exist? In the language of perception, Kanizsa (1976) and Kellman and Shipley (1991) will tell us it all depends on whether we can see a purpose in our interpretation. The study of illusionary or subjective figures goes to how the human mind processes visual cues; understanding such images hinges on a perception of the whole rather than the parts (Kanizsa, 1976). No one questions if linears exist. The question is, can we lead our mind to see beyond the few visual clues to a pattern or purpose behind them to a lineament?

If all we saw of Figure 2.1 was the inside of the circle, an observer might think it was interesting short linears, but without any significance. However, if Figure 2.2 sees all of the linears and infers they are connected as observed, these short linear segments start to take on a larger pattern. We infer the existence of larger linears based on a recognized possible connecting purpose. Emphasizing those inferred lineaments may lead us to Figure 2.3 where a very different pattern is suddenly recognized.

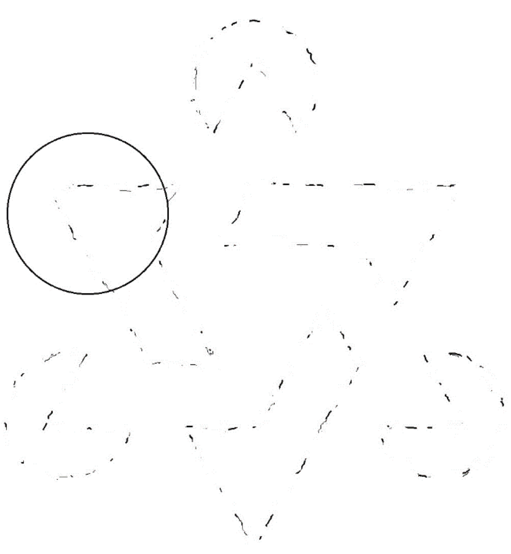

Figure 2.1: A collection of short lineaments. Are they random? Do they have a purpose?

We can never tell if they are random until we see a pattern, if any. That may involve only a small part, or require looking at them in a much larger context. In these chapters I will present many pattern, but for everyone I present, I have discarded several, and in some cases, very many. I have discarded them looking for the best answering purpose.

Is the pattern in the circle representative of the entire pattern? We will never know until we are willing to extend the area we are looking at and continue exposing the pattern.

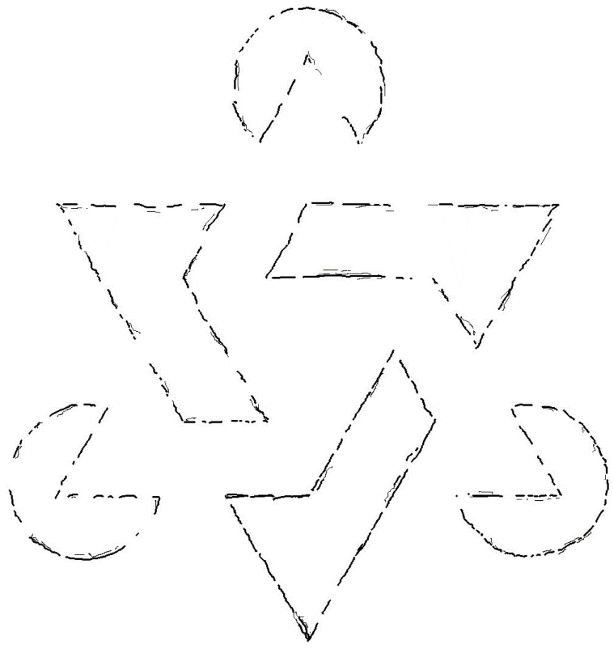

Figure 2.2: One possible pattern interpretation of the short linears.

Figure 2.2 is one possible interpretation of the linears. Go back to Figure 2.1, can you see other possible patterns? Maybe, this one is correct, maybe not. We will not know until we are willing to acknowledge the possibility of a pattern, and pursue as many possibilities as needed to see if a purpose emerges. Sometimes arriving at an answer in science is a matter of how long we are willing to spend considering the problem. Sometimes it is dependent upon taking an intuitive leap. The more familiar we are with the linears, the smaller that leap appears.

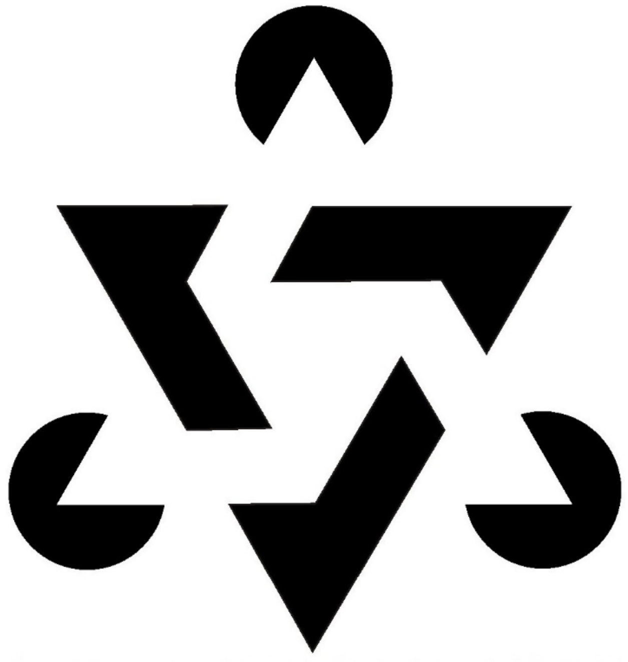

Figure 2.3: Colored to accentuate the pattern the author wants considered in these linears.

A purpose is not something that magically appears when a pattern is discerned and tried. A purpose is something we make-up and put on a pattern. Figure 2.3 is one option for the pattern reflecting my purpose.

What is a purpose?

In Figure 2.3, I see two triangles, a white and a black one. Do both of them exist? The white triangle has no edges. Its absence defines its existence and holds the entire pattern together. But, is the white triangle really there or physically absent? If it is not there, what is holding the other parts together? What about the three “Pac-Man” units? Without the white triangle would they be the same or would they be circles? The existence of the white triangle is a problem. Many times a circular ring (crater) can be seen but part of it is missing. Can we figure out why that particular part is missing? The missing part becomes our major purpose in finding and understanding rings. In part, it is perception of a pattern that enables additional details to be added that reinforce the total pattern. But, that reinforcement can only come *after* we are willing to take the leap and admit existence of a pattern. To question the existence of part of a pattern inside the circle in Figure 2.1 is to deny the pattern's existence, and that it has some purpose when we see it. To be understood, the figure must be viewed *as a complete pattern. Only when we see the whole and accept the existence of constituent forms can we define the significance of presence or absence of some part.* The parts only have meaning as they are part of a whole. With lineaments, the lack of specific segments may seem to be a problem. Yet, *that void may be the clue to understanding the purpose of the larger whole*.

How much is enough?

You view Mt. Rushmore through a grove of large pines. You see a bit of smooth carved rock here, the curve of a lip there, the indent of an eye elsewhere. We instinctively see even this much of a pattern to be artificial, not a result of natural erosion. Knowing that you are in the area of the presidential monument, you infer the carving's presence. Partial occlusion works this way. The more familiar you are with a possible purpose, the more ready you are to see the inferred pattern.

Like these patterns, lineaments are usually represented by small segment (Figure 2.1, circle) linears. The human brain must fill in the pattern. Therefore, the human perception problem is necessarily open to interpretation.

Figure 2.4: Mount Rushmore partially occluded by a grove of trees. How much do we have to see to recognize the view?

Reliability

Understanding lineaments then requires a pattern and details that mutually reinforce each other. While the risk of circularity is a source of uncertainty, but without it, lineament studies remain simplistic, and confined to human scale. It is only when enough of the entire figure can be seen that the more complex pattern will be revealed. Sometimes *it is the voids that define the total picture*. The individual parts are important, but the total picture often requires an intuitive thought leap to the whole, in order to explain the parts.

(1) Does the figure contain repeated elements? Cut Figure 2.3 through the packman shapes, it would produce three repeated units. Random arrangements lacks symmetrical repetition, and are without purpose.

(2) *Do regular elements occur at regular intervals?* Random arrangements seldom provide regularity. This figure provided regularity in that the three circles are equal size, the two triangles are equal size, and they are equilateral triangles of equal length legs.

(3) *Are concentric or parallel elements repeated?* Parallel elements are not a part of random arrangements. They are exclusively connected to a cause.

If arcuate to circular lineaments and parallel, concentric lineaments can be used to explore ancient impacts, we should be able to see these 3 elements regularly in the lineament's patterns. Once a potential structure is defined, geological and geophysical data, such as lithology and sedimentary structure can add understanding to the gravity maps used in this paper.

Seeing Tsiolkovskiy and Fermi Craters

In learning to recognize craters, let us look at some less distinct ones on the moon (Figure 2.5) and try to understand why they are less distinct. Tsiolkovskiy and Fermi are two craters in the southwest quadrant of the moon's farside. Named for Konstantin Tsiolkovskiy and Enrico Fermi, Tsiolkovskiy is the more distinct one. It is centered at -20.38ºN, 128.97ºE, with a diameter of 159 km, and easily recognized by its roughly triangular pool of lava. The Fermi crater lies to the east and is partially occluded by the Tsiolkovskiy. From this pattern we conclude the Fermi preceded the Tsiolkovskiy. The Fermi centers at -19.61ºN, 123.24ºE, and is about 206 km in diameter (Lunar Impact Crater Database 2015).

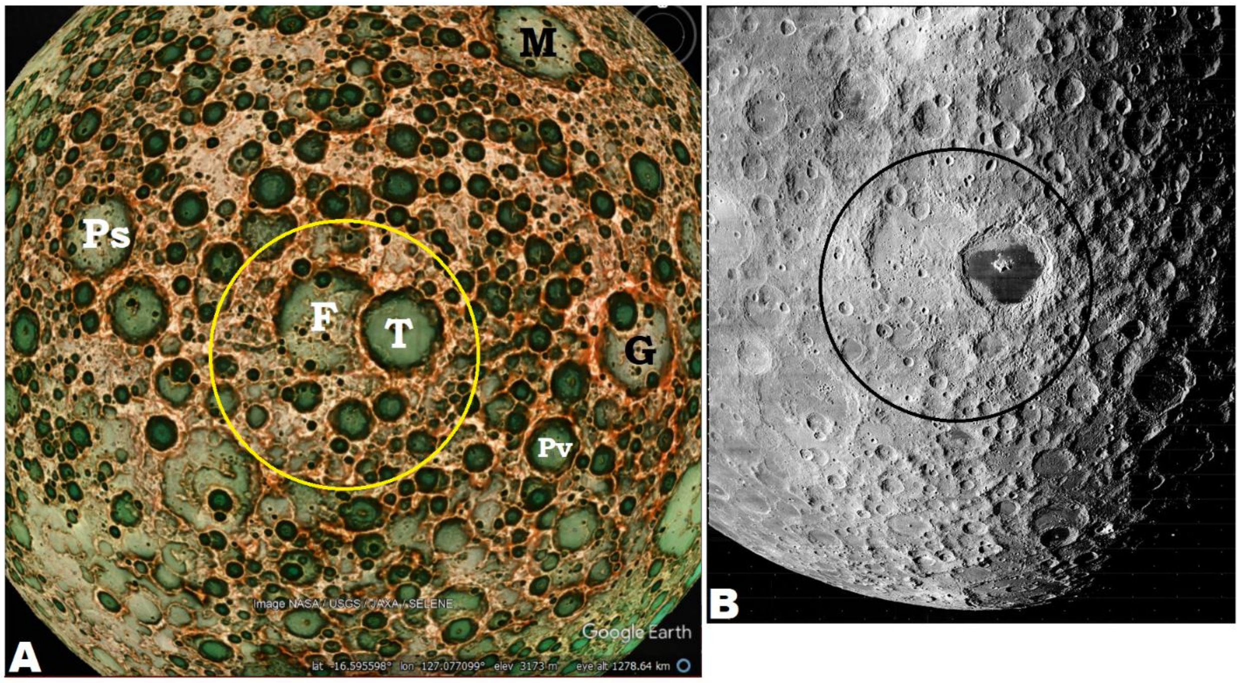

Figure 2.5: The craters Tsiolkovskiy (T) and Fermi (F) on the far-side of the moon. Pasteur (Ps), Mendeleev crater (M), Pavlov (Pv), and Gagarin craters (G) located as landmarks. (Image Credit: (A) Red relief overlay, Chiba 2017, (B) Image from NASA 1967 Surveyor mission.)

While the Fermi crater's rim is very distinct on the Red Relief map, it varies much in its visibility in the Surveyor's photo? But, it is not a flat plain. The majority of the variation appears to be because of ghost craters and straight linears crossing the area. In Figure 2.6, the red ring and linear between the red arrows had a clear effect on the south and southwest rim of the Tsiolkovskiy crater, and the southern green ring with the red ring lowered the south rim of the Fermi crater. The upper green ring and white inner ring of the ghost crater, as well as the ghost crater, itself, lowered the northern rim of the Fermi and provided disruption in the northern rim of the Tsiolkovskiy crater. In other words, we can see the ghost craters because they serve a purpose, accounting for the Fermi crater's rim changes. The blank copy of Figure 2.6 is included to encourage the reader to find for yourself the indication of rings that are observed by the author.

Since the rims of both craters are partially obscured, it is reasonable to try to determine why. Hartmann and Kuiper (1962) recognized that neither tectonic movements nor water erosion ever took place on the moon, therefore all ridges and mountains were pushed up as part of crater rims, central peaks, or annulus, and any rim erosion is also confined to these processes.

The analysis of crater formation proposed by Shoemaker (1974), and used by NASA, was based on detonated nuclear explosions, and assumed impact craters were also formed by explosion initiating ballistic excavation. While Tsiolkovskiy crater and several of the smaller craters visible in Figure 2.6 do has a classical bowl shape crater and may appear to be excavated by ballistic ejection, none of the other four ghost craters have such a profile.

Studying Figure 2.6, it is clear that the Tsiolkovskiy on-laps the Fermi crater and thus postdates it. But, it is less clear where the other four ghost craters came in the sequence. I believe they arrived after the Fermi and before the Tsiolkovskiy. Even the red crater arrived before the Tsiolkovskiy, which was probably the last to arrive, and may have been delayed by several days. This would allow the general area of country rock to cool off and give some more pronounced form to its rim.

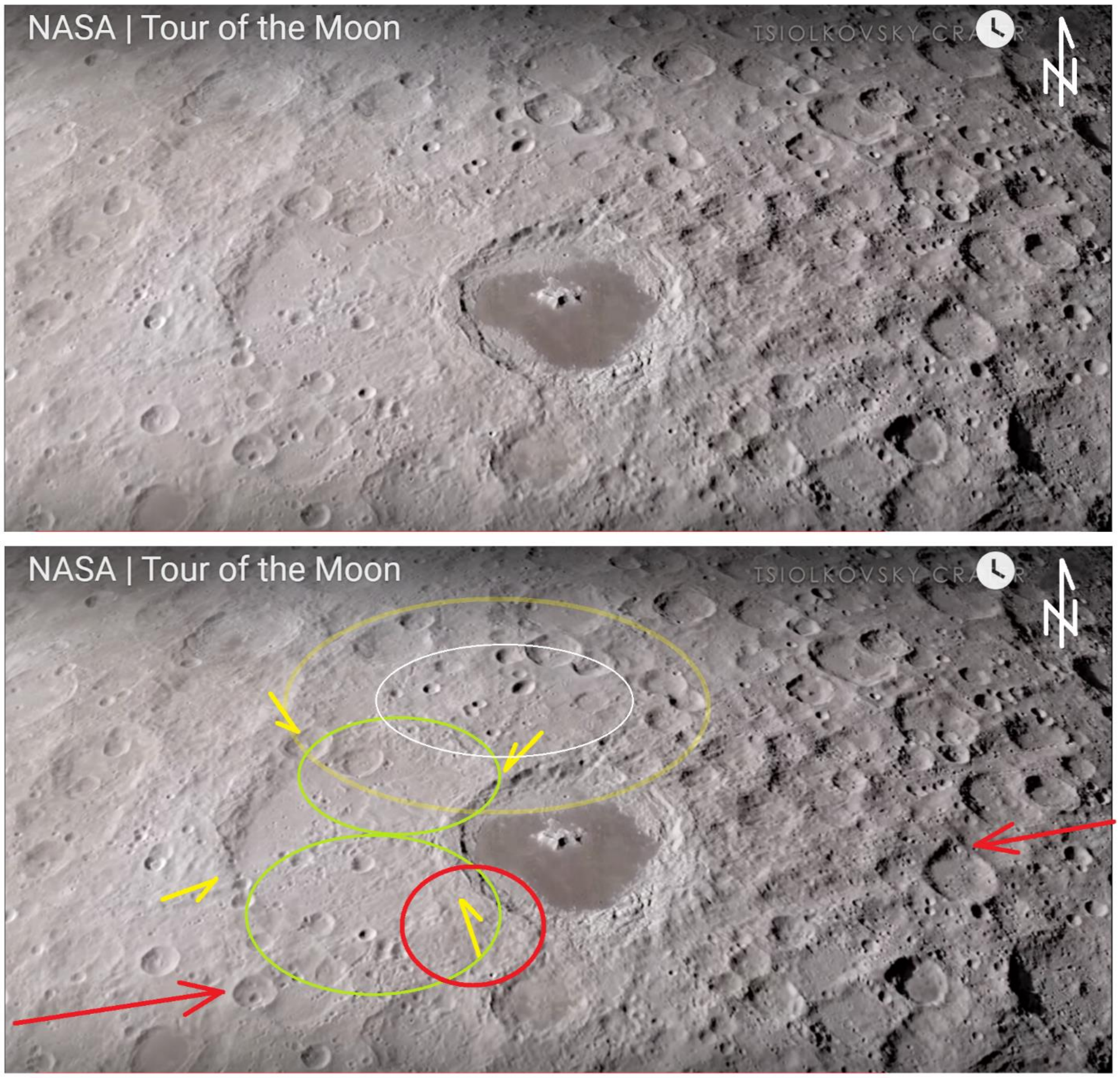

Figure 2.6: Tsiolkovskiy and Fermi craters and their immediate environs. The red arrows indicated a linear affecting Tsiolkovskiy's rim. Yellow arrows indicate points at which the Fermi's rim was affected by something changing its visibility. (Image credit: NASA, Tour of the Moon, YouTube.)

Figure 2.7 shows the portion of the ghost crater that overlaps the rim of the Tsiolkovskiy and Fermi craters. While the rim of the Fermi crater was mostly leveled, it is still visible as a roughened linear. The energy from the ghost crater was still in the substrate when the Fermi's shock/compression wave was expressed. The northern edge of that disturbed linear is distorted in an arc from the northern green ghost crater (Figure 2.6). By contrast, the pattern in the Tsiolkovskiy's rim is a pattern of faults and slumps in the rim, showing the energy was there but not obliterating the rise of the rim although its occurrence happening at different times. The ghost crater got help from a straight lineament when it made the eastern crossing of the Tsiolkovskiy's rim.

In Chapter 1, I suggested, consistent with an impact crater being formed by a shock-release wave, the actual excavation of the crater was a result of the adiabatic expansion of the release wave and a great deal of heat energy being transferred into work on the substrate. Analysis of these four craters suggest a sequence of events. All of the ghost craters may have come first followed by the Fermi after a day or two of cooling and then finally the Tsiolkovskiy cratering event after another few days of cooling.

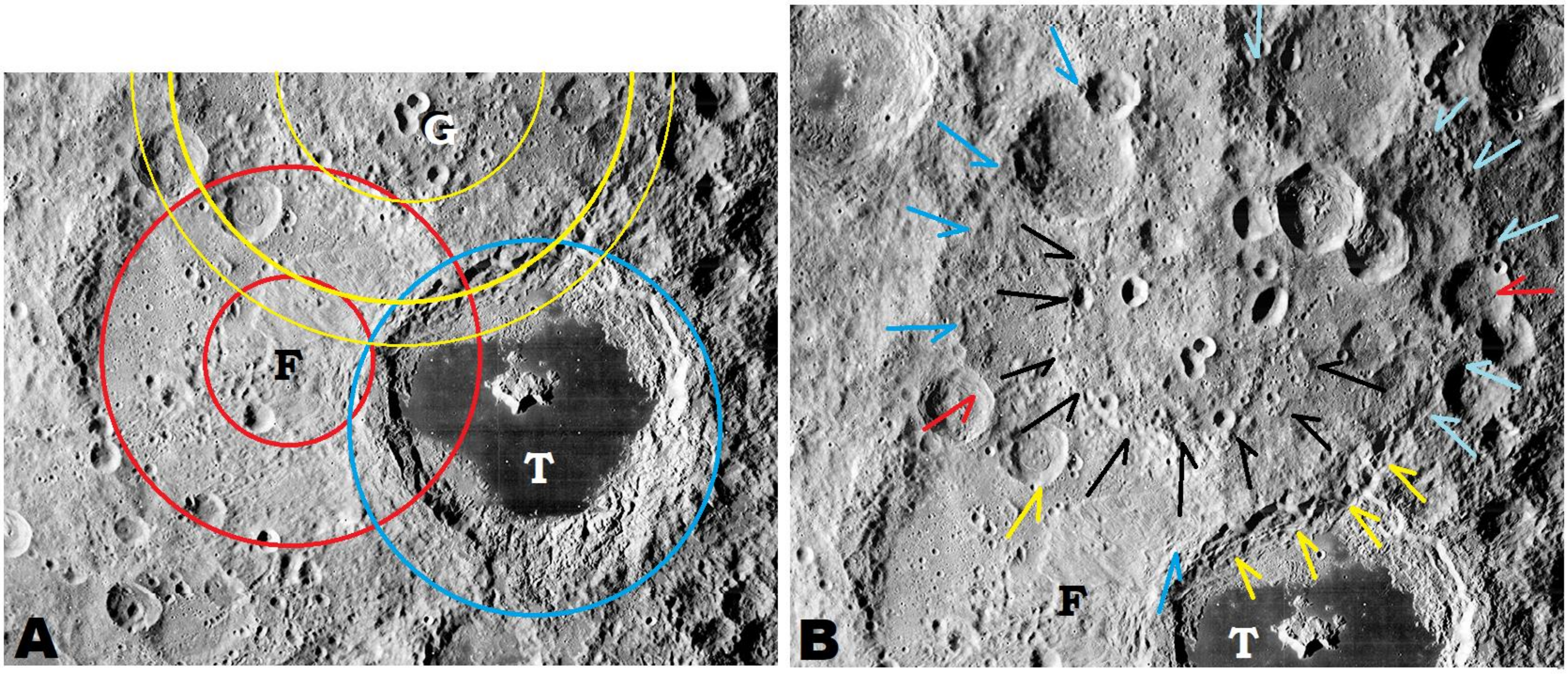

Figure 2.7: Tsiolkovskiy (T) and Fermi (F) craters with the most pronounced ghost (G) crater bordering them. (A) Rim of ghost crater appears to be between heavy and light yellow lines. Additional inner ring of Fermi and ghost crater indicated. (B) Raised points of the ghost crater's rim and inner ring indicated by arrows. Ring of ghost crater even seen in floor of smaller craters. (Image credit: NASA 1967 Surveyor Mission.)

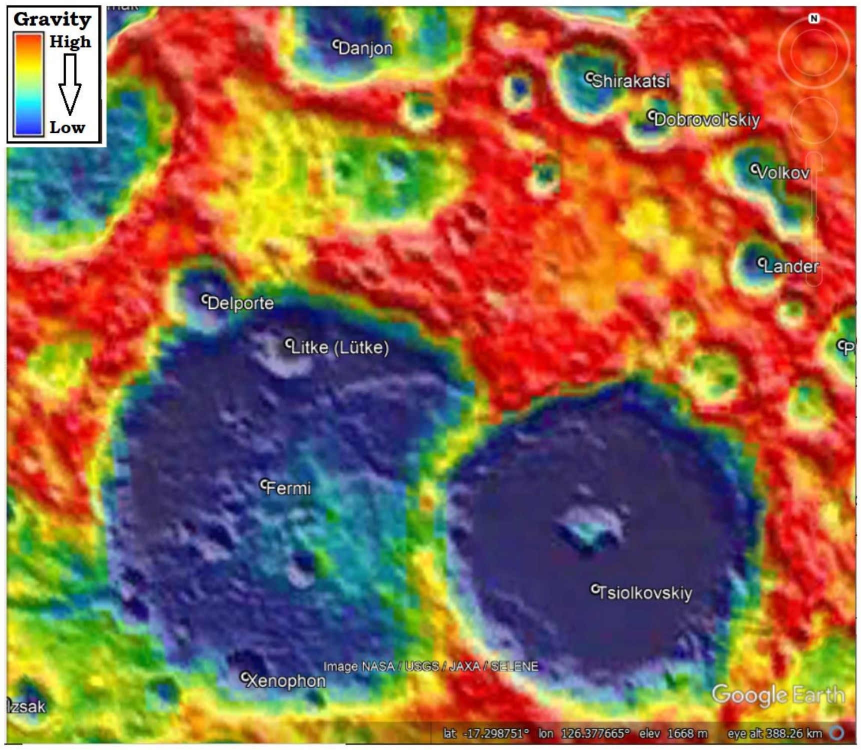

Figure 2.8: Fermi and Tsiolkovskiy craters observed in GRAIL Gravity mapping, (Image credit: NASA)

Figure 2.8 is a gravity map. The ghost crater essentially cannot be seen. This shows the energy in the rim and inner ring was mostly lost in the energy pattern already there. Since the shock-release wave puts a large amount of energy into the compression wave for the rim and the expansion wave for the following release valley, the logical conclusion is that there was not a large amount of energy difference present and the energy in the substrate was already great. A very gradual change is a change, but it is not as visible as a more sudden change. If the impact rock was already heated to near the elevated temperature of the shock-release wave, when the impact added its energy, the change would be much less significant, and less visible. Phinney (1991) suggest minerals found in the moon regolith form at 600^{o} C to 1200^{o} C. If the substrate was already at a temperature of 580^{o} C, if the impact produced an additional 200^{o} C, much of the additional heat would be diverted into mineral crystallization changes rather than being available to the adiabatic envelope for compression and evacuation.

Straight linears

Not only circular lineaments are found on the moon surface but straight lineaments. Straight lineaments are small circle expressions of circular lineaments at considerable distance (Figure 1.3). If straight lineaments are occurring, there must be other large distant craters forming them.

A prominent linear cuts across the northern edge of the ghost crater in Figure 2.9B, marked by two golden arrows. It is extended in Figure 2.9A, and multiple groups of them are shown in Figures 2.9C and D.

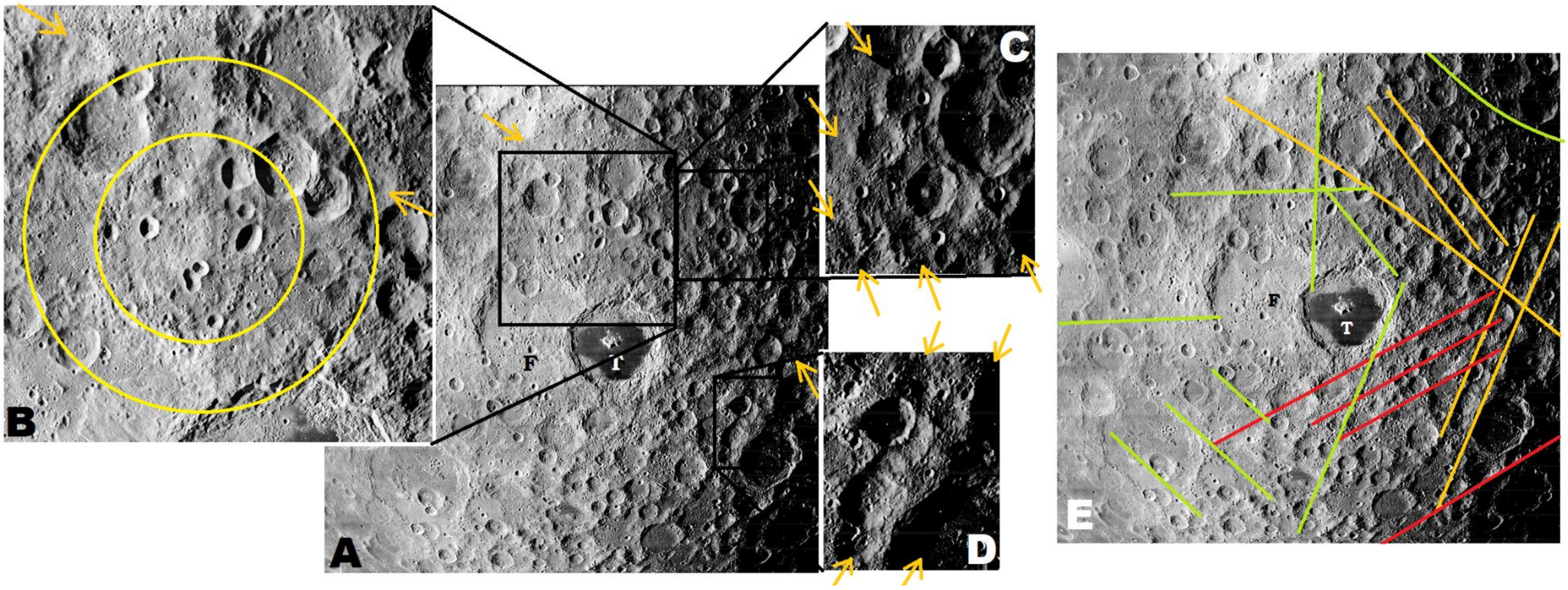

Figure 2.9: (A) Tsiolkovskiy and Fermi craters. (B) The ghost crater. (C&D) Patterns of straight linears. (E) Some of the straight linears visible in the area. (Image credit: NASA 1967 Surveyor mission.)

The Fermi-Pavlov Basin

I postulate the pink larger ring in Figure 2.10 defines the inner ring or rim of a crater forming the Fermi-Pavlov (F—Pa) basin. Assume the greatest topographic change takes place where the shock wave suddenly descends into the release wave, I have tried to put the rings in that vicinity. The outside of the ring will be the shock wave and inside the ring will be the release wave. The basin was recognized by the high number of craters against the inside of the third ring (Figure 2.11). If craters formed within the release wave energy valley (Figure 2.12), the cumulative energy would add in a similar manner like ripples in a pond. Craters forming within the shock wave would have their energy imprint swallowed, decreasing the energy in the rim, but failing to produce a rim for the smaller crater against the greater energy of the F-P impactor. On the northern half, such a gap is seen between the dark craters inside Ring 3 and the dark craters inside Ring 2. This suggest the actual number of these medium size craters was originally much greater than the present count indicates. While the occurrence of a mare size crater and concentric rings for the F-P impactor are not obvious, understanding the evidence for its energy signature increases the probability of its occurrence.

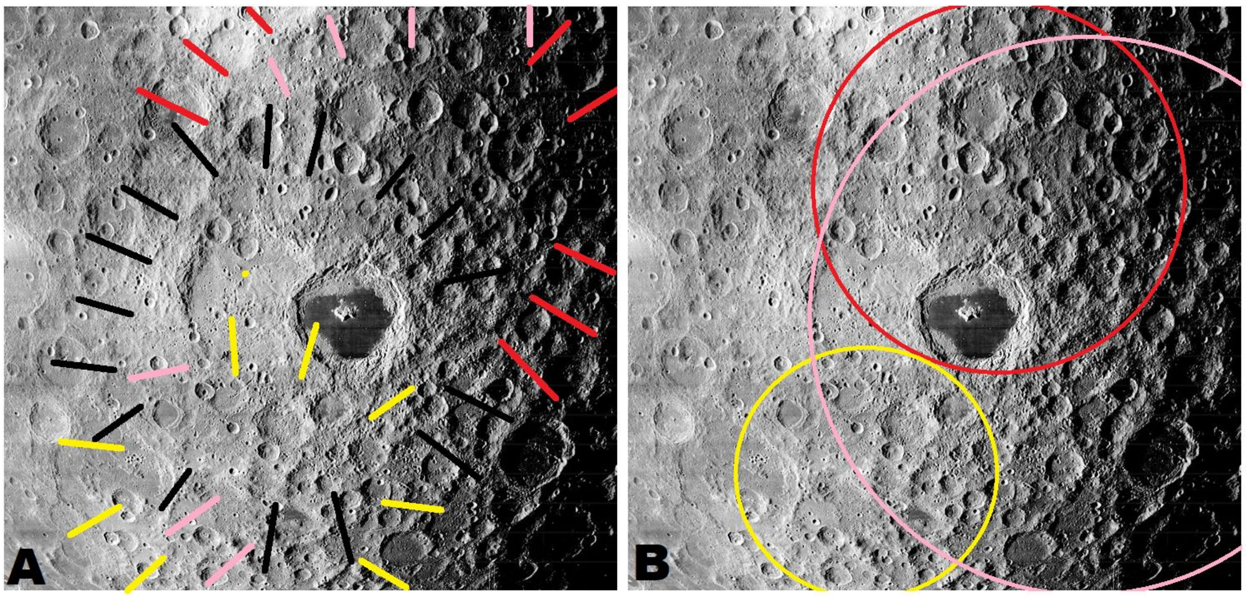

Figure 2.10: Some larger crater in the vicinity indicated by points in A and with circles in B. Comparing the two images will help the reader know what the author is seeing. He acknowledges that lines on the image strongly detracts from seeing lineaments. (Image credit: NASA 1967 Surveyor mission.)

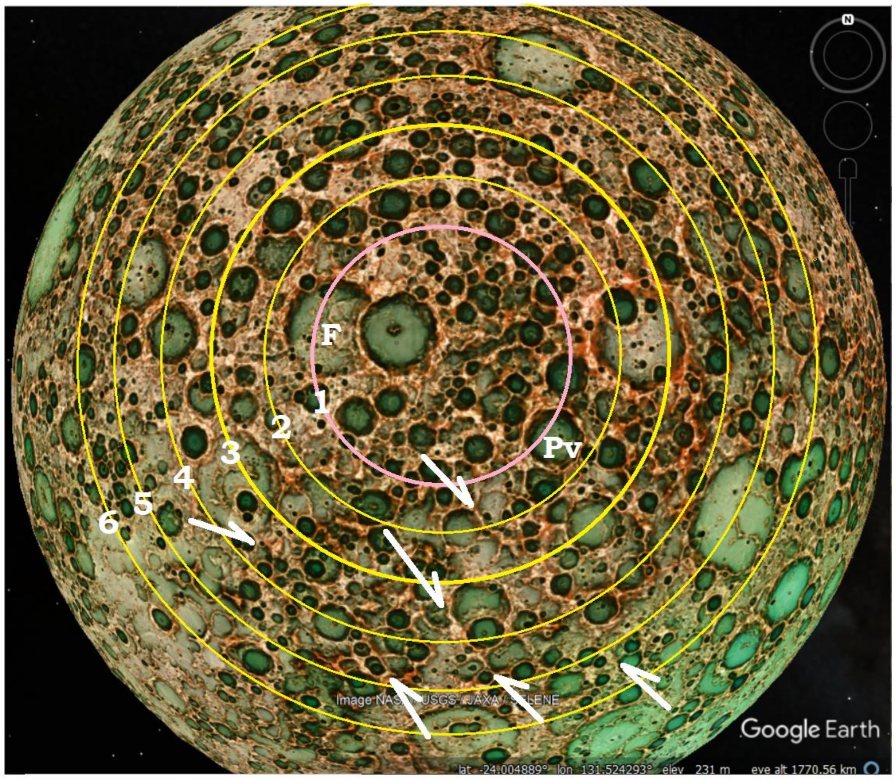

Figure 2.11: Red Relief map overlaid on Google Earth of backside of the moon. The Fermi--Pavlov (F--Pv) Basin and traceable concentric rings around it. Ring 3 is the most prominent. Pairs of white arrows point out another arced linears and two straight linears. (Image Credit: Red Relief, Chiba 2017.)

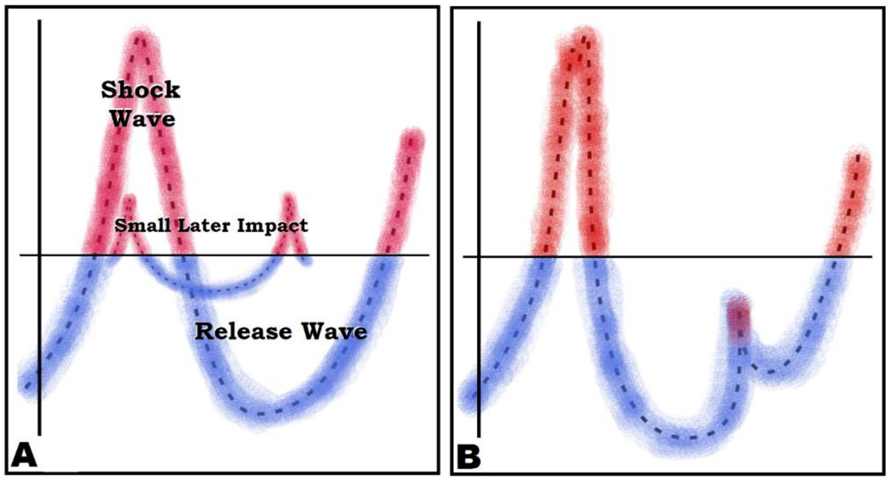

Figure 2.12: (A) Energy profile of shock and release wave from the F-Pv basin, with a smaller crater. (B) Cumulative Energy profile from the F-Pv basin and the smaller crater located within the release wave valley.

Like the missing white triangle in the first puzzle, interruptions to a pattern become part of the pattern and understanding them becomes the purpose for recognizing additional rings and completing the pattern.

The missing parts: Ghost craters on Earth

Chapter 1 pointed out two examples of circular ring structures in the United States. Most will say these two rings are not very obvious. What are the most obvious rings on our planet? There are three, two on land and one in the ocean. The most obvious on land is in southern Africa. Centered at -26.03°N, 23.35°E, I refer to it as the Mabule crater. It is ~1,800 km diameter for its second ring.

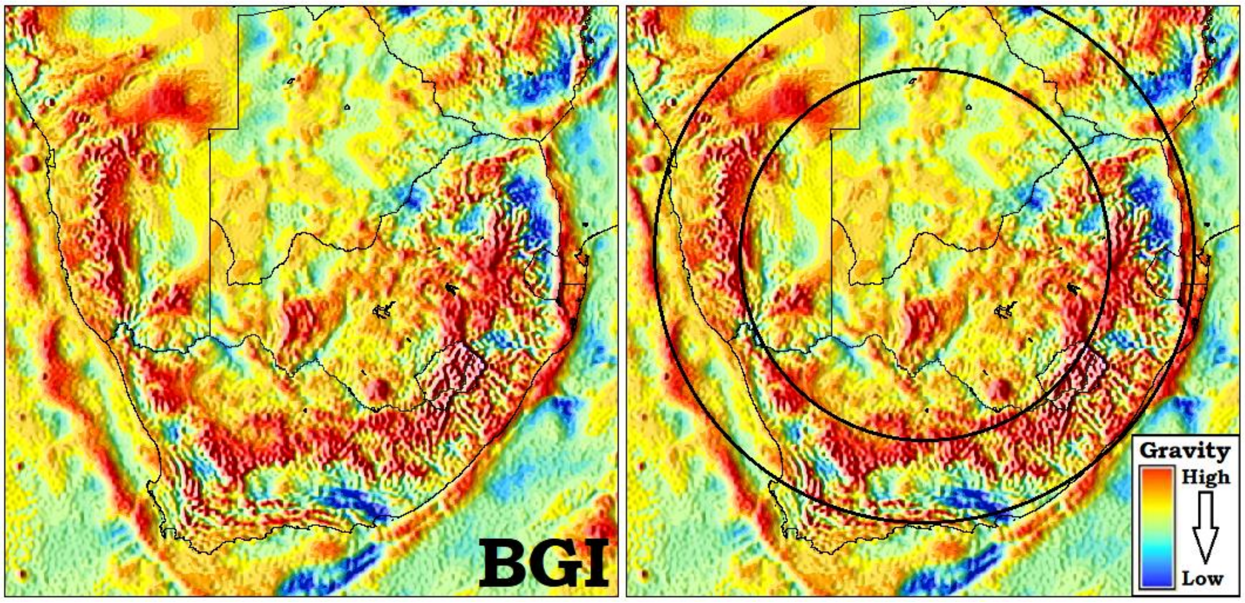

Figure 2.13: Free Air Gravity Anomaly of southern Africa showing two prominent concentric high gravity circular lineament patterns. (Image credit: Gravity map from BGI 2012, accessed 2/10/2020.)

Mabule Ring

While gravity is not topography and the rings do not necessarily form a crater bowl or shape inside the rim, gravity does tell us that there is a denser lithology at the point of the rings, and those ring approximates three-quarters of a perfect circle. The model of the shock-release wave that has been presented expects a denser lithology at this point as a result of the compression wave. The release wave valley is just inside that ring of high density, and is produced from the rarefaction/ expansion wave that necessarily follows the shock/compression wave with lower density. Figure 2.15 shows the compression ring, high density rim, between 2a and 2b, with a release wave, ring of lower density from the expansion wave, and inside it is the inner high gravity ring (1). The Vredefort craters is just inside this inner compression ring, Figure 2.16A, and ring (1) of the Mabule may have had a bearing on the gold field associated with the Vredefort crater. The association of these two craters appears to be like the many visible craters around the F-PV basin on the moon.

The Mabule rings are about 75% complete, but why are they missing in the north? Figure 2.16A indicates the location of three additional rings, seen in gravity, but gravity together with topography suggest many more. Can the reader find any? This area of southern Africa seems to be blanketed with these rings.

One problem with seeing cratering rings is that they always occur with many other overlapping ring and straight linears interfering in their visibility. This is very similar with the Fermi and Tsiolkovskiy craters and the Fermi-Pavlov basin on the moon.

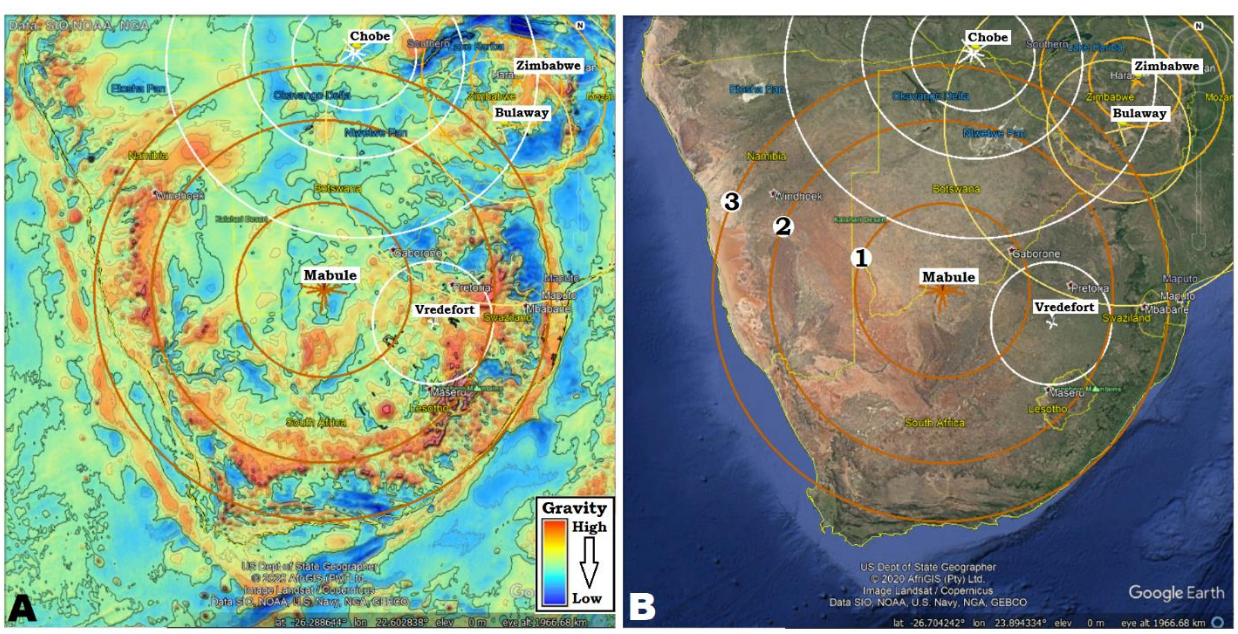

Figure 2.14: Southern Africa in (A) Global Gravity Anomaly and (B) Landsat image. Both represent the exact same area. Yellow circles are craters that obscure the northern rim. (Image credit: (A) Scripps 2014 and Google Earth.)

Kara Crater, a ring in the ocean

While Google Earth does provide some topography from the ocean's bottom, the National Oceanic and Atmospheric Administration data is generally rather coarse. Global Gravity Anomaly, which is used to visualize the Mabule rings in Africa does work, but Vertical Gravity Gradient, also from Scripps (2014), provides a view of the bathymetry (depth of water, essentially topography) of the ocean's floor.

The Kara rings centers at 79.23°N, 86.57°E and is ~900 km diameter in the northern Kara Sea, north of Siberia (Figure 2.15). On Google Earth, it borders on the blank area at the North Pole. On BGI (Figure 2.16) it suffers from stretching, as their source is an equirectangular map.

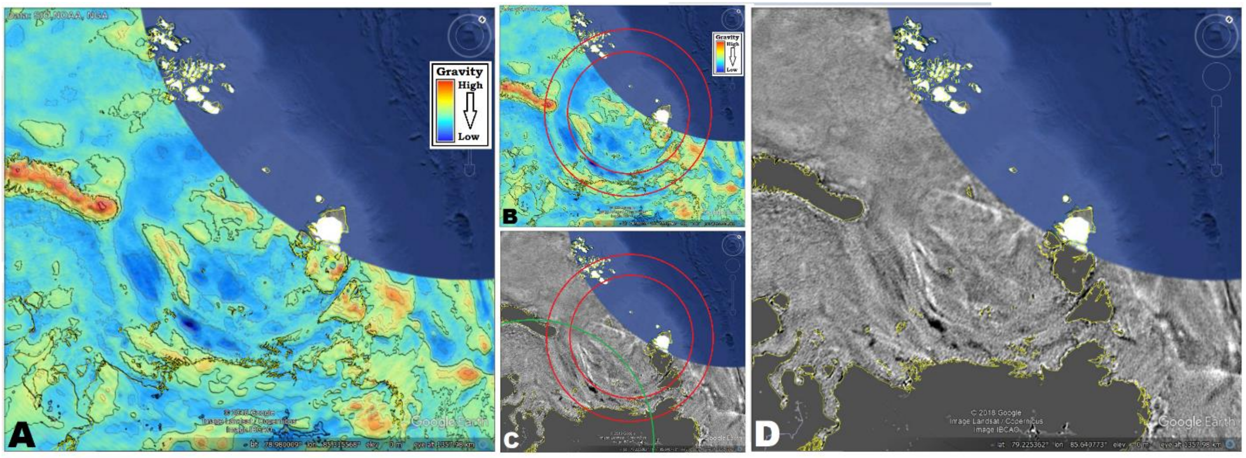

Figure 2.15: Kara Crater in the Kara Sea, north of Siberia. (A) Global Gravity Anomaly image. (D) Vertical Gravity Gradient map of same area. (Image credit: Scripps, 2014, overlaid on Google Earth.)

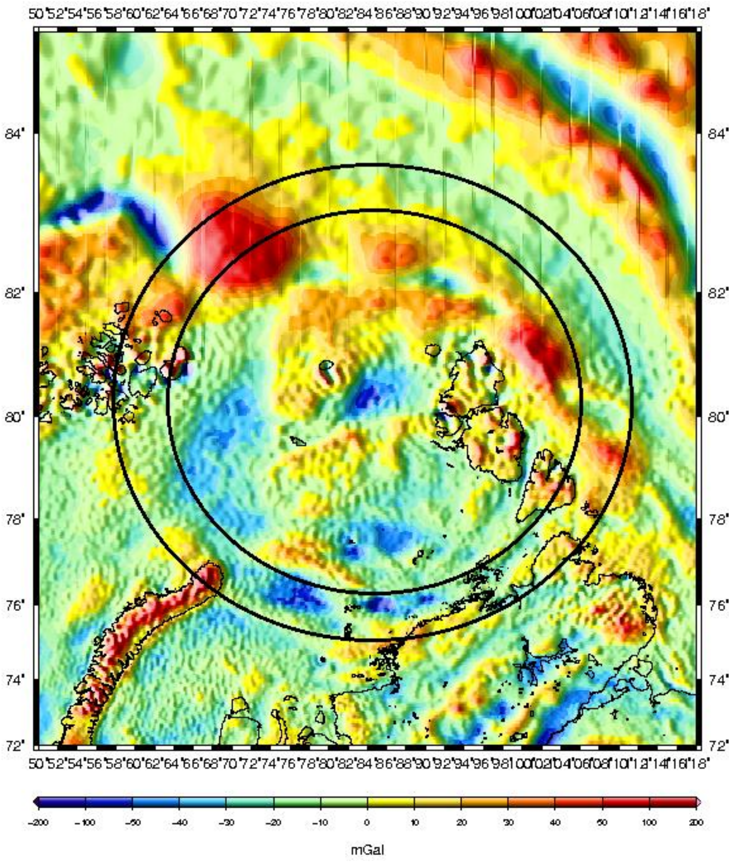

Figure 2.16: BGI map of Kara ring on an equirectangular map with lines of longitude (meridian) spread out more as they near the North Pole, causing the circular shape to show as an ellipse. (Image credit: BGI, 2012.)

As the discontinuities on the Mabule rings make more sense when the other rings that disrupt it are identified, so too it is with the Kara rings. Figure 2.17 shows some of the most obvious straight and circular lineaments interrupting the circular shape of the Kara ring. The many straight linears showing in the Kara would require an equal number of other centers to exist at a distance, just as we saw all of the yellow rings disrupt the northern edge of the Mabule ring.

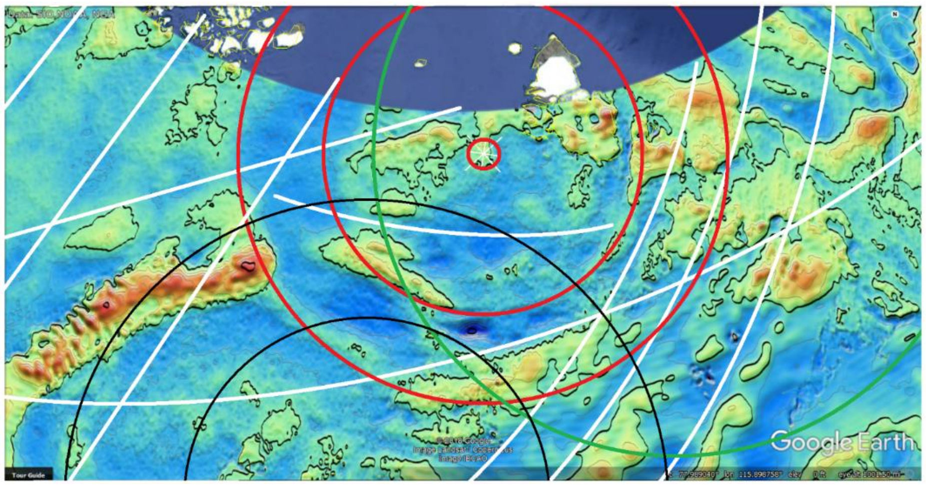

Figure 2.17: Global Gravity Anomaly map of the Kara Ring, with other circular and straight linears. (Image credit: Scripp's, 2014, overlaid on Google Earth.)

A second nearly as obvious continental ring on gravity maps is the Australian crater. E.S.T. O'Driscoll, a very successful mining consultant in Australia in the mid-1960s, started thinking in terms of straight and circular linears with his work in finding minable mineral deposits. Using military airplane images, in 1980 he mapped two pairs of lineaments globally, and in 1986 produced the first map of Australia with 10 trends. (His #7 equals Pacific CGRS 12, see Chapter 4). Although he tied these trends to Plate Tectonics, their recognition was a start. Today, Google Earth's images make his small photos seem primitive.

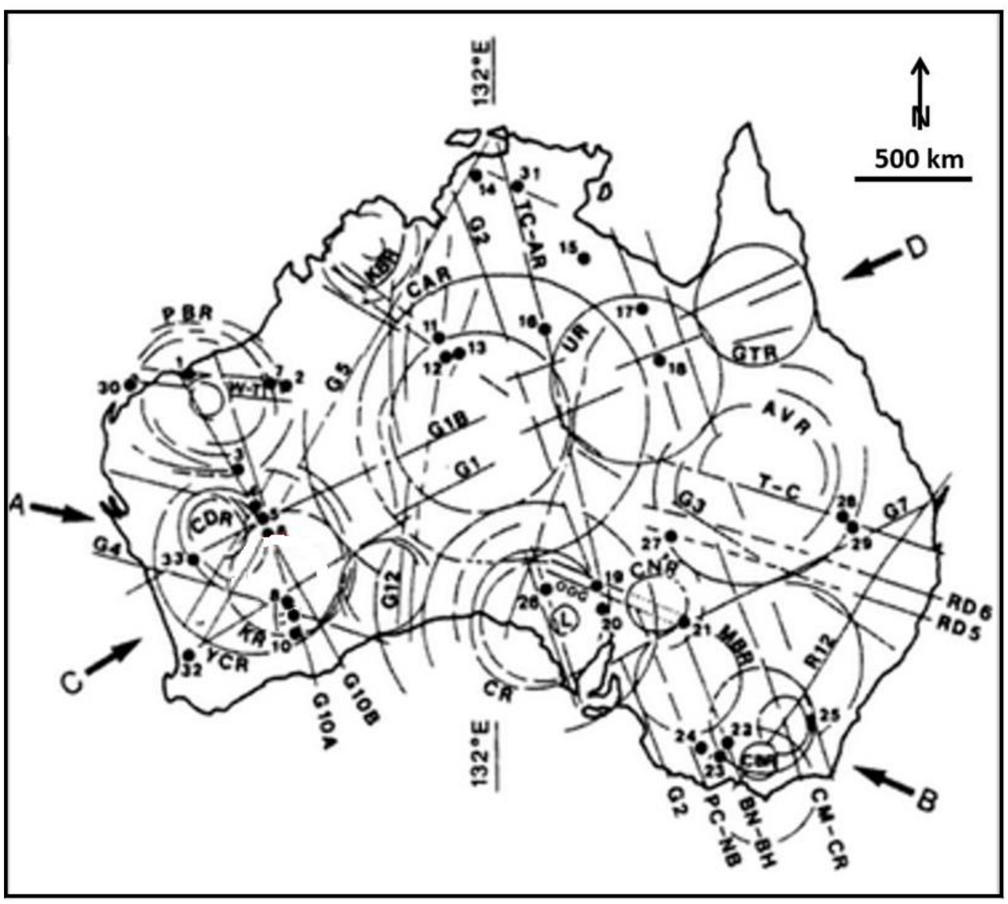

Figure 2.18: O'Drischoll's map of Australia showing the linear trends and circular linears he located. (Image credit: O'Driscoll and Campbell 1997)

The Australia rings center at approximately -24.52°N, 134.67°E, and involves the entire continent and the surrounding continental shelf (Figure 2.19). There is a definite circular high between the two outside red lines (2a and b), which could be the original cratering rim ring. If so, it would be 4,000 km in diameter, and the largest presently located impact crater anywhere is our solar system. I believe it is more likely the number 1 red ring that is the compression rim, but most of it has been obscured by later cratering. This smaller ring is ~2800 km in diameter, only slightly larger than other known craters. The Australia crater does appear to be limited to red ring 2. While it only has a small portion ring 2 indicated on the eastern half, significant sections of that outer ring/rim are missing all the way around. The largest is in the south were the Great Bight takes a large toothy bite out of the ring by landing afterwards and leaving a large release valley/ trench just off shore of the continent. Other craters also take smaller bites except the Western Aust which overlaps the continent and leaves a very distinct edge in the lithology.

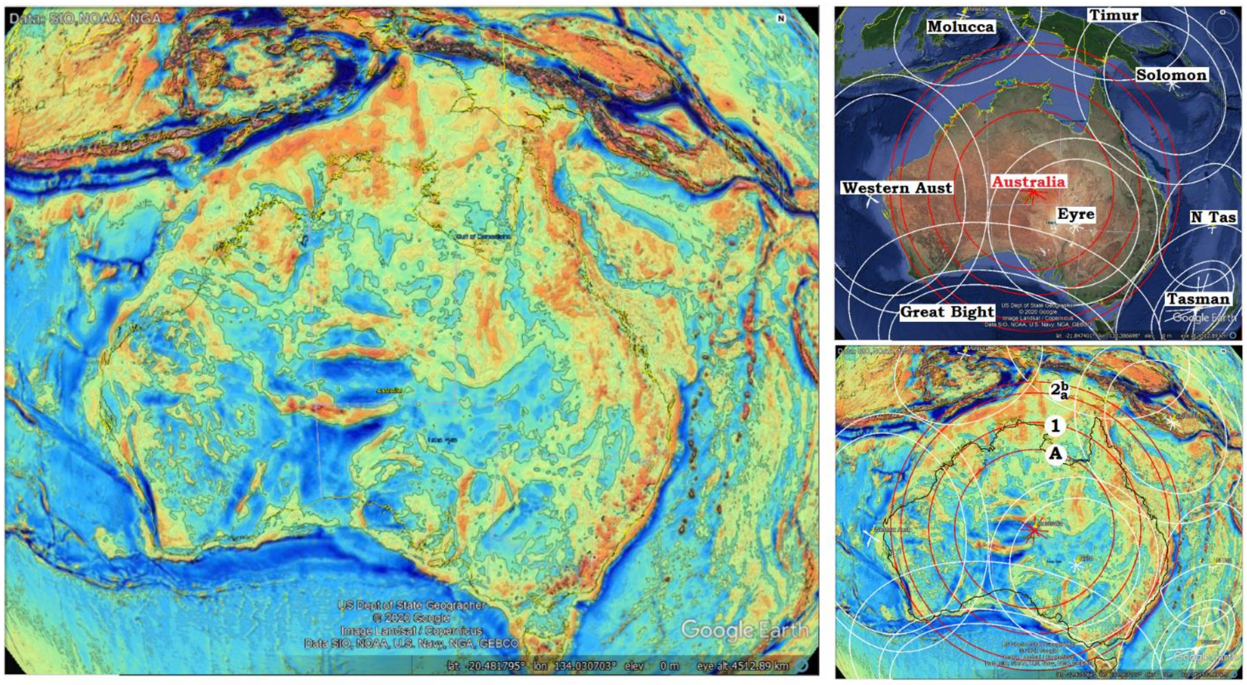

Figure 2.19: GGA image of Australia Continent. Use the small image to locate the ring for yourself on the large image. Smaller craters encircle the craton limiting the gravity expression. (Image credit: Global Gravity Anomaly, Scripps (2014) overlaid on Google Earth, accessed 3/16/2020.)

Even geology maps make circular lineaments obvious. But, again you may ask, if an impactor hit in a spot of country rock with a sedimentary cover, would it not blast all of the sedimentary rock away? No, craters are not blasted out of the ground, but the rim is pushed up by a compression wave. Yes, some rock from the crater's interior will be ejected by the release/ expansion wave when the adiabatic envelope burst. But, what would that energy difference do when the country rock has an already elevated temperature of 600-700°C? The adiabatic envelope would be very shallow, because the added energy would be swallowed by the elevated temperature. It would resemble erosion more than it would an impact crater. It would leave its energy signature from the shock and release wave but not leave much topographic difference in the total lithology.

The circles seen in Figure 2.19 are in the gravity readings. We have got to understand the cratering process as one that will leave the results we find. Remember, no one lived through the process to explain how it happened. We are dealing with clues found in the data. It is like a fantastic crime mystery, and we are the CSI (Crime Scene Investigation) crew to figure out what happened. Our models are not based on what we hope is true, but what the evidence will support.

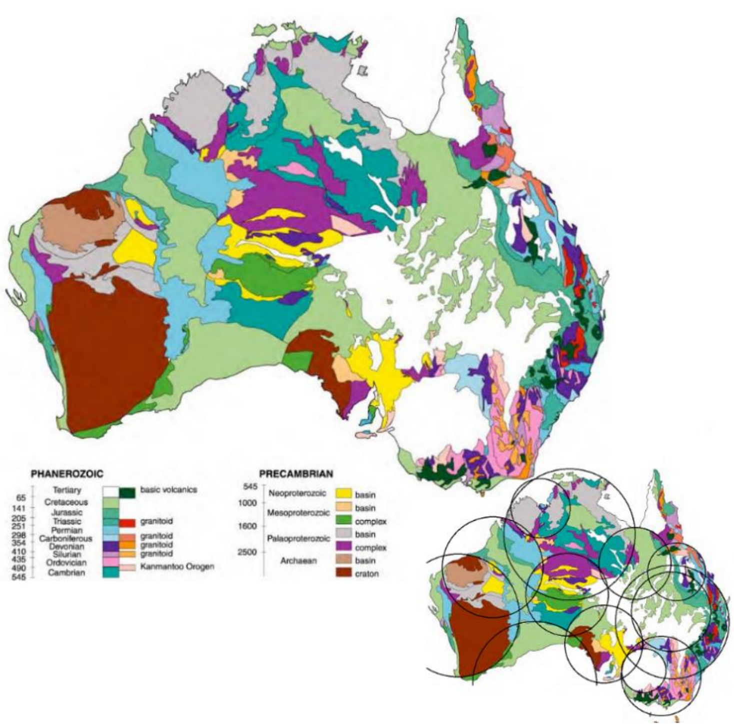

Figure 2.20: Generalized surface Geology of Australia. Small lower map shows circular linears seen in the lithology pattern. (Image credit: Geology of Australia, Wikipedia, CC.)

Multiple layers of craters

The Art Desert crater, Figure 2.21, is at least the fourth impactor to make overlapping craters to land in that area, and possibly the 6-8th. The Australia, Figure 2.19, was the first we recognize. Next the Great Bight cut the chunk out of the southern edge of continent. The Eyre crater covered the eastern half of the continent. The geology map circles, Figure 2.20 shows 2-3 more craters lapping over that area, and then the impactor for the Art Desert arrived. If each of these craters added 100-150ºC to the rock, and each of them arrived before any of that heat could dissipate, as I model it to have done, the sedimentary rock is laying there on the ground as condensate (very hot fallback from the crater's vapor cloud). The sediments from each of the various impacts stack up in an extremely hot, near melting temperatures, pile. It is no wonder most of the sedimentary grains are fused into lithified stone. It was not because of deep burial, but hot deposits.

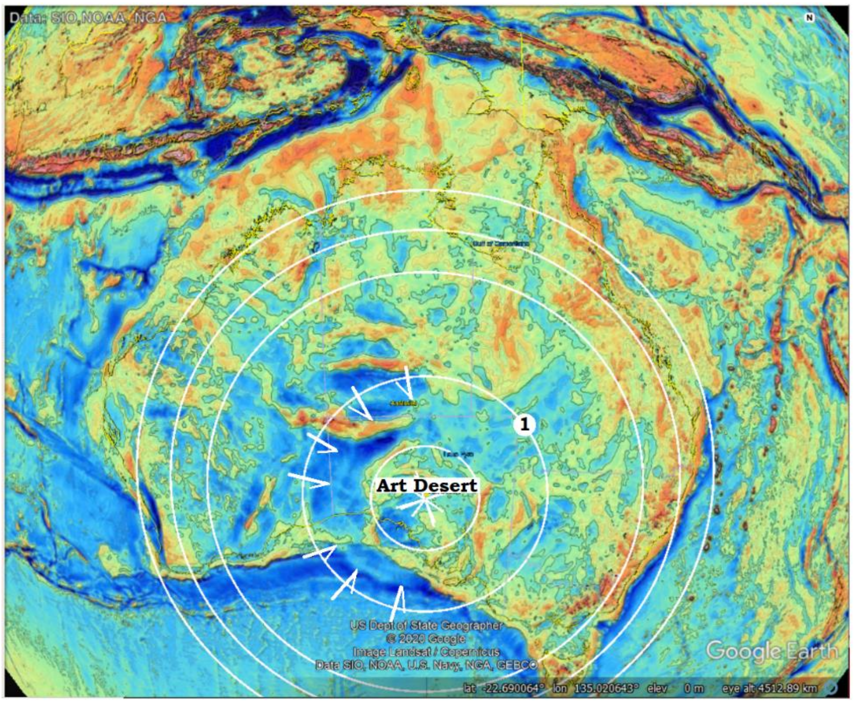

Figure 2.21: Global Gravity Anomaly map of Australia and the rings from the Art Desert crater seen in gravity readings. Clarity of its rings suggest it was the last large crater to arrive in this area. Arrows point to an inner ring of slightly higher density that overlay the release valley of previous larger impacts. (Image credit: Scripps 2014)

If there are three prominent rings on our planet, at ~900 km, ~1800 km, and ~2800km, and we recognize similar rings on the other rocky bodies of our Solar System, what is the likelihood that similar numbers of impactors in similar size did not strike the face of our planet? These three impact craters suggest these numbers of impactors have struck our planet, and we have not recognized them.

We see that identifying individual craters on the earth is much like identifying ghost craters on the moon's surface. On the moon we expect to find craters, but in fact, we find many more when we start to recognize the deviations in ring expression from ghost craters. In the same way, we will find many more on earth as we learn to recognize clues in the energy patterns and account for the great overlapping of craters.

Similarly, with recognizing possible cratering rings on earth, the gravity patterns make much more sense when we assume a nearly continuous bombardment of impactors leaving energy patterns and increased temperatures.

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