Chapter 10B: Sevier and Laramide Orogenies and Earth's Mascons

Abstract

Differences between the Sevier and Laramide Orogenies are explored for evidence of a cratering origin. Recognizing bullseye structure in gravity mapping of the Rocky Mountains ties the Laramide peaks and ranges into a ring structure recognized in moon cratering. This suggests the cratering history for the moon needs to be also considered for the earth. If the earth's surface is a result of cratering, comparable structures in the Laramide Orogeny equates these structures to moon mascons in their origin. This similarity of structural origin adds to confident recognition of large earth craters.

Keywords: Mascon, Alvord Crater, Sevier Orogeny, Laramide Orogeny, Rocky Mountains, Green River Basin, Wind River Range, Bighorn Mountain, Uinta Mountains, Mid Continental Rift, MCR Crater.

Introduction

Mountain building within the Plate Tectonics model for the Rocky Mountains is attributed primarily to two different process, the Sevier Orogeny and the Laramide Orogeny. The Laramide Orogeny is characterized by thick-skinned deformation, with steep thrust faults framing cores of granitoid gneiss that are traced into the crystalline basement. By contrast, the Sevier Orogeny is believed to be a thin-skinned orogeny that originates typically in a basal granitoid, with relatively flat faults that raft sedimentary layers to thrust over each other. Both types of mountain building are believed to have been caused by the under plating of the Farallon (Pre Pacific) Plate. It is believed to have started by direct convergent pressure of plate pushing against plate, but later the less dense ocean plate slipped shallowly under the North American plate. This makes the Sevier Orogeny, closer to the coast, generally prior to the Laramide Orogeny that was further inland, but some overlap of timing is found (Lawton, 2019 and DiPetro, 2013). Trying to connect the Laramide Orogeny to a source of shear, many authors are preoccupied with finding a pattern to the resulting mountain peaks.

If Concentric Global Ring Structures (CGRS) really cause mascons in lunar craters (Chapter 10A), do they form something similar in earth craters? We need to meet a rather large crater that I will propose determined much of the geomorphology of the North American Cordillera. For one crater to have determined the topographic characteristic from Mid Canada through Arizona and New Mexico, may seem rather fantastic, but a careful study of the gravity patterns in the area will reveal the structures this recognition is based on.

Alvord Crater

The Alvord crater centers in the Alvord Desert of southeast Oregon, with the Great Basin covering much of its central rings, Figure 10.13A. The Great Basin terminates between the 2 and 3-ring. In the gravity map a significant dark blue ring occurs between the one and two ring on the north and south, outside the Great Basin, and a second dark blue ring extends from between the 2 and 3-ring to between the 7 and 8-ring indicated by the red arrow in Figure 10.13B. These two dark blue/low gravity rings compare with similar ring structures in Mare Orientale, Figure 10.10. The 2-3-ring I will equate with the 2-ring of Mare Orientale (The Open-ring containing the mascon.) and the 7-8 ring will equate with the 4-ring of Mare Orientale (The original cratering rim ring [OCR-ring] constituting the original bowl depression of the crater). I will propose the Great Basin represents what is left of the original Alvord's cratering basin, significantly modified by later craters building mountains within it. These two blue rings define the Alvord crater, but irregular occurrences of CGRS can be recognized to the eastern continental shelf.

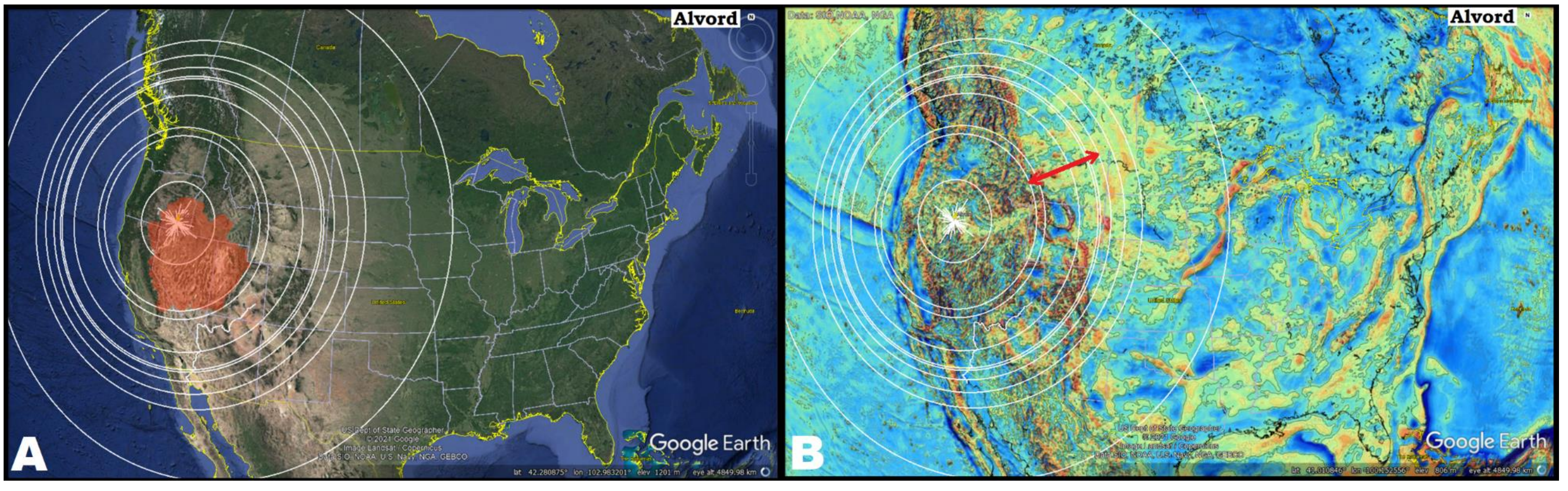


Figure 10.13: Alvord crater and its relationship to North America. (A) Landsat image of Alvord crater, with the Great Basin indicated in red. (B) Global Gravity Anomaly image of same area. Red arrow indicates wide dark blue/low gravity ring. (Image credit, A: Google earth, B: Scripps, 2014.)

Ring structure and cutoff linears.

Looking at the Alvord crater in greater detail, Figure 10.14, the symmetrical large area of dark blue/low gravity between the 1 and 2-ring, encompasses the Columbia River Basin on the north and continuing around the 1-ring between the pair of 7-linears and pair of 5 linears into the Central Valley of California on the south. Both the inner and outer rings form a distinct edge around the Columbia Basin, with the western edge cutoff abruptly by two pairs of linears. The 7a-linear defines the western Cascades, and 7b-linear defines the northern Coastal Range. Likewise the Central Valley is also cutoff by two linears, 5a-linear is the southern Coastal Range and 5b-linear is the Sierra Nevada. Linears 6, 7a, and 7b center in the Ipojuca center off of the nose of Brazil. Linear 5a and 5b center in the Great Bight center south of Australia.

While linear 7b does not terminate on the north with 2-3-ring like 7a does, it does diminish, with a dark blue path making its way in from the low gravity blue of the off shore Pacific Ocean. Both north ends are cut off by the Maka Luta ring that formed the foundation of the continent and continental shelf. Linear 5b, the Sierra Nevada, is also cut off with dark blue on its south end, just south of Alvord's 3-ring. Linear 6, a significant contributor to the Front Range of Colorado, makes a short appearance that is cut off similarly between Alvord's 2-3-ring on both ends.

All five of these linears are cutoff on one of their ends by the Alvord's Open-ring, as the mascon of Mare Orientale is cutoff by its Open-ring. I will assume mascons on earth take the form of straight or curved linears that are cutoff by the Open-ring of earth's craters. It can be reasonably assumed all five of these linears are CGRS, and therefore are capable of global expression. But, within the Alvord crater their most distinct expression are cut off by the Open-ring. This identifies each of these CGRS as mascons in these expressions.

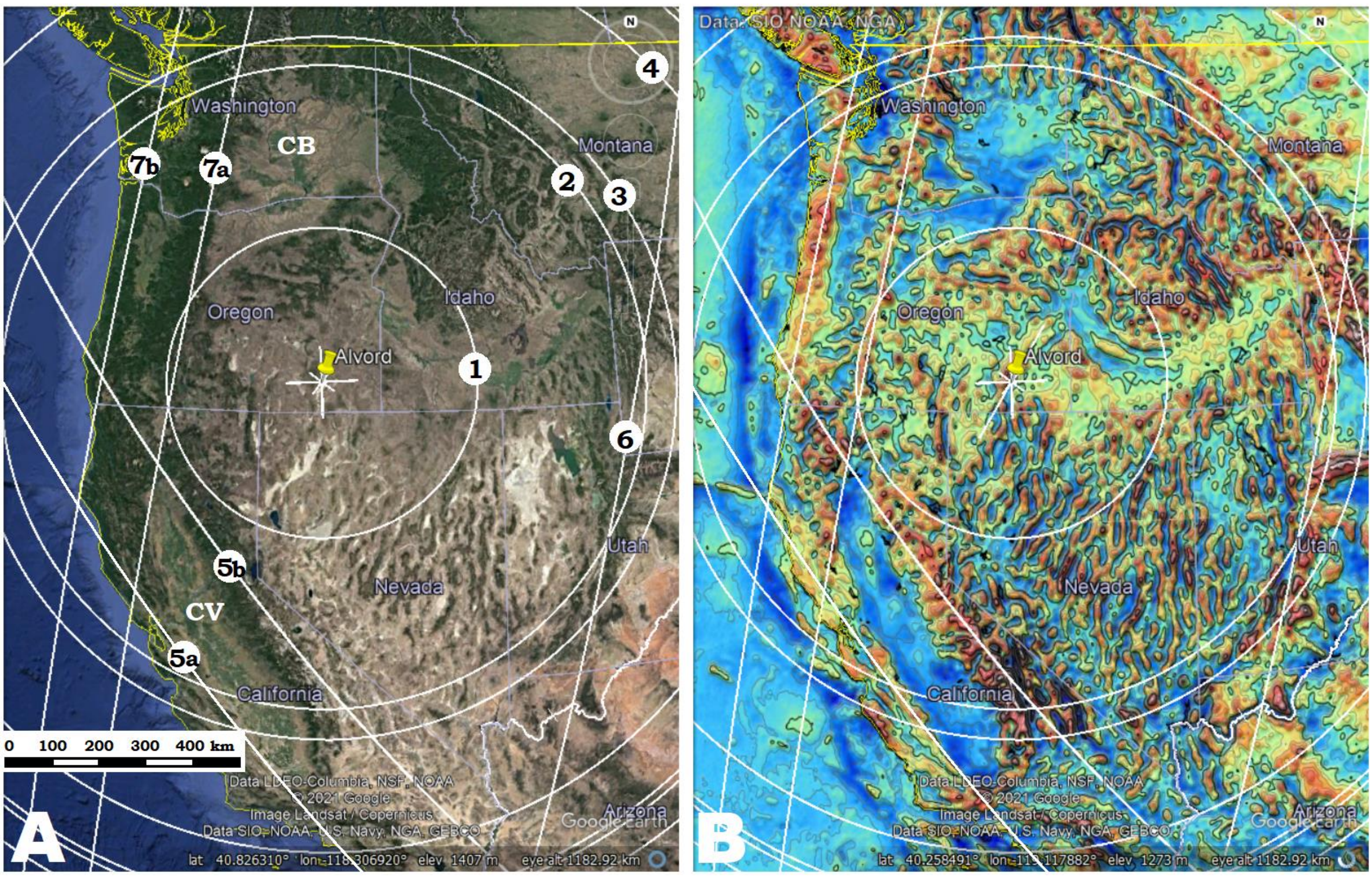


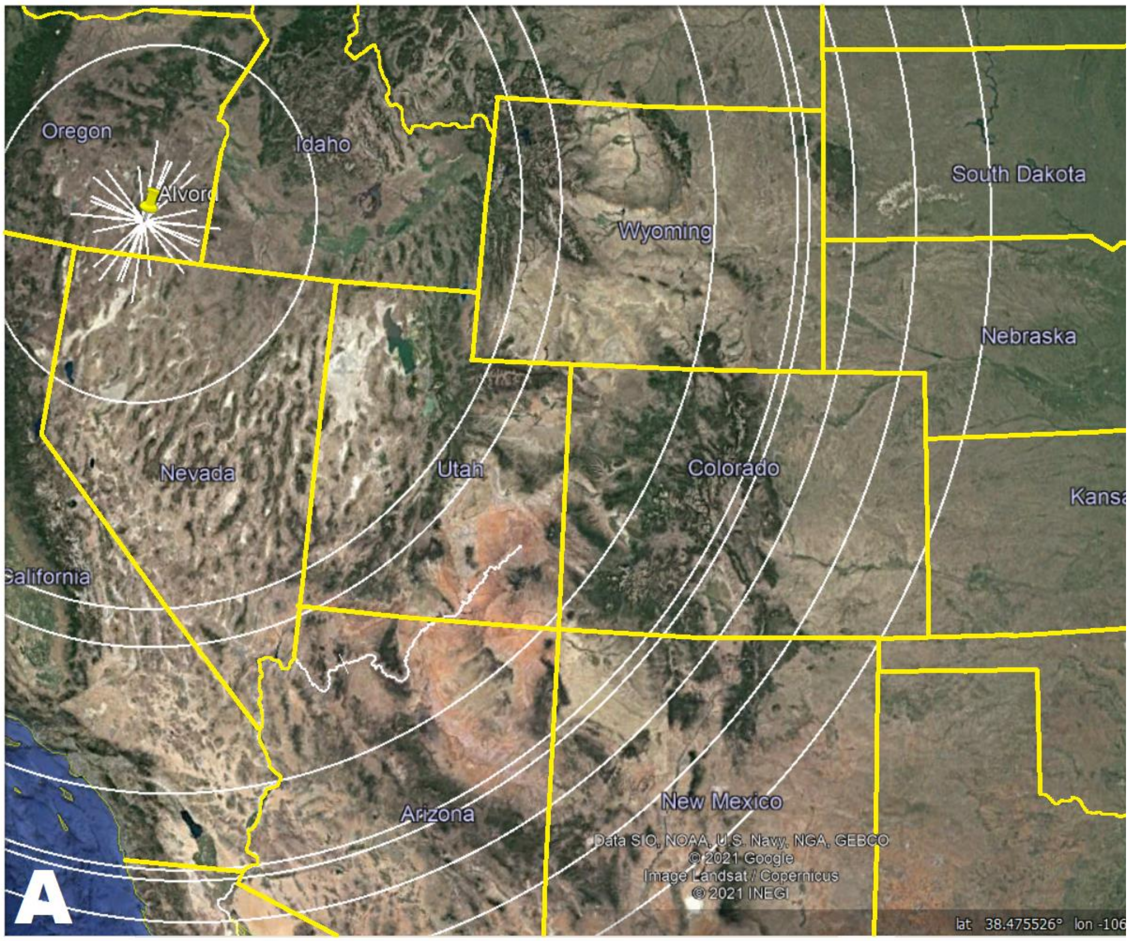
Figure 10.14: Alvord crater and CGRS from the Great Bight center (5a and 5b) and Ipojuca center (6, 7a, and 7b). The path of the Colorado River through the Grand Canyon is indicated in a white wiggly line near lower right corner. Large blue areas: Columbia Basin (CB) and Central Valley (CV)

The release valley between the 7-linears and 5-linears would directly compare with the wide dark blue/low gravity valleys on the east and west side of the Mare Orientale Mascon in Figure 10.10, and the Grand Canyon is similar to the wiggly dark blue area just north of the mascon in that same figure.

While Creationist place undue faith in the designation of Sevier and Laramide Orogenies (Clarey, 2017), secular researchers recognize significant problems with fully characterizing low gravity cored highlands; like the Wind River Mountains, Beartooth Mountains, Colorado's Front Range, the Black Hills, the Laramie Mountains, and the Bighorn Mountains (Hamilton 1981and Lilligraven 2015, all assumed to have been pushed up in the Late Cretaceous Laramide Orogeny); occurring far away from plate boundaries. Low gravity readings are consistently seen under these large areas where high gravity reading from mountain's roots were expected to be found. Instead, deeply cored (into the mantle) crustal uplifts are found to correspond with uplifts in the Moho (Yeck et al 2010), requiring the uplifts to be connected to the Middle to Late Precambrian (Worthington et al 2016) rather than the Late Cretaceous Laramide Orogeny.

This is seen to be a huge problem in developing a geological timeline in Plate tectonics. I find both of these orogenies and the Moho are direct results from cratering.

My version of a pattern for the Laramide Orogeny is illustrated in Figure 10.15, which shows many of the examples of Laramide Orogeny to be contained in the largely dark blue/low gravity area of the Alvord crater from 2-3-ring to the 7-8-ring. Placement within the Alvord crater explains the low gravity foundation is a result of cratering, not subducting plates.



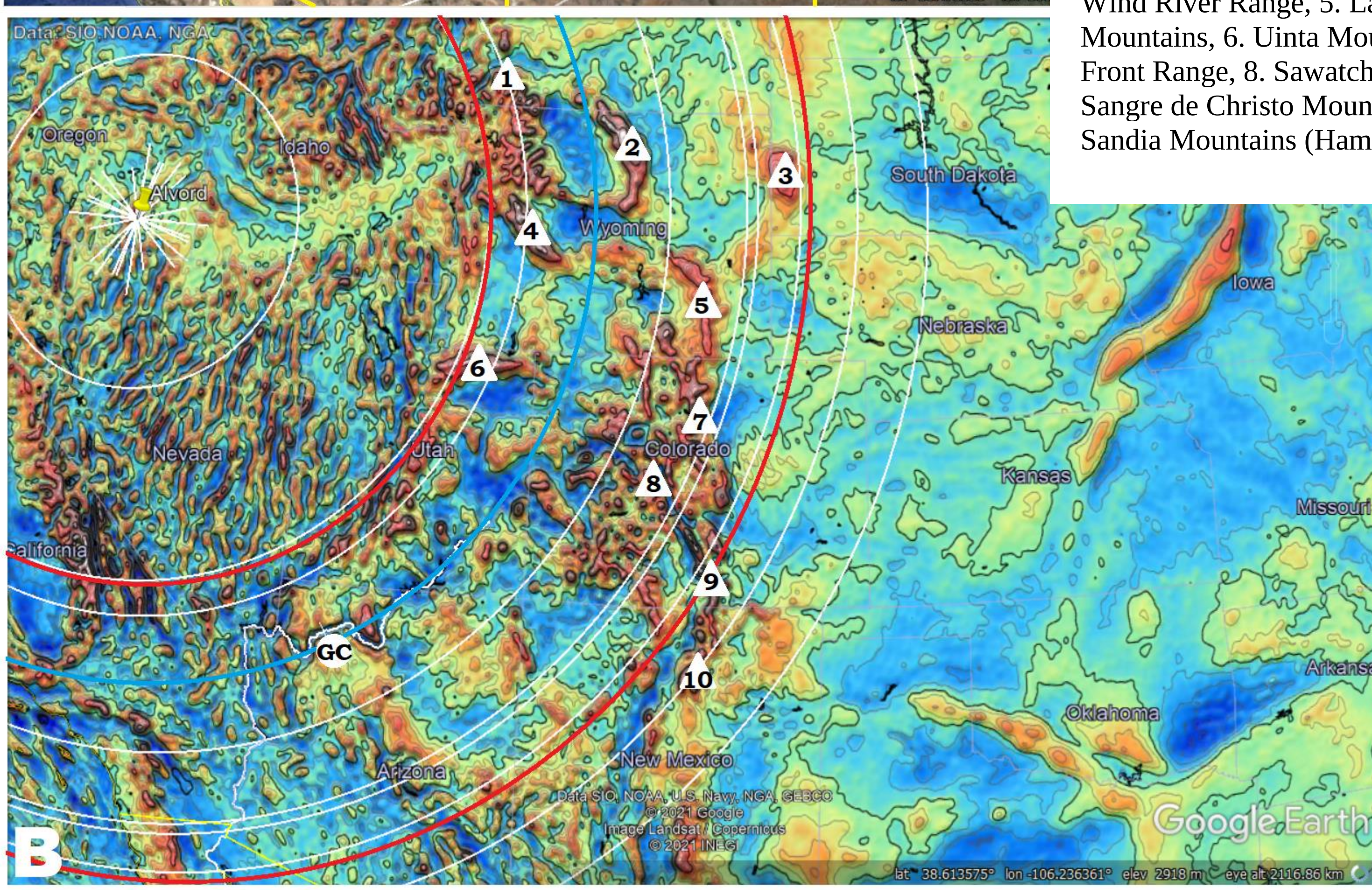


Figure 10.15: (A) Alvord crater in Landsat. (B) Alvord crater in Global Gravity Anomaly of the same area showing gravity roots of Laramide mountains: 1. Beartooth Mountains, 2. Bighorn Mountains, 3. Black Hills, 4. Wind River Range, 5. Laramie Mountains, 6. Uinta Mountains, 7. Front Range, 8. Sawatch Range, 9. Sangre de Christo Mountains, and 10. Sandia Mountains (Hamilton 1981).

While the rings of the Alvord crater limits the expression of the Laramide Orogeny on the southwest and northeast by its rings, the west and south edges are limited by the overlapping Gorda and Blowout Mountain craters on the west and the Pedregosa crater from the south by the black rings shown in Figure 10.16. I propose that the Gorda and Pedregosa craters arrived before the Alvord and the Blowout Mountain crater arrived after, largely mimicking the thrust of the earlier Gorda crater in this area, and their energy patterns worked together to form the Sevier Fold and Thrust belt across Utah, Wyoming and Montana. The combined energy pattern of these four craters limited the area of mascon expression.

An alternate explanation for the arrangement of these mascon peaks recognizes they all occur within an additional dark blue/ low gravity pattern identified as the Bridger crater. Which explanation will ultimately be able to answer the most questions will depend on further research into understanding all of the nuances of the cratering process, but either grouping suggest greater explanation power than any Plate Tectonics pattern that tries to separate the Sevier and Laramide Orogenies peaks and ranges.

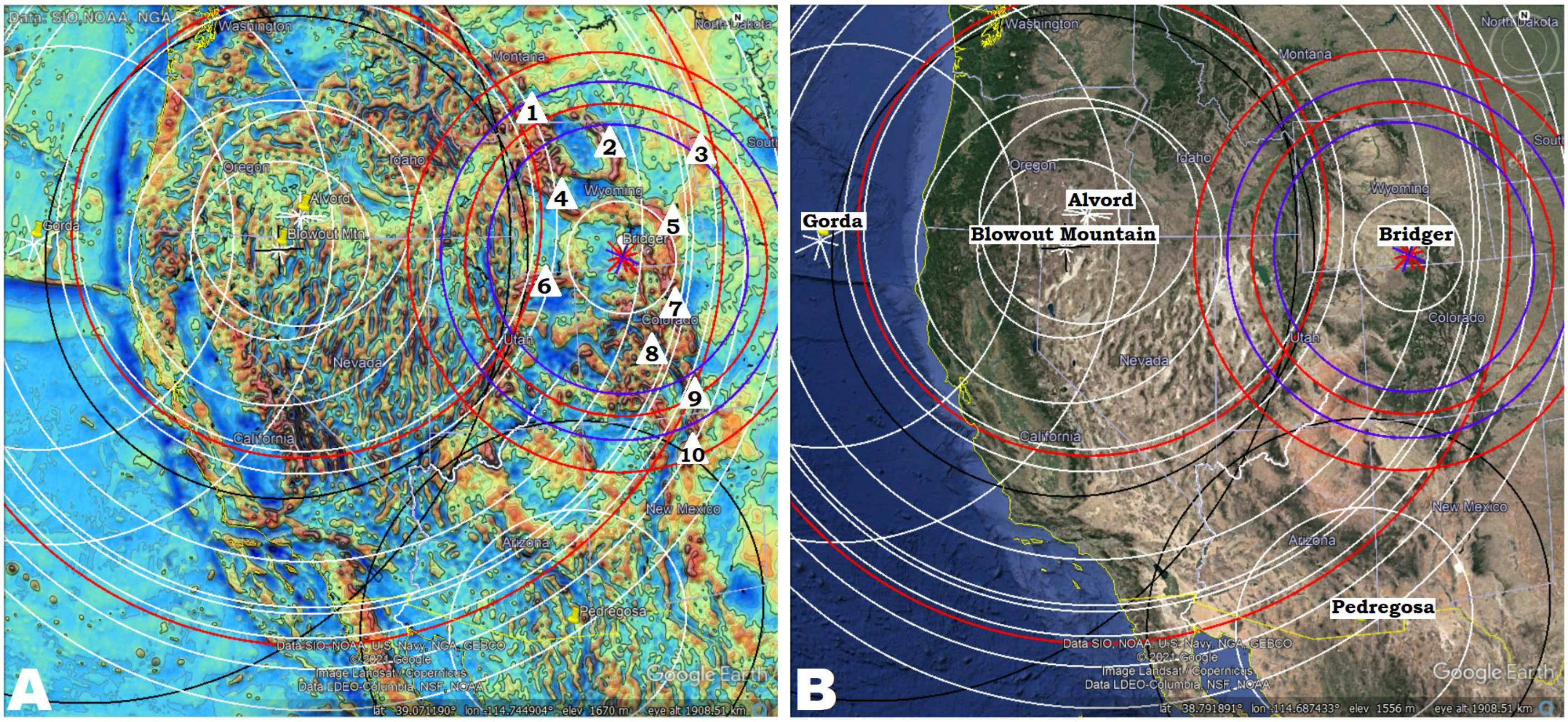


Figure 10.16: The early Gorda and Pedregosa and later Blowout Mountain craters as they intersect the Alvord crater, and limit the expression of Laramide up thrust by their overlapping energy signatures. The Bridger crater and its overlap with the Alvord offers an alternative explanation. Both explanations may eventually add to our understanding of the mountain building processes. Peaks identified as in Figure 10.15.

Pond and Gravity Ripples

The alternating high and low gravity ridges are reminiscent of pond ripples, Figure 10.17, with their high and low expression of shock and release-waves as was seen more extensively in Chapter 9.

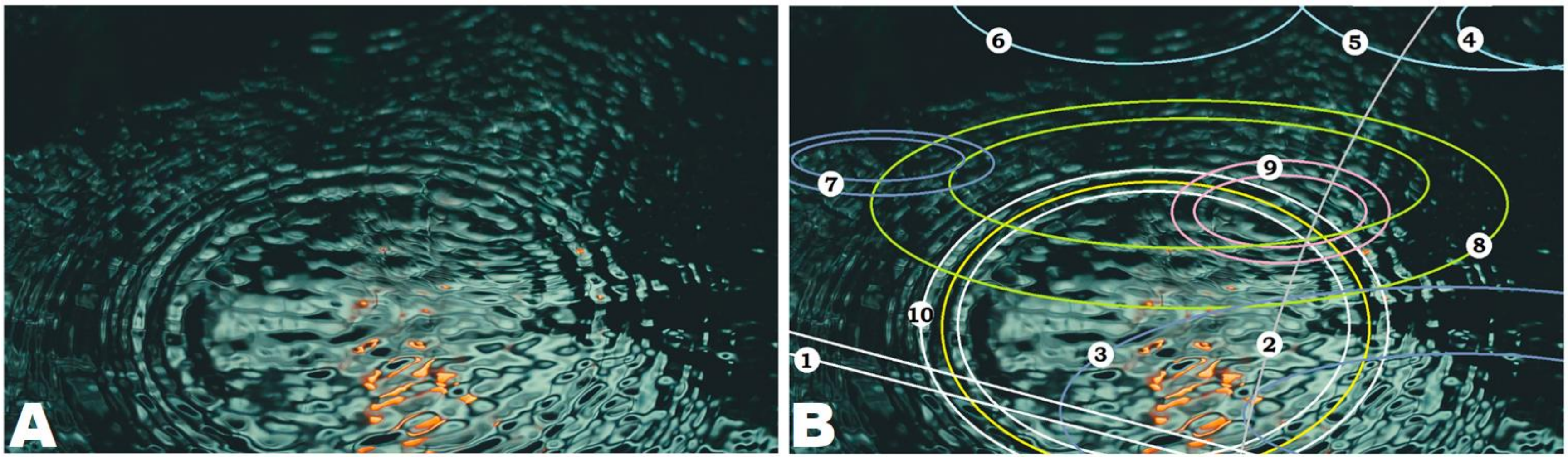


Figure 10.17: Ripples in a pond. While the overall pattern seems extremely complex, grabbing a snapshot allows the overlapping circular shapes to be sorted out. While 10 ripple sets have been identified, can the reader locate others?

Green River ripple patterns

The Greater Green River basin is geologically composed of Green River Basin, Uinta Basin, Piceance Basin, Sand Wash Basin, Washakie Basin, and Great Divide Basin. These six basins share a single depression that spans the intersecting corner of Wyoming, Colorado and Utah, divided only by some up-thrusting mountains, of the Laramide Orogeny. Why should “up-thrusting-mountains” suddenly occur within basins? Their formation is an unexpected topographic expression within Plate Tectonics, but fully expected in a cratering model if mascons form in earth craters as was seen in moon craters.

I propose, when the Green River impactor struck the earth, it formed the Greater Green River Basin (here after referred to as “Green River” crater), like Mare Orientale, Mare Nectaris, or Moscoviense Basin on the moon. These large moon craters produced a bullseye pattern of alternating high and low gravity rings. Do we see a similar bullseye pattern in gravity maps of the earth?

While the earth’s gravity map does not show the simple alternation blue-red ring pattern that is obvious on the moon, Figure 10.4 and 10.10; the pattern is still there, Figure 10.18. Based on density of ghost craters on the moon, Figure 9.10, I am going to estimate the earth has been covered with a minimum of 5-6 layers of craters over its entire surface after these craters. Therefore we are looking through 5-6 layers of overlapping gravity patterns like 5-6 added layers of ripples on a lake.

While the eastern half of the Green River crater is in the yellow, green, and blue range with less gravity contrast, while the western half is in the red, yellow, and blue range, with greater gravity contrast, the rings still show up as repetitions of concentric higher and lower gravity rings that are reduced to gravity nodes, and mountain peaks, through additive constructive interacting between ripple patterns.

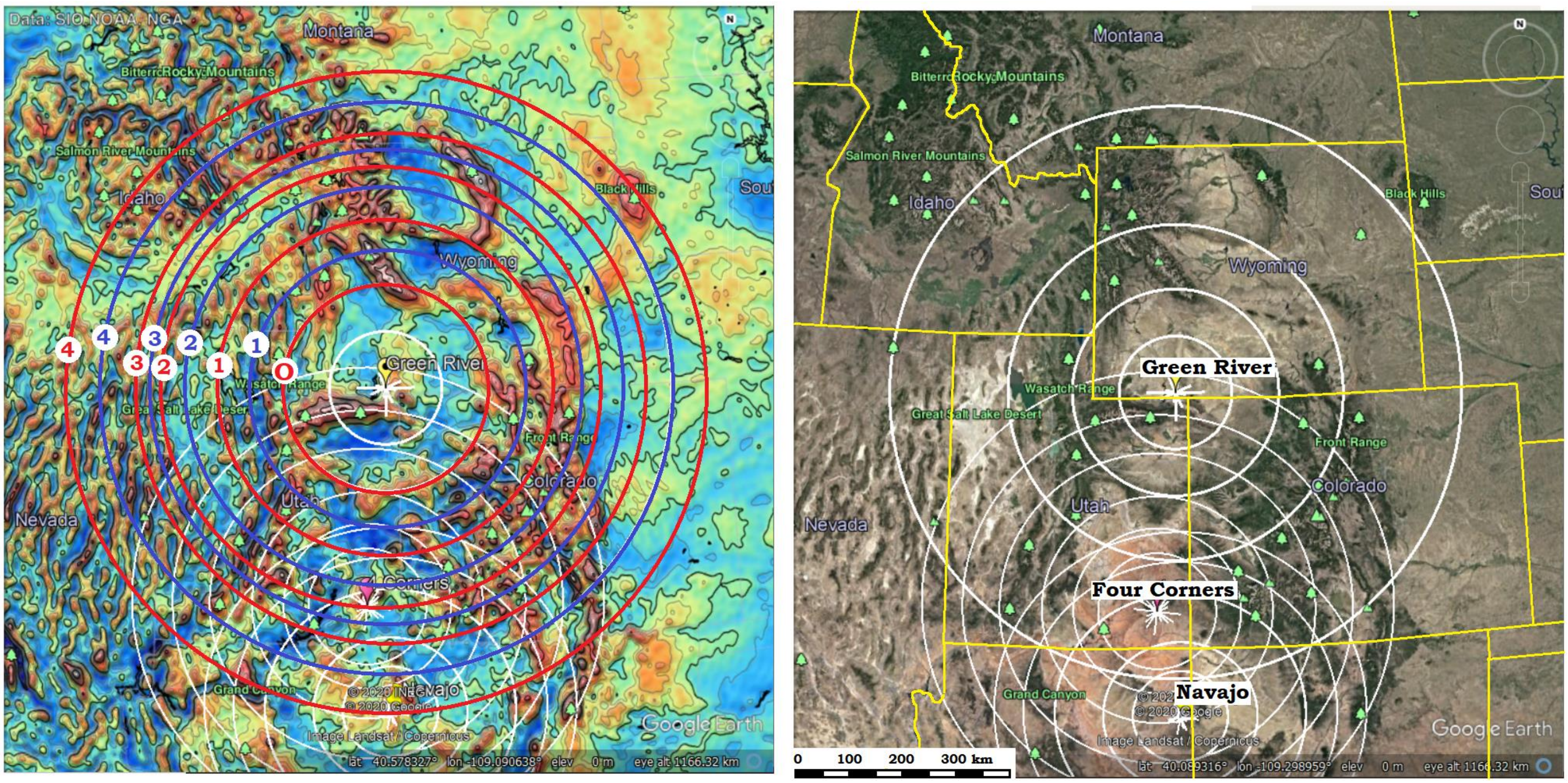


Figure 10.18: Green River showing the ripple pattern the author sees in the gravity reading. Red circles represent the original uninterrupted high gravity rings and blue circles represent original low gravity rings. The reader is encourage to search for the high points of gravity in the red rings, and the underlying dark blue pattern under the blue rings.

This is emphasized in Figure 10.19 showing the southwest section of the Green River crater’s ring system. The white circle has significantly thinned crust like the Freundlich-Sharonov Basin (Figure 10.5) on the moon. I refer to the first red ring as the “open”-ring, implying that it was the outer ring of the uplifted cratering center and will constrain mascon expression. The compression annulus, or CGRS from other impactors, were pulled up in the impact rebound or more able to express themselves through the thinned crust. This corresponds with the “inner” ring of many lunar crater. The mascon can often be recognized by its termination at both ends in blue/low gravity pattern, as in the Alvord crater, Figure 10.14.

The same pattern of red-blue bullseyes gravity pattern can be extended to the Four Corners and Navajo craters, Figure 10.20.

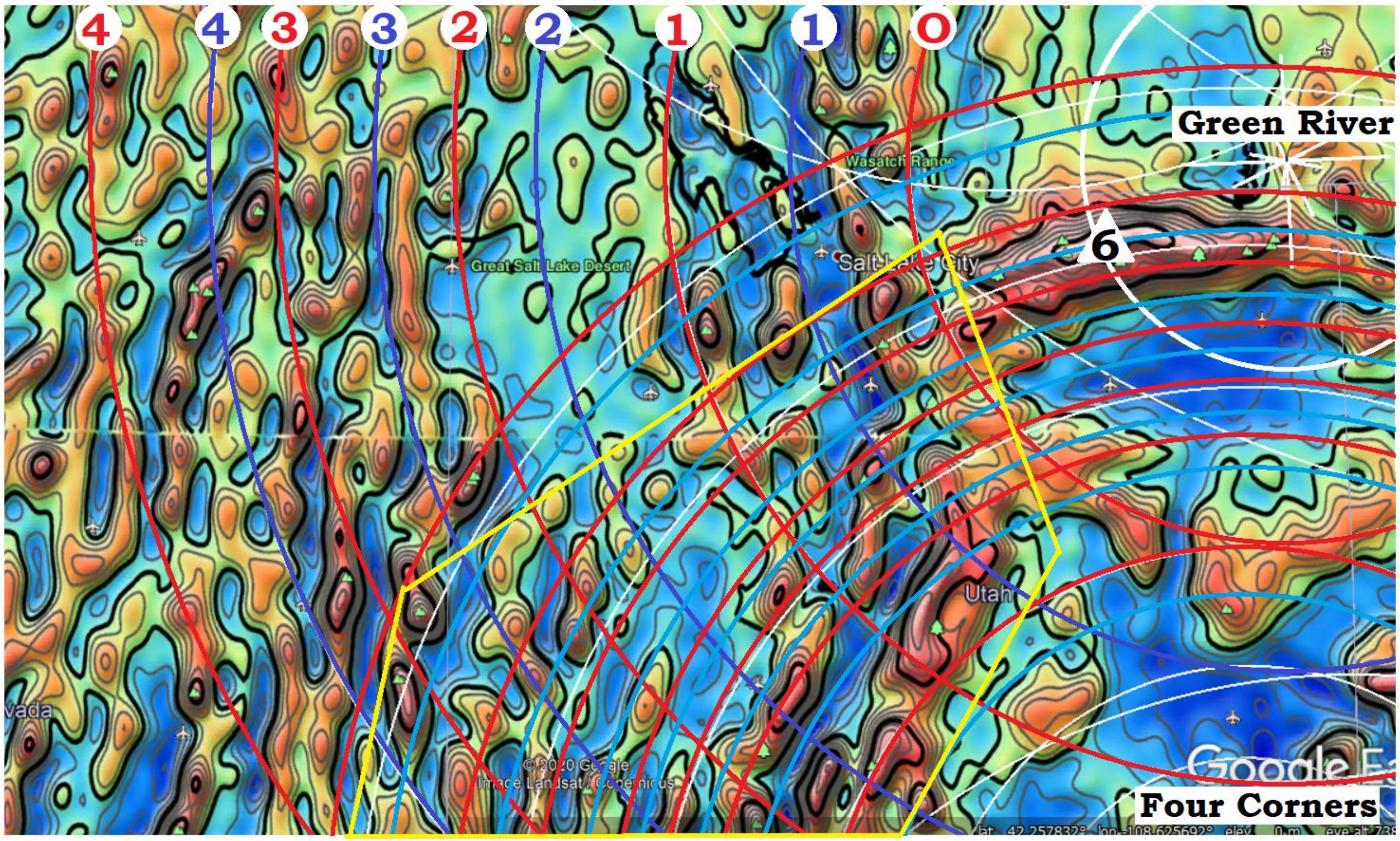
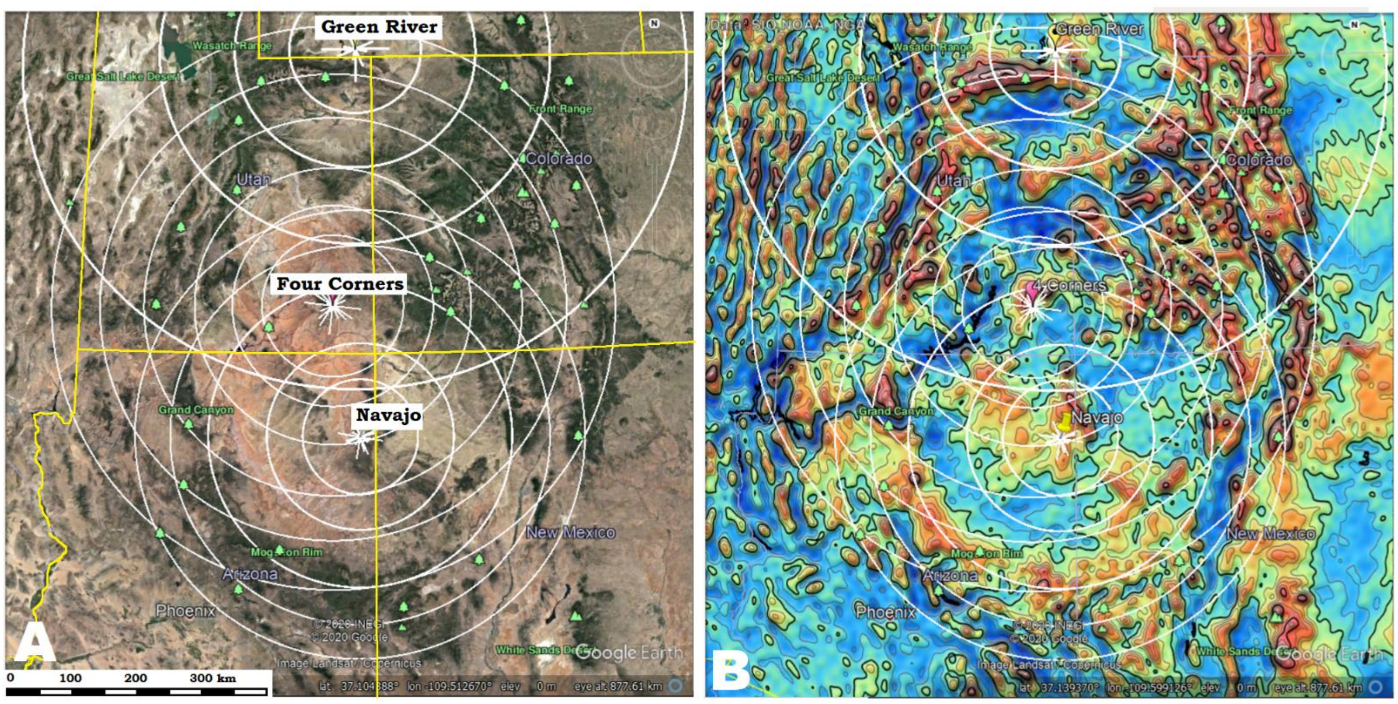


Figure 10.19: Detail of Green River's gravity ripple pattern. Sometime the pattern seems more discernable when an overlapping pattern is also recognized as in the yellow box of overlap by the Four Corner crater.



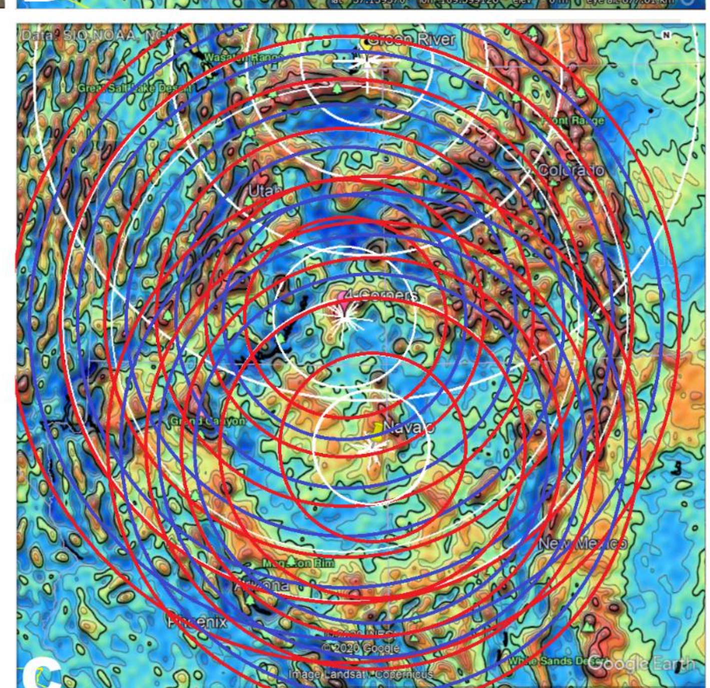


Figure 10.20: High-low gravity pattern is extended to the Four Corners and Navajo craters. Readers are encouraged to view them in Global Gravity Anomaly (Scripps 2014) overlay on Google Earth, following instructions in Chapters 1 and 2 to see the patterns for themselves.

Trying to sort out the many sources of shear in any cratering uplift/mountain, quickly becomes a tangled web of overlapping energy patterns, because many craters add energy to the ultimate expression. An early energy input for many of the "Laramide" mountains is the Nye crater, centered in central Nevada. While a few of the peaks lie on rings drawn for the Nye craters, almost all show concentric linear crossing them. I propose the Nye crater arrived a few days after the Alvord crater while much of the energy/heat from the Alvord crater was still in the substrate. The Alvord crater provided the low density trough for the Laramide orogeny to happen in, and the Nye crater provided an "early" up-thrust/push underneath the peaks.

The red on white linear in Figure 10.21A suggest the 3-ring of the Nye crater is the open-ring forming the Sierra Nevada as a mascon. While the Sierra Nevada linear originated as a mascon of the Alvord crater, Figure 10.14, it was shortened to the Sierra Nevada region's expression by the Nye crater. Therefore the Nye cratering event would be a major force behind the Nevadan Orogeny. The portion of the CGRS not drawn up by the Nye crater was more subject to later alteration. The granitic composition of the Sierra Nevada suggest they were earlier and experienced less "kneading" as in the more gneissic expression in Laramide peaks.

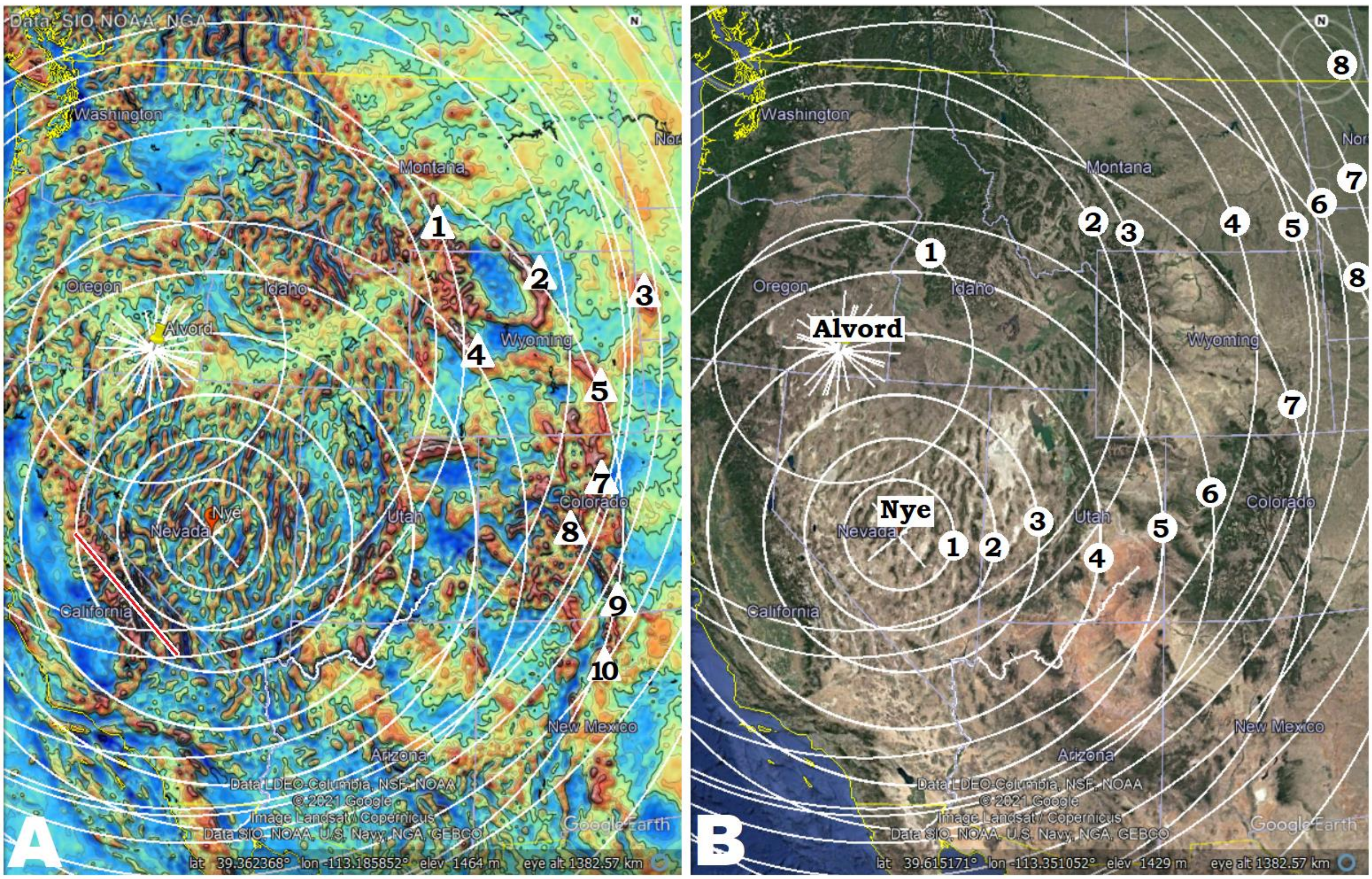


Figure 10.21: The overlapping pattern of the Nye and Alvord craters showing concentric linears to the Nye center in the gravity pattern for the Beartooth Mountains (1), Bighorn Mountains (2), Black Hills (3), Wind River Range (4), Laramie Mountains (5), Front Range (7), Sawatch Mountains (8), Sangre de Christo Mountains (9), and Sandia Mountains (10). The only Laramide ridge not showing concentric linear is the Uinta Mountains.

Uinta Mountains

While the Nye crater did not contribute any significant energy to the Uinta Mountains, Figure 10.22, the Four Corner and Uinta craters both contributed to the higher western Uinta Mountains. Judging from the size of the Four Corner's rings, it was earlier than the Uinta crater, and left a record of an "earlier" source of energy in this uplift. A small gap, portion of a release valley, separates the shorter eastern Uinta Mountains. Shorter because it only has the Four Corner's energy up thrust behind it.

The 1-ring of the Green River crater is its Open-ring and pulled up the Uinta Mountains, both western and eastern, inside of it. It contributed to the Wind River Range with the south end's turn towards the east, and was a significant contributed to the Book Cliffs and western end of the Roan Plateau south of Uinta Basin. The 2-ring of the Green River crater contributed to the up lifting of the Laramie Mountains, Front Range, and Sawatch Mountains. The western half of the 2-ring crosses west of the Sevier Fold and Thrust Belt, demonstrating its division between the Sevier and Laramide "style" of orogeny.

The Book Cliffs-Roan Plateau arc is covered with the same sedimentary layers as the Uinta and Piceance Basins (Hail 1992), and hardly shows in topography, but is much more pronounced in gravity. I will propose this is a result of less energy behind the up-lift as the Uinta is a much smaller crater, the arc is still cored with Gneissic Granite.

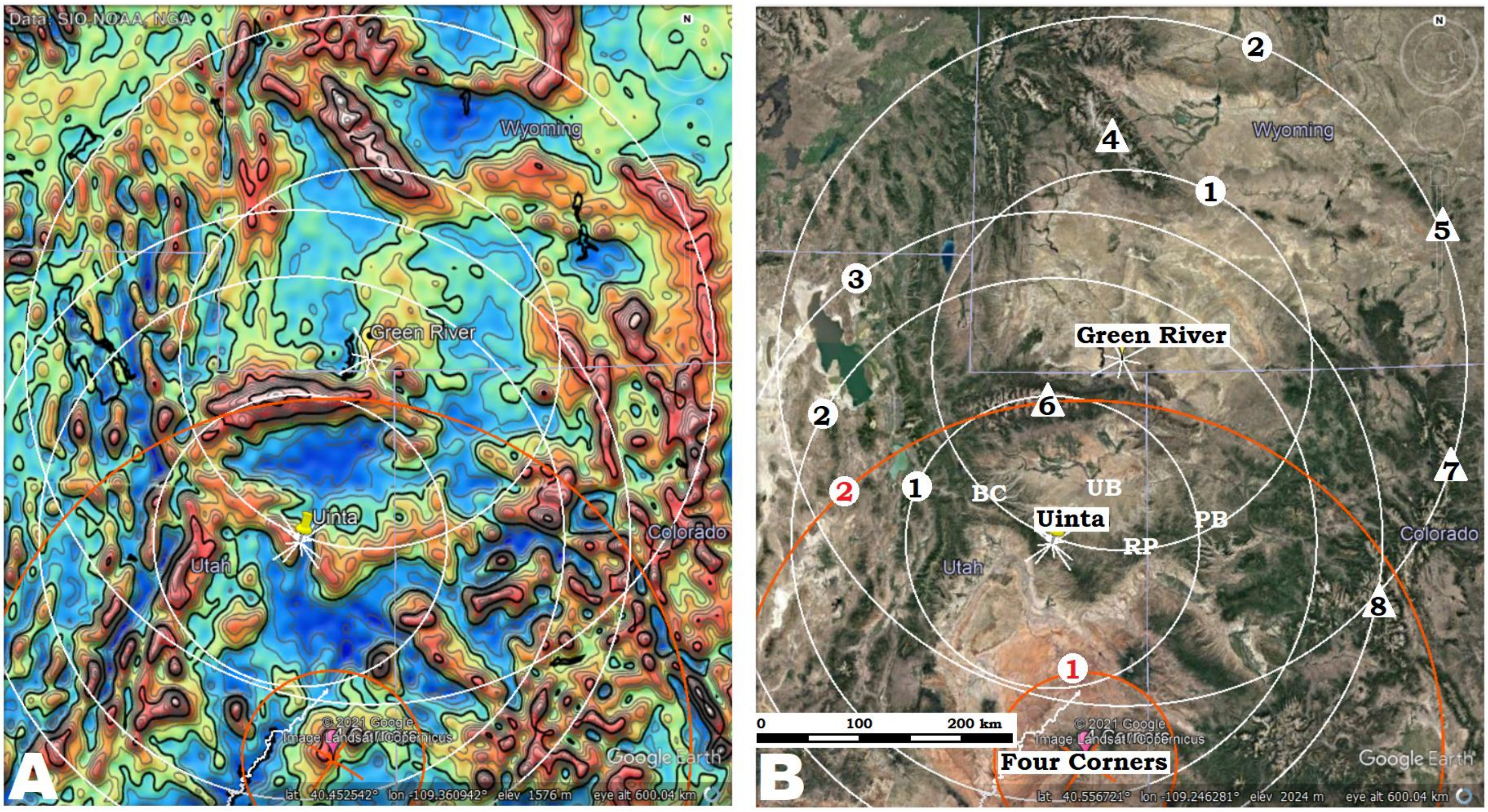


Figure 10.22: Overlapping rings of the Green River, Uinta and Four Corners craters, and the mascons they contributed to Laramide peaks: 4. Wind River Range, 5. Laramie Mountains, 6. Uinta Mountains, 7. Front Range, and 8. Sawatch Mountains. Abbreviation: BC = Book Cliffs, UB = Uinta Basin, PB = Piceance Basin, and RP = Roan Plateau.

Bighorn Mascon and the Laramide Orogeny

Bighorn Basin, Bighorn Mountain, and Powder River Basin (Figure 10.23, B, C, D) are considered a *typical fold structure* in the Laramide Orogeny (Yeck et al 2014) of the Plate Tectonics model for the origin of earth's geomorphology, but their *origin remains enigmatic* because of their distance from all proposed plate boundaries. The proposed Bighorn crater of Figure 10.23 encompasses all three structures and proposes the Bighorn Massif is not a fold, but a Mascon. The basins an either side are part of the basin whose floor dates back to at least the Alvord crater event.

But, other craters added to the uplift of the Bighorn Massif. One of those is the Teewinot crater. I would designate the 1-ring of the Teewinot crater as the compression ridge of the Open-ring, and the gravity trough between it and the white and blue circles are a very distinct Release Valley. The Release Valley-ring crosses the Bighorn Basin adding its negative, expansion energy into that basin. The compression wave on the outside of that release-ring provided the up thrust of the southern limb of the massif, south of the 2 in Figure 9.24A. Besides the Wind River Range that is cut off on its south end, the Mascons include the Pioneer to Beaverhead Mountains of Idaho, the Sapphire to Adel and Absaroka to Beartooth (1) Mountains of Montana and Wyoming. Much of the heart of the Southern Rocky Mountains owe their existence to the Teewinot's Open-ring. The Release Valley contains the lower reaches of the Salmon River of Idaho and portions of the Bitterroot, Blackfoot and Sun Rivers of Montana.

The Grand Tetons at the center of Teewinot crater may be an uplifted mascon of the Blowout Mountain's CGRS at its leading edge as it was forming the Sevier Fold and Thrust Belt over the rest of the area.

Figure 10.24 section through the Wind River Mountains confirms the direction of thrust faults I will ascribe to the Bighorn cratering event. It also gives some information on the cratering sequence of sedimentary layers and the thrust. As the Flathead Sandstone arrived with the Maka Luta crater and the "carbonate dominated rocks" with possibly the Nye crater, and the upper clastic sediments were probably later craters, then when the Bighorn crater arrived the rock was so heated that the impact's energy was simply absorbed into the substrate and only the thrust of the cratering event was transferred outwards. As the impactor punctured these sedimentary rocks within the Bighorn up-thrust, a significant part of the energy would have been expended below the surface, and not leave a record of that disruption in the sequence of the stratigraphic record layers, but it would be interesting for-on-the-ground research to determine what disruption occurred within the lay of the stratigraphy. This needs much more study.

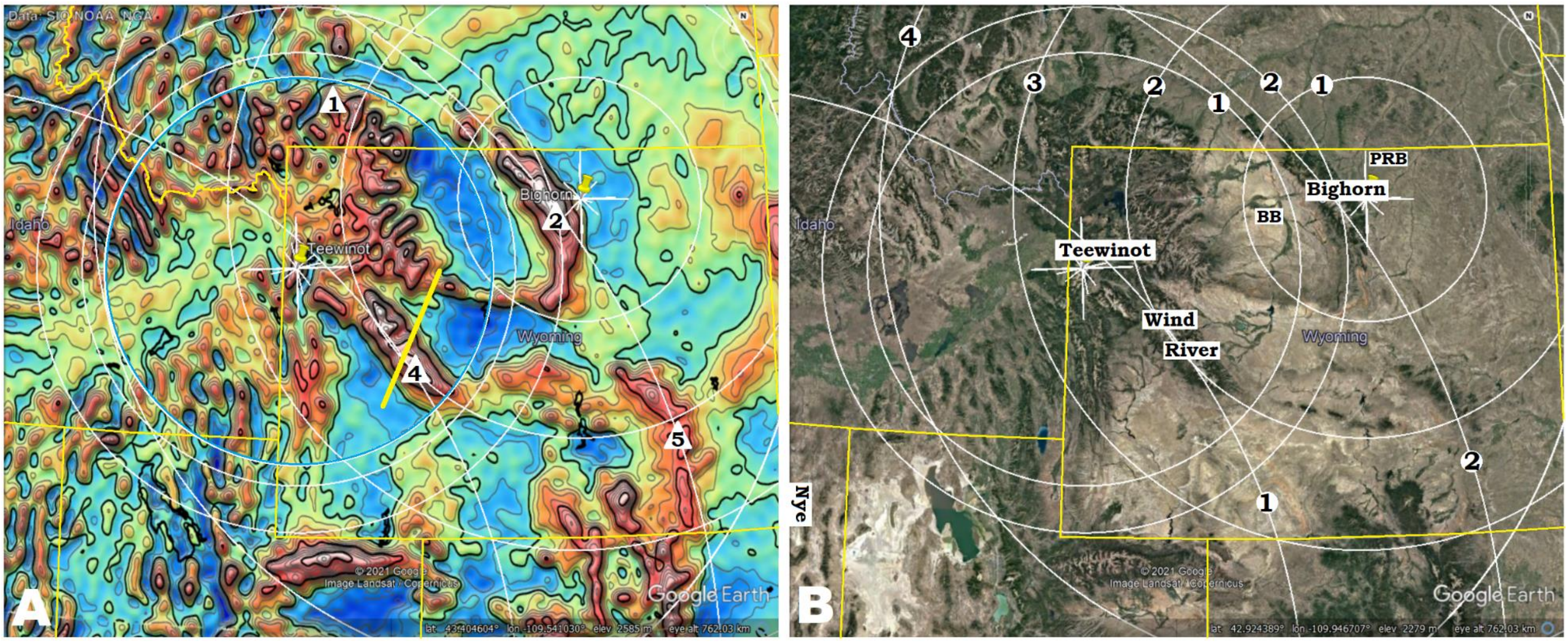


Figure 10.23: The Nye, Teewinot and Bighorn craters locations and some of the ascribed Laramide Orogeny peaks Bighorn Basin (BB), Bighorn Mountain (2), and Powder River Basin (PRB) mostly within the Open-ring of Bighorn crater that forms a mascon of the Bighorn Massif. The One/Open-ring of the Teewinot crater forms Mascons of the Pioneer to Beaverhead Mountains of Idaho, the Sapphire to Adel and Absaroka to Beartooth (1) Mountains of Montana and Wind River (4) Mountains of Wyoming, while the lower reaches of the Salmon River follows a portion of its Release Valley. The Nye crater directly contributing to the Bighorn Mountain (2) Wind River Range (4), and Laramie Mountains (5).

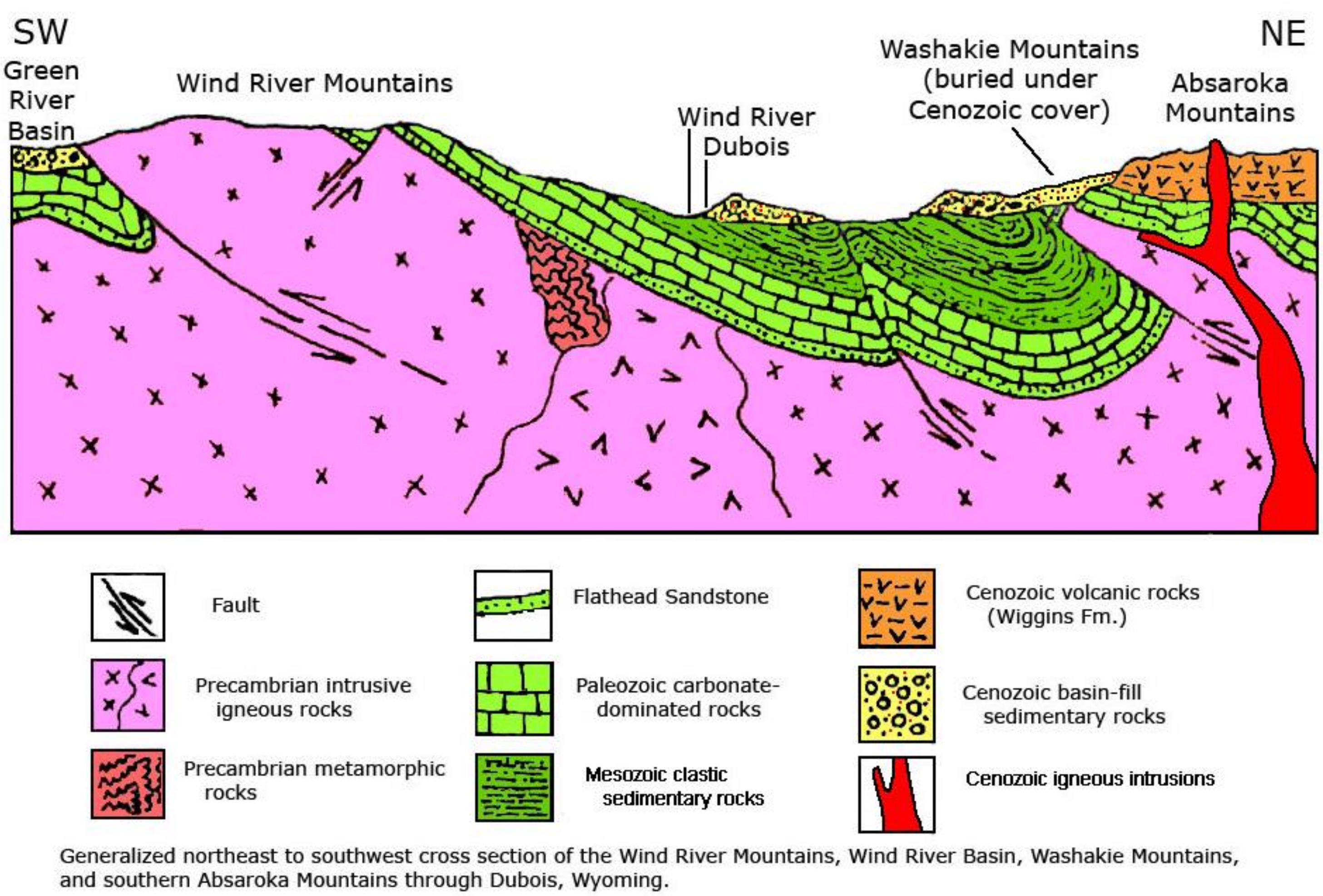


Figure 10.24: Section in Wyoming between Absaroka Mountains and Green River Basin showing the direction of thrust faults and persistence of pre-cratering sedimentary layers. (Image source Miracosta edu., 2017.)

Cratering Model for Mascons on earth

Distinguishing between mountain peaks that were formed in the Sevier Orogeny from those formed in the Laramide Orogeny is simple in principle. All mountain ranges and peaks are a result of cratering up thrust. The Sevier ridges were thrust up directly by the cratering process, like the three ridges on the left of Figure 10.26 and ring 7 around the smaller crater. By contrast, Laramide ridges can only form when a smaller crater (10) pulls up (8) a buried CGRS (9) forming a ridge exclusively within the crater. The CGRS that it pulls up originates within the crystalline basement, or pushes through the crystalline basement, moving the crystalline structure to produce the gneissic characteristics of that ridge.

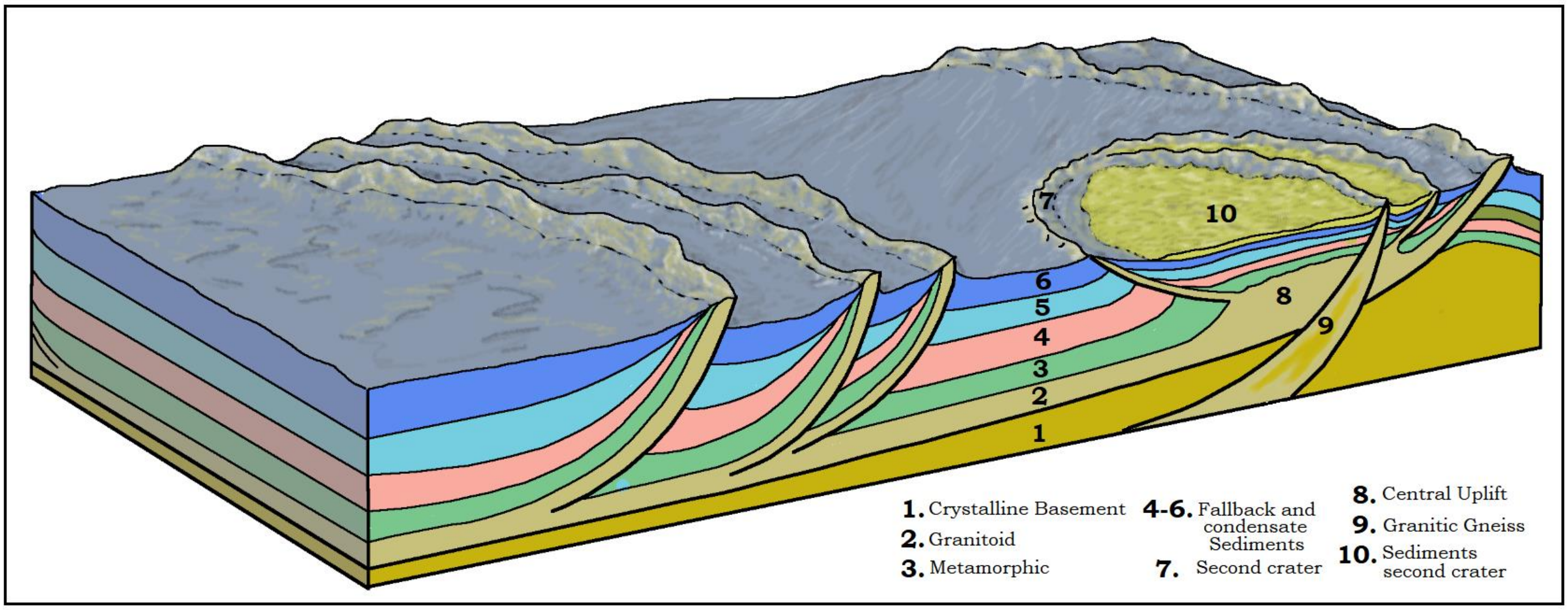


Figure 10.25: Diagram of the differences between the Sevier and Laramide Orogenies accounted for in a cratering model

While the origin of the Sevier and Laramide Orogenies are different, does the "crystalline basement" each originates in have a precratering origin? Is it evidence of a precratering structure to the earth? I propose that it is not, and originated as the result of the first large craters. Only after alkali magmas were able to concentrate near the planet's surface where cratering could reach them, did the cratering sediments start to form the sandstones, carbonates, and shales that we are most familiar with in sedimentary layers.

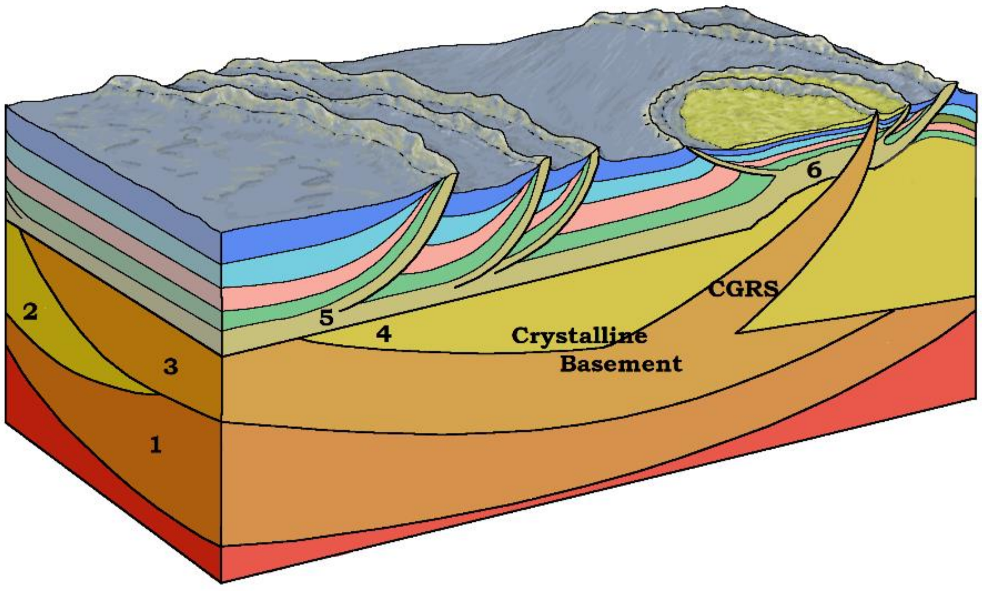


Figure 10.26: The origin of the Crystalline Basement with the first five layers of impacts before the sandstone and carbonate dominated rock started to appear. Even the metamorphic rocks are a type of sediment produced under conditions of great heat, not metamorphed under great heat during these early cratering events.

Using this model for the orogenies let us look at the middle of the Rocky Mountains and four craters, Figure 10.27. Keeping our eye on Bighorn Massif, the Rocky Mountain crater provided the uplift for the northern Bighorn Mountains with its 3-ring. This thrust with the Teewinot crater thrust worked together to push up the entire mountain range. But, the push was not enough, the Bighorn crater was pulled up with the rebound of the compression layer. The Bighorn Mountains is cutoff on both of its ends by the 1/Open-ring, while providing uplift to the Beartooth Mountains (1), Wind River Range (4), and the Black Hills (2) with its 2/OCR-ring. Additionally, the 2/OCR-ring from the Bridger crater added its thrust to the Black Hills and Beartooth Mountains. The cutoff at both ends of the Bighorn Massif emphasis the importance of the pull-up and the limiting aspect of the Open-ring as in lunar mascons. The area of Granite Mountain (GM) was pushed up by the Bridger crater, showing that it had to arrive after Bighorn crater or the mountains would follow the curve of the Bighorn's 2-ring.

Are all of earth's mascons part of the Laramide Orogeny? No, one of the most distinct example is the Mid Continental Rift.

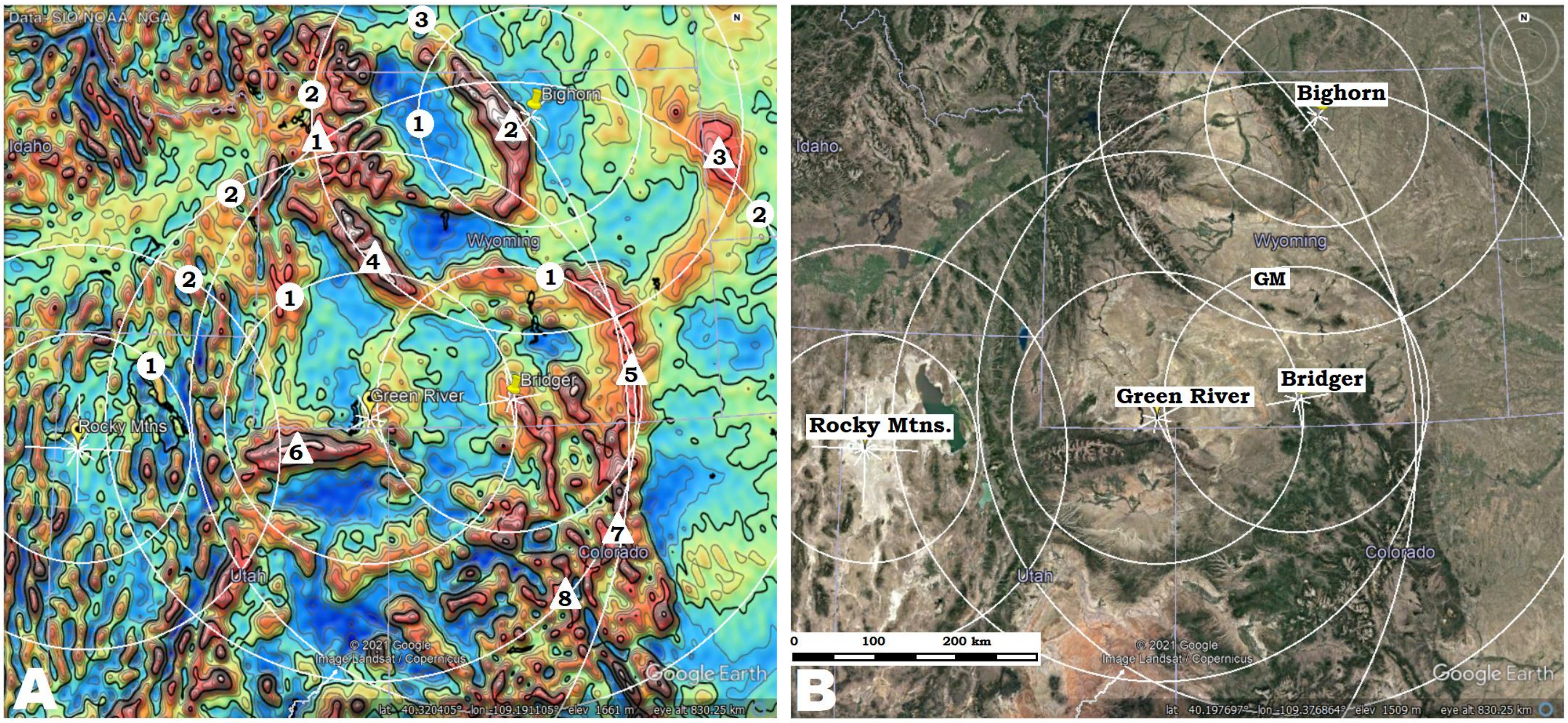


Figure 10.27: The Rocky Mountain, Green River, Bridger, and Bighorn craters combine their energy patterns. Beartooth Mountains (1), Bighorn Mountains (2), Black Hills (3), Wind River Range (4), Laramie Mountains (5), Uinta Mountains (6), Front Range (7), Sawatch Mountains (8), Sangre de Christo Mountains (9), and Sandia Mountains (10).

MCR Crater forming the Mid Continental Rift as a Mascon

The geomorphology of the Mid Continental Rift has been defined in several ways. In this paper, I am going to only be discussing the portion between the two large white arrows in Figure 10.28A. It is the portion that shows up most distinctly in a gravity map. The "rift" designation is given to it in Plate Tectonics as it is presumed to be where the earth tried to tear open and failed. That is a just-so story as no one was there to see the origin.

What is the actual evidence? The irregular linear of high gravity has both ends limited by the same ring, Figure 10.29. This would be the Open-ring in a mascon definition. While the contained linear is only an irregular line of up and down gravity readings, Figure 10.28 shows it to be the junction of at least five CGRS. To understand its structure, we need to become familiar with these craters. I propose the Ipojuca crater (yellow) was first, centering off the nose of Brazil in the Atlantic Ocean. The Bermuda crater (white) was second, centering on the Bermuda Islands of the Atlantic Ocean. The Tatanka crater (black) was third, centering in Montana just west of the Williston Basin. The Maka Luta crater (gold) is fourth, centering in Nebraska. And, the MCR crater (red) is credited with pulling up the three contributing CGRS. The smaller craters that shaped the curves, like the moon's Altai Scarp around Mare Nectaris, will not be delineated at this time.

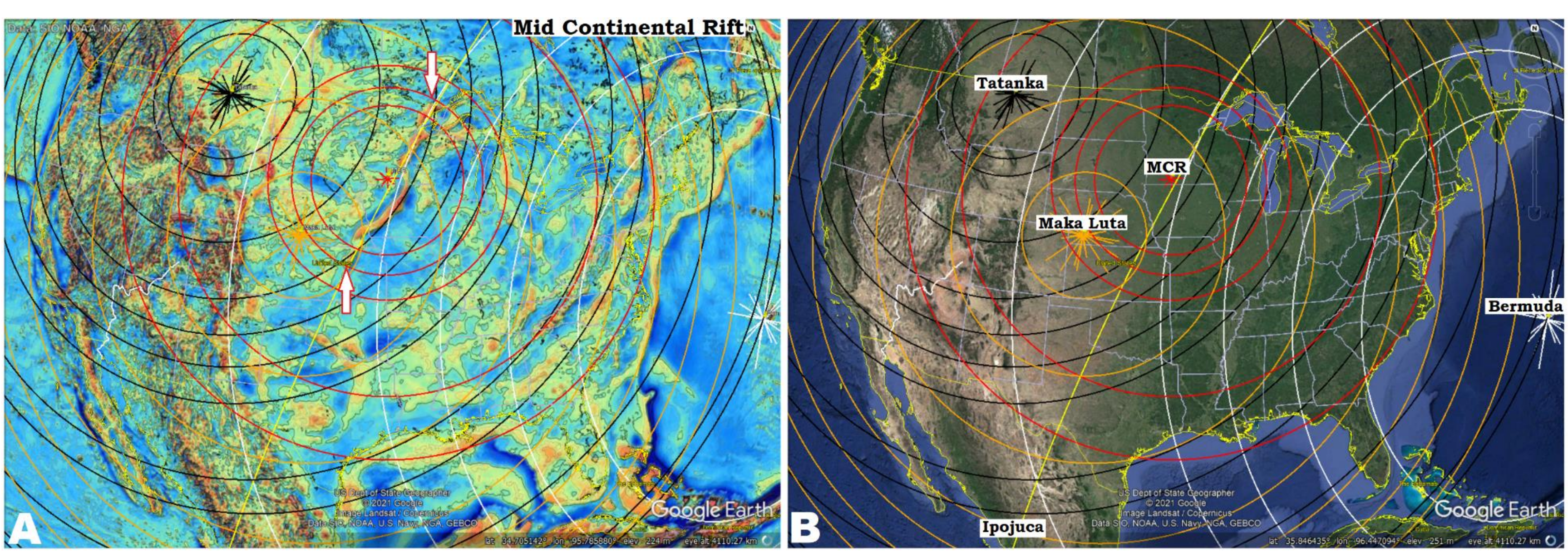
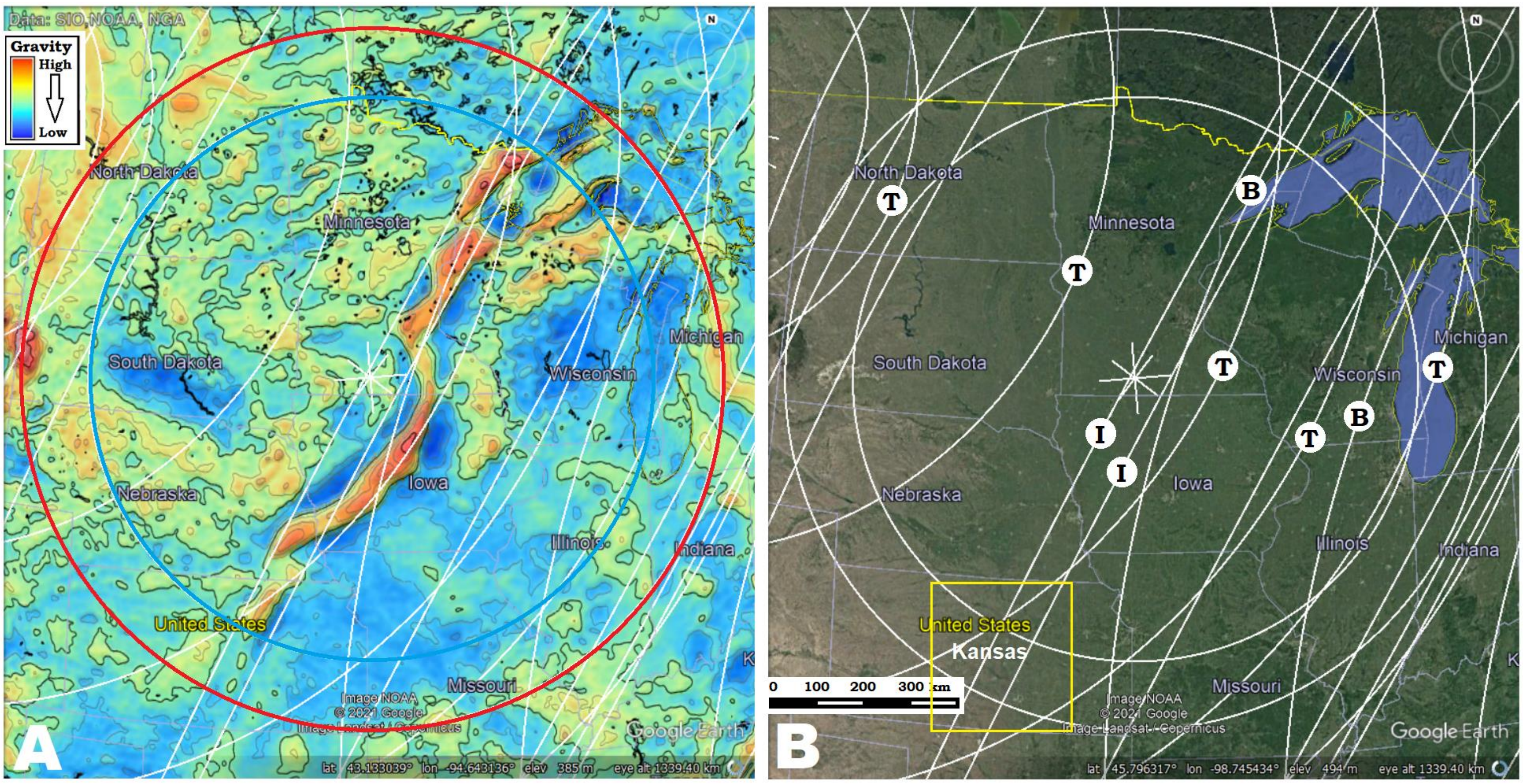


Figure 10.28: The five primary craters behind the geomorphologic structure of the Mid Continental Rift (only the portion between the two white arrows). (A) Global Gravity Anomaly map of southern half of North America. (B) Landsat image of the same area as in gravity. (Image credit: A) Overlay for Google Earth (Scripps 2014), B) Google Earth Landsat/Copernicus missions.)

The CGRS from the Ipojuca center may have already been in the substrate when the Bermuda CGRS and later the Tatanka CGRS arrived. As cratering occurred on a rotating earth, all three of these craters could have arrived within a day or two, and Figure 10.29 shows their interaction. A heavy dark blue/low gravity area surrounds the red/high gravity areas, with the northern half conforming more towards the shape of the Bermuda CGRS and the southern half more towards the shape of the Tatanka CGRS, while the Ipojuca CGRS supplied the general linear trend. The blue circle defines both ends of the uplift and cuts it off, while the red circle defines the small uplift of the Open-ring. Together they would define the edge of the mascon from the mantle.



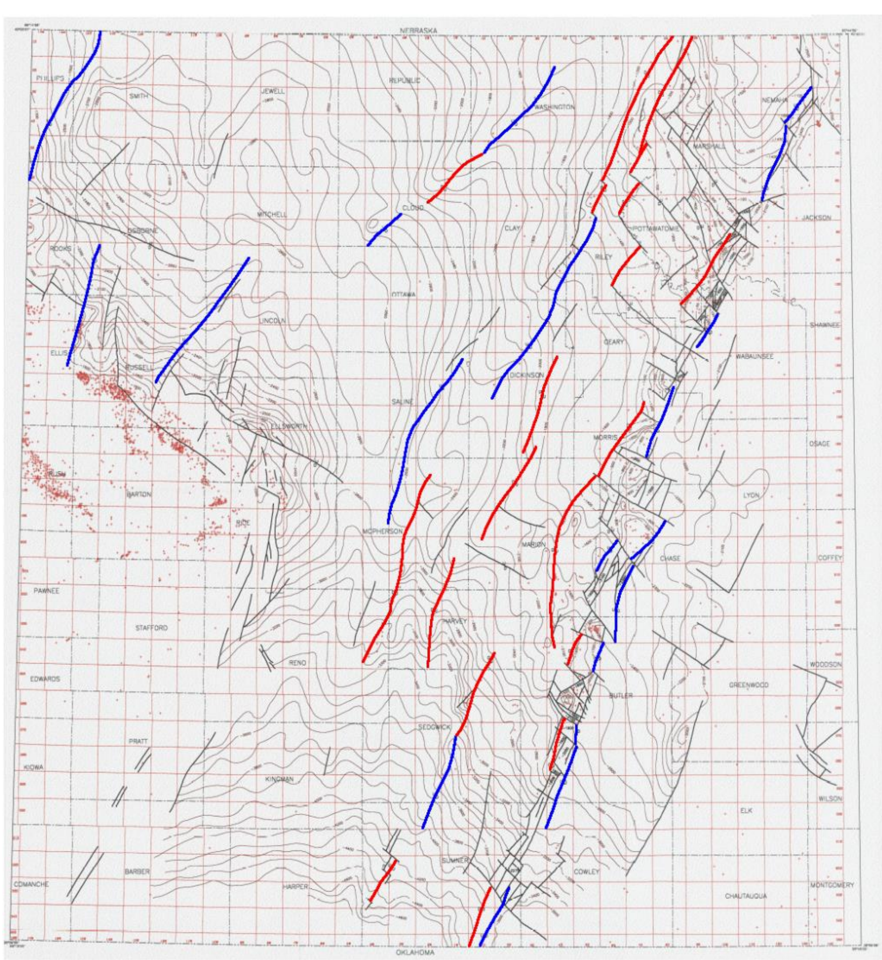


Figure 10.29: The Mid Continental Rift showing MCR (full circles), Tatanka (T), Bermuda (B), and Ipojuca (I) craters overlapping to form the Mid Continental Rift. Blue circle, ~980 km diameter, and the red circle, ~1450 km diameter.

Figure 10.30 is a detailed map of the faults of the Mid Continental Rift crossing Kansas, yellow box in Figure 10.28B. The up-thrusting to the west are colored blue and the shear is assumed to originate in the Bermuda center. Faults up-thrusting to the east are colored red and the shear is assumed to originate in the Tatanka center. The normal faults are assumed to have occurred with the Ipojuca CGRS. It is worth noting that the faults form a much tighter pattern than the gravity ridge.

Figure 10.30: Fault pattern under the Mid Continental Rift in Kansas (See yellow box in Figure 10.29 for location). Thrust faults are marked in red or blue. Red faults are up to east, blue faults are up to west. Many of the remaining faults are assumed to be normal faults. (Image modified from Berendsen and Blair 1996.)

Like every other large crater, the MCR crater does not only do one thing. Figure 10.31, left black ovals, shows how the arc from its CGRS determined the shape of the Appalachian Mountains that had been thrust up possibly just hours to days before by the Bermuda crater. The dark blue linear through the middle is the Great Appalachian Valley, which runs the length of the Appalachian uplift, and is formed by another CGRS linear from the Ipojuca center. The Sigsbee Escarpment, lower black oval, is a major off-shore up thrust through the Gulf of Mexico sediments. Figure 10.32 shows the MCR crater had to arrive after the Gulf of Mexico crater, pushing up the Sigsbee Scarp after the Upper Cretaceous sediments had been deposited, and maybe even much of the Tertiary sediments. The interaction of the two cratering events, considering the intervening sediments, will help understand the timing and sedimentation processes, and needs more study. Additionally, around the Grand Canyon (white wiggly line in yellow oval) comparing the gravity map, the MCR crater pushed up the Mogollon Rim, Mount Humphrey, and Black Mesa of Arizona; around the Chama and headwaters of the Pecos Rivers of New Mexico; and Uncompahgre Plateau area of Colorado.

This means the Mid Continental Rift is a buried CGRS (more correctly, a collection of CGRS) pulled up by the MCR crater. A typical expression of a mascon on the earth's surface.

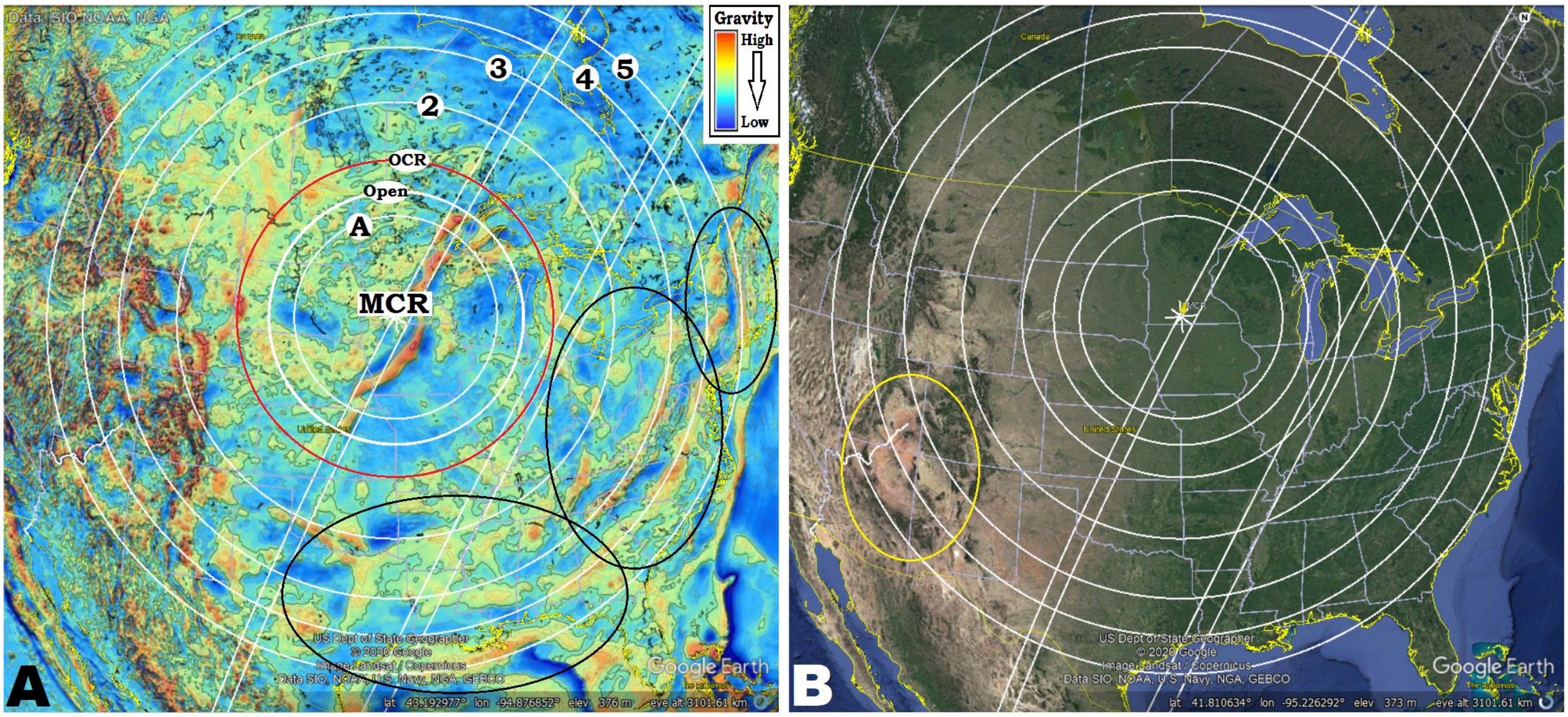


Figure 10.31: CGRS from the MCR crater reach out to form continental edges on both the East Coast and Gulf of Mexico (black ovals), while lifting gravity ridges in the vicinity of the Grand Canyon (yellow oval) and north into the Rock Mountains.

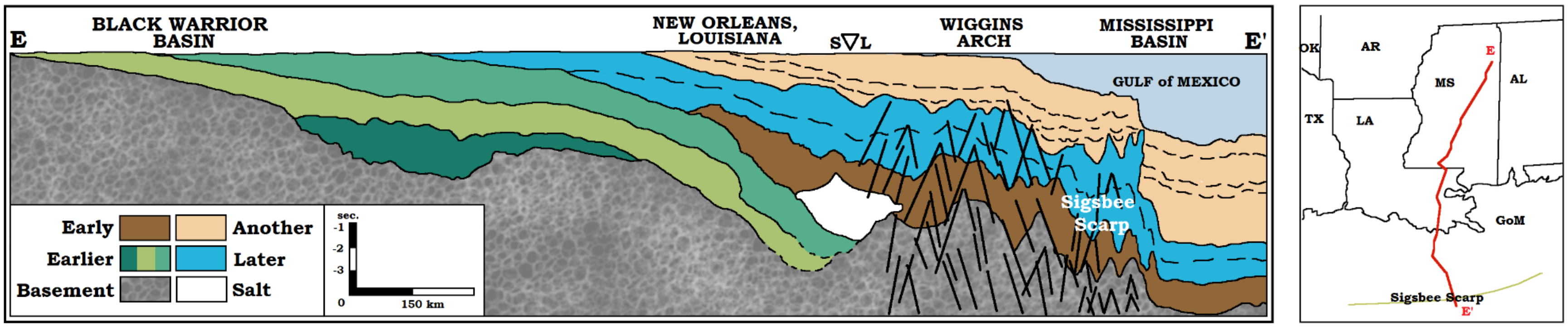


Figure 10.32: Section from Northern Mississippi through Louisiana and into the Gulf of Mexico across the Sigsbee Scarp. Sediments shown in greens are Jurassic, brown is Lower Cretaceous, blue is Upper Cretaceous, and cream is Tertiary. Black lines trace trends of disturbances in the sediments. (Redrawn from Mega SPAN 2014)

Conclusion: Mascons on earth

Chapter 10A concluded mascons on the moon surface are formed when impacts lifted the mantle in the cratering rebound and pull shock wave/compressed material from CGRS with it, inside a limiting collar of the Open-ring. This is the same definition we need to use for mascons forming on the earth's surface, Figure 10.33. A: An impactor forms a crater with its alternating layers of compressed and expanded substrate forming concentric rings of high density and low density substrate. B: While future impact arrive randomly, those that arrive in the low density areas have a greater opportunity to lift portions of the mantle into the uplift of the crater rebound blanketed by brecciated fall back. C: All craters produce vapor condensate. The first larger ones produced the crystalline basement, and later ones contribute the sedimentary layers we recognize. These later impactor pierce the highly heated sediments and expend much of their energy underground. D: The vapor condensate still forms above the substrate and contributes new sediments from each impact. CGRS from other impactors are either in the substrate and pulled up by the uplifting crater rebound or are able to pierce further within the thinned crust and lift the sediments or rupture them to form granitic gneissic peaks. While this is an idealized view, reality looks more like E: with the confused collection of a multitude of additional energy imprints. Some of the energy patterns are distinct enough that they have been labeled as discontinuities, the upper most being the Moho, but extending downward to include all of the discontinuities in the lithosphere and asthenosphere. I propose some of the craters left imprints as far as 600 km under the surface.

The major difference between moon mascons and those are earth, the earth mascon rebound in a linear shape that reflects the curve of the CGRS. Whether that difference is a result of CGRS expression in greater gravity or other causes need more research.

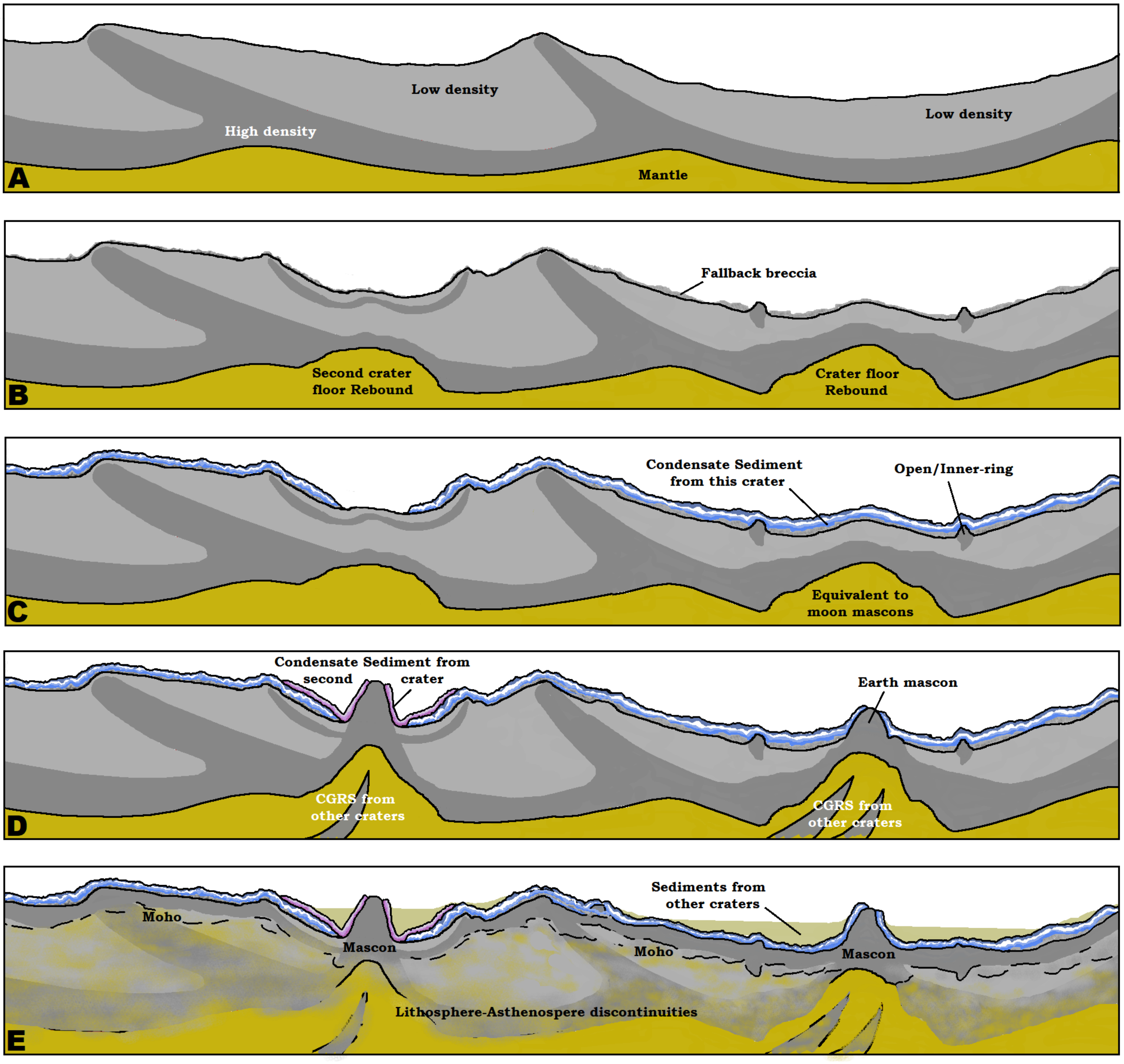


Figure 10.33: Steps in the cratering formation of a mascon and discontinuities in the crust.

Finding a similarity in mascons between the moon and earth raises the likelihood of a common origin for those structures and a common origin for the common cratering on the rocky spheres. If the moon, Mars, and Venus, the rocky bodies of our three nearest neighbors in the Solar System, all experienced cratering, what is the chance that the earth did not? And, since the ring structure are located in spatial relationships where we find them, it is very unlikely that Plate Tectonics has happened to relocate them since their beginning. The earth's fossil record is contained in the condensate sediments that I have connected to the impact events. Therefore, I propose that these impact arrived after Creation making their arrival most likely within the Flood events.

Acknowledgements

Special thanks to Maarten 't Hart for his invaluable help in creating a program for me that draws the circles on Google Earth where I need them and creating the KML files for the Lunar maps from NASA images. Without these tools I would never have seen the spatial relationships which are so crucial to understanding this topic.

Proverbs 17:18. "The one who states his case first seems right, until the other comes and examines him."

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