Electric Scarring of the Earth's Surface

Dr. Paul E. Anderson
US Army ARDEC, Picatinny Arsenal, NJ 07806
e-mail: eu4you2@gmail.com

The macroscale appearance of river beds, mountain ranges, and other geological features exhibit characteristics which are typical of electric scarring on a dielectric medium. This paper explores this hypothesis and presents evidence that most canyons and riverbeds were initially formed by electrical events and not by fluvial erosion. To quantify the differences in geologic structures, high altitude images of selected geological formations were pixilated and their fractal dimension measured using the Box counting method. When the images were skeletonized, it was found that the fractal dimensions of the geologic structures were similar to the fractal dimensions of laboratory electric discharges on dielectric media to a 95% confidence level; in contrast statistical similarity to fluvial events was lacking. Furthermore, the geological features exhibited self-affinity, a characteristic of electrical discharges but is not a characteristic of unconfined fluvial systems.

Key words: Rivers, Terrain, electric universe, scarring.

1. Introduction

Within the past quarter century, a growing number of scientists and engineers have developed a new theory of the cosmos known as Electric Universe Theory (EU). The methodology and findings of this theory were the result of a combination of multidisciplinary interactions, including electrical engineers, physicists, astronomers, geologists and others. While some basic tenets were outlined in Hannes Alfven's works, the EU community more or less generally agrees on the following: the same basic laws of plasma physics hold throughout the universe, knowledge of the electric field distribution in the universe is central to understanding the plasma universe, space is filled with filamentary and cellular structure as a result of the plasma, and double layers/pinch effects are central to understanding how matter is formed throughout, from planets to elemental distributions [1].

In a plasma universe, there are no mysterious theoretical matter constructs as are presently put forth in the literature arising from the gravity-dependent theories, such as black holes, dark forces, dark energies and dark matter. Gravitational theories consider itself responsible for the high energies in objects such as neutron stars and black holes. In contrast, plasma physics shows that energies are derived from currents which are field-aligned with the magnetic fields of other current sheets. Such interplay inspired the Nobel Laureate chemist Irving Langmuir to coin the name plasma for its lifelike appearance [2]. In space, just as in a properly equipped physics laboratory, charged particles experience a force proportional to the magnetic field, velocity of the particle perpendicular to the field, and the charge of the particle (Lorentz forces). Once electrons in elements are separated from host nuclei, the separated charges also respond to magnetic fields and self organize into freely moving currents over vast parsecs of space [3]. These filamentary structures were named after Kristend Birkeland ("Birkeland currents") and have been measured and verified with satellites [4]. Even the popular press has recognized and published findings of "current ropes" attaching the earth to the sun[5]. These and other observations have shown the reality of charge separation and current ropes in space.

The EU community further holds that there have been and still are dense plasma discharges on planetary surfaces [6, 7]. These arise from impingement of a roving Birkelend current, the surface of another body at a different potential, or a sudden large flux from a coronal discharge. A coronal discharge could also be caused by a large current flux, which is consistent with electric sun theories put forth by Juergens [8] and Alfven [1]. It was hypothesized that a sudden increase in output of the sun, only 4 times the current solar output, would lead to such large electric fields that our atmosphere would have to break down and carry the current to the earth's surface. Thomas Gold put forth a description of such an event:

> *"It is of interest to consider the magnetic storm effects of such an outburst....A magnetic storm of that kind [4 times the current output of the sun] would be a totally different kind of phenomenon from the usual one. The Earth's magnetic field could clearly not hold up the incoming gas, and it would indeed drive down to the atmospheric level where the gas pressure can resist further flow. At that level the atmosphere is dense and the ionization that could be maintained would not result in good conductivity. The incoming gas bringing its strong field into the virtually insulating atmosphere would then result in very large electric fields so directed that the resulting currents would maintain those fields. But in the atmosphere that can be done only by electrical breakdown...This breakdown would be in the form of a series of sparks, burning for extended periods of time and carrying currents in the hundreds of millions of amperes. One might search whether there is any geological record or surface fusing and vitrification of rock or sand which cannot be accounted for by volcanic or meteoritic events. Large quantities of glass, far too much to be made by ordinary lightning discharges, are indeed found on the surface in a few places, notably in the Libyan Desert. Perhaps it might be worthwhile to pursue this clue further..."* [9]

For the sake of this paper, a catastrophic view will be accepted in which a large discharge event took place that sparked through the dielectric medium of the atmosphere and discharged current into the earth's crust. This discharge event was decidedly different than typical auroral currents observed today. As Gold points out, if the auroral currents were to increase, the plasma instabilities would progress to near the equator, where finally the atmosphere would become unstable and unable to carry the current flux. The plasma discharge would then erupt from glow current mode to arcing, resulting in numerous current paths to the surface of the earth. The discharge results in some type of pattern from the primary discharge stroke and subsequent distribution of charge which can take the form of craters, sinuous rilles, or stochastic patterns, more commonly known as Lichtenberg patterns. Lichtenberg patterns form when an electric arc strikes a grounded plate beneath a dielectric material. As early as 1777 scientists were studying this phenomenon using charged powders of various colors, and more recently workers have used such Lichtenberg patterns to study the effects of electric discharge on insulation materials [10].

Niemeyer and coworkers established that electrical discharge behavior occurs in a stochastic manner that is best described by fractal structures [11]. In Mandelbrot's seminal book, a fractal is described as "*a rough or fragmented geometric shape that can be split into parts, each of which is at least approximately a reduced-size copy of the whole*" [12]. This indicates that these geometric shapes are repeated regardless of size. Current research has utilized the self-similarity of electrical trees to identify causes of electrical breakdown in dielectrics [13]. Electrical and auroral experiments have been modeled and verified in both modern and older experiments, such as Birkeland's original terra experiments [14]. Self-similarity in electrical breakdown trees is widely accepted [15]. By way of contrast, self-similarity in water systems only exists when the existing water body is confined by the self-affine landforms [16]. In freely open floodplains, it has been shown that water systems and braided rivers are not self-similar [17]. Since the characteristics of unconfined fluvial systems do not form self-similar structures, the question should be raised as to why rivers exist in self-similar structures. The idea being put forth here is that these self-similar structures were formed first and the fluvial systems then accommodated themselves to these forms.

At the planetary scale, geologic structures should possess a fractal dimension similar to the origin of their creation. But, if the structures arose from fluvial events, then known fluvial events should possess similar fractal dimensions. If, however, these geologic structures were the results of electric scarring, electrical events should possess similar fractal dimensions. This paper shares a method in an ongoing effort to address the origins of unique geologic structures that cannot be reproduced in the laboratory by fluvial processes. The study was accomplished by fractal dimension comparison of certain geological formations with documented fluvial events and patterns formed from known electric discharges.

2. Experimental

Fractal analysis of geological features was carried out by pixilation of maps from Google Maps in "terrain" viewing mode. The latitude/longitude location of each studied structure is given in Table I. Fractal measurements were made by first saving the map in JPEG format. ImageJ microscopy analysis software (National Institutes of Health, US Government Public Domain Software) was used to process the image and conduct 2-D fractal analysis. Typically, the image was converted to 8-bit grayscale, the maximum and minimum pixels contrasted, and the image then converted to binary. In some cases some picture manipulation was necessary in order to eliminate roads and labels on the Google map. Fig. 1 shows an example of the procedure. The box counting method was used to determine the fractal dimension D, which is the same as the Hausdorff-Besicovitch dimension for $1 \leq D \leq 2$. In this procedure, the algorithm places a grid over the picture and boxes with increasing numbers of pixels are used to fill in the black region of the picture. The resulting counts of boxes, N, of size s associated with the filled in picture is given by:

$$\log N = D \log \frac{1}{s} \tag{1}$$

where D is the slope of the line and fractal dimension from a log-log plot of the number of boxes N as a function of box sizes. The images were reduced by the skeletonization algorithm in ImageJ to gauge the extent of branching, yielding a pseudo-assessment of self-similarity in the primary pattern of the geologic landform. The area of each image was on the order of about 500-1,000 square miles, and the maximum resolution of the binary images at this vantage point is 1 pixel per 1/25 of a square mile, or about 25 acres. The topography was ignored for these studies; essentially the pixilated landscapes were projected onto a 2-dimensional plane. It has been shown that projection of 3D electrical tree patterns onto a 2D plane does produce valid assessment of the fractal dimension when $D < \sim 1.7$ [15]. In light of those studies and considering the analyzed area sizes, it can be assumed the earth is a 2D surface for the purpose of this paper. The same procedure was followed for rivers and newly formed canyons from known fluvial events. Pair-wise Tukey-Kramer HSD (Honesty Significant Difference) tests were conducted at the 95% confidence interval to gauge the similarity of data sets. All data analysis was performed with JMP 8.0 statistical software (SAS Institute, Cary, NC USA).

3. Results

Tables 1-3 show each item, the item category, the measured D values and measured skeletonized D values according to the procedure above, as well as the ratio value (D divided by skeletonized D). The categories were divided into three types; "Unknown" for the measurements of the geologic items of interest (Table I), "Fluvial" for known flood events (Table II), and "Electrical" for known electrical events (Table III). Pairwise Tukey-Kramer HSD test results are shown in Fig. 2-4. Overlapping circles denote no significant difference of the values measured. In the case of original D values, there was no significant difference between the various categories (Fig. 2). However, once skeletonized, there was a significant difference between the sample sets (Fig. 3), as well as with the ratio values (Fig. 4). According to the data, the "unknown" data sets are not any different statistically than the structures caused by electrical discharges. The difference was only resolved when the total amount of branching was measured in the skeletonized D values. At lower box sizes, the fractal dimension was higher than the skeletonized measurement, i.e. the slope (D value) was higher (Fig. 1). The difference arises because, as the binary image body was skeletonized, the number of pixel counts in the small box sizes decreased. The total D measurement decreased more only if there was not extensive branching. If one looks at photos of newly formed fluvial events such as those listed in Table II, it is apparent that fluvial events form more linear, smoothed structures, as will be discussed in the section dealing with river formations. The data shows there is no statistical difference between small scale electrical discharges and larger scale landforms.

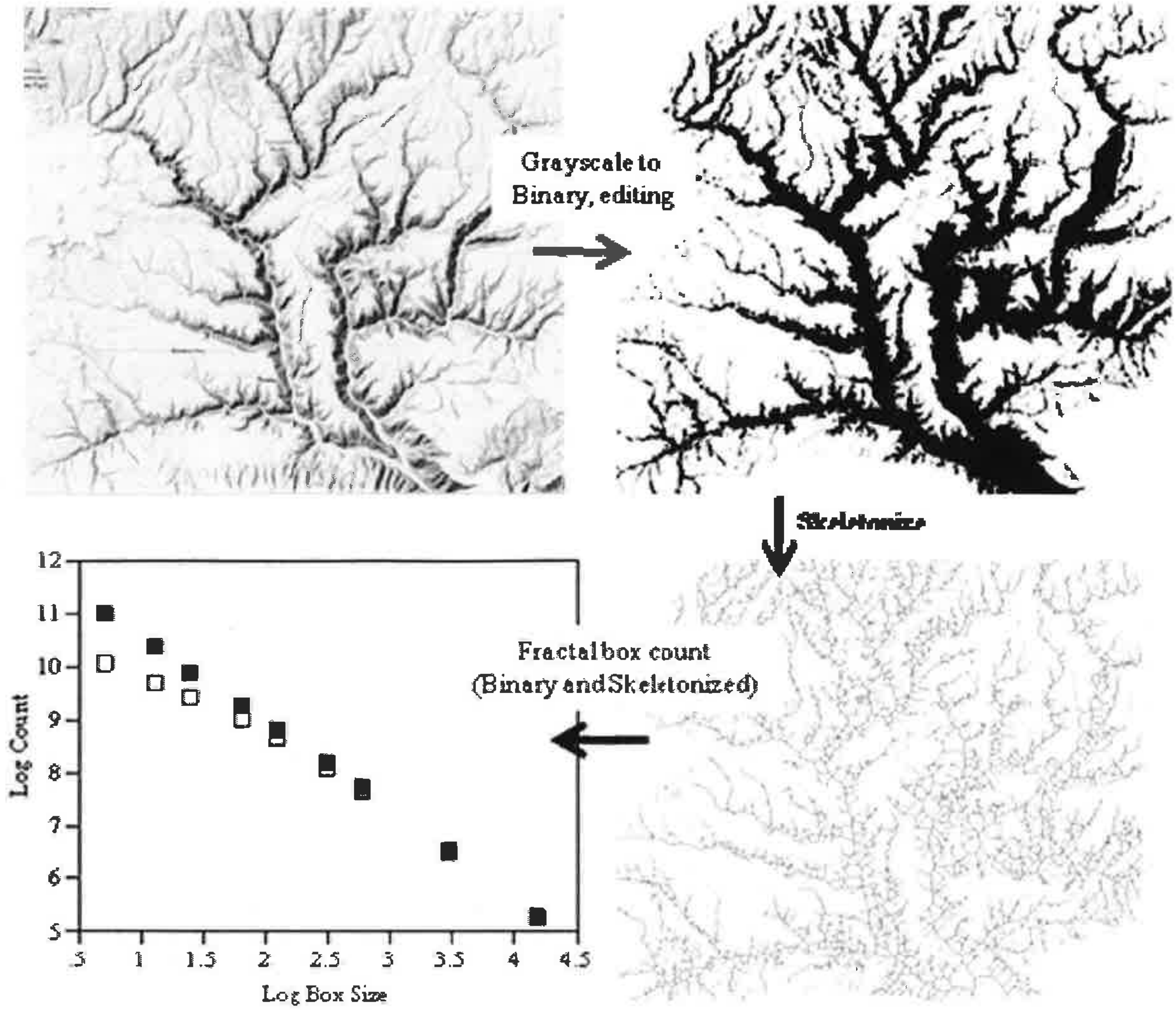

Fig 1. General procedure for performing fractal analysis on geological landscapes in this study. Closed squares are binary measurements and open squares are skeletonized measurements. Structure pictured is from Pleasant Valley, WA, USA.

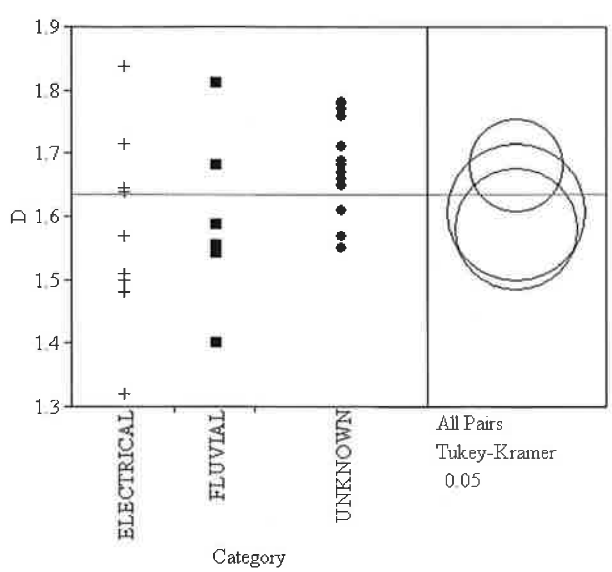

Fig. 2. Tukey-Kramer comparisons of various measured *D*-values of three categories of measurements. Overlapping circles denote no statistical difference based on a 95% confidence interval.

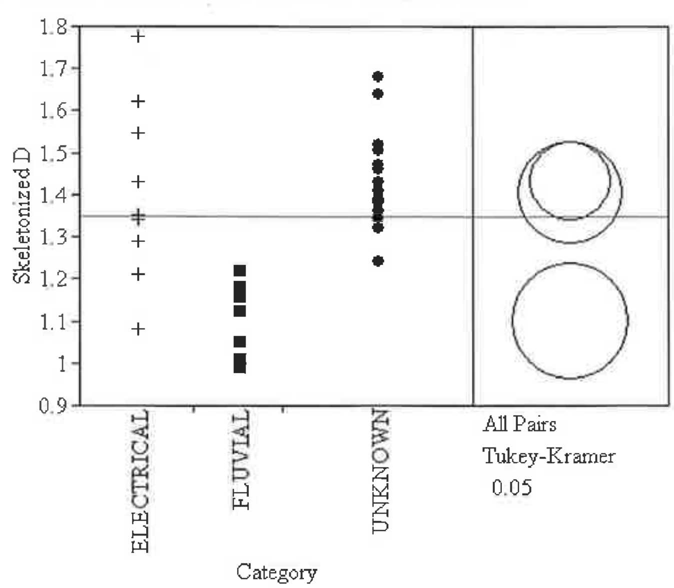

Fig. 3. Tukey-Kramer comparisons of various measured skeletonized *D*-values of three categories of measurements. The FLUVIAL category is statistically different at the 95% confidence interval.

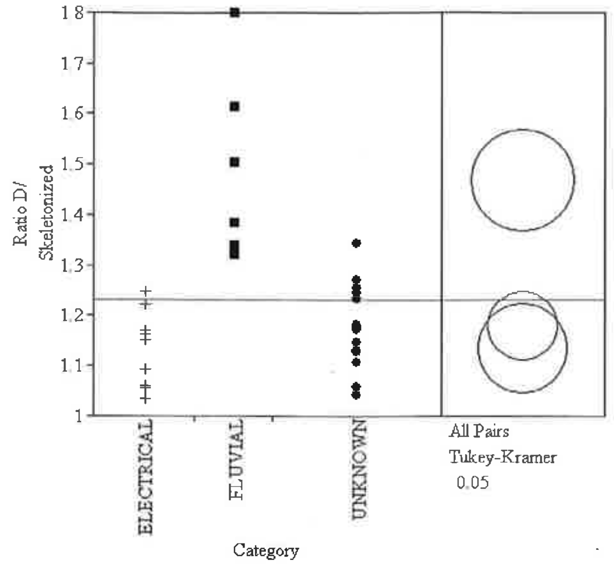

Fig. 4. Tukey-Kramer comparisons of various ratios of D / skeletonized D. As the level of branching increases, the relative difference between D and skeletonized D decreases, resulting in a ratio nearer to 1.

Recent fluvial events were needed to calibrate the fluvial fractal dimension. Most rivers chosen for this analysis were braided networks with known, regular tidal basins such as the Mississippi (North America), Amazon (South America), Nile (Northern Africa), and the rivers of New Zealand (Rakaia and Waimakariri). Braided networks were chosen because they are a type of river that is not constrained by surrounding geology and thus take on a morphology dictated by flow rate. Chosen for analysis in this paper as flood inundations were recent mud volcanic events and other known flood events.

As a case example, the fractal dimension of the Armistad Reservoir (Armistad National Recreation Area, Texas, USA) was analyzed. It was calculated to have a $D = 1.66$. If one consults the history of Armistad, the dam was erected in 1969 and the reservoir took nearly 4 years to reach its present capacity. Upon closer analysis of the Armistad, however, its shorelines clearly depict fractal patterns. Either (a) the damming itself created the shoreline or (b) the existing land structure already possessed the fractal patterns and the water now fills those patterns. If we analyze the path of the Rio Grande nearby and measure its fractal dimension we obtain $D = 1.51$ with virtually no branching. Thus, the land could only possess the fractal pattern due to (a) uplift from tectonic activity (b) erosion by past water bodies or (c) electrical scarring.

An additional challenge to such a result could be the following. One could point out that certain trees have a fractal value of $D > 1.5$, but that does not necessarily mean they are formed from an electrical discharge. However, we know from observation that trees are not formed by onslaughts of water or a discharge of electrical energy across a dielectric. Mandelbrot addressed this concern in his book, where items from seemingly different, unrelated processes possess a similar fractal dimension [12]. If one is to assert that certain geologic structures arose from EDM processes, then there must be other tenable support for such occurrences happening in the recent past. Such evidence will now be reviewed.

4. Ancient Records

Since we do not observe active discharges today, we must turn to the past and look for any proof of possible discharges. In *Worlds in Collision*, Immanual Velikovsky described effects of charge equilibrating between two celestial bodies and its possible relation to many worldwide mythologies and characteristics of the pagan gods [18]. As mentioned in the introduction, Gold described what would have happened in the event of an extreme solar discharge [9]. While it is acknowledged that some of Velikovsky's ideas were proved to be incorrect, his description of possible electrical discharges was seriously considered in catastrophist circles, independently by Gold, and now by EU theorists.

Permanent records of great antiquity are found in petroglyphs. Petroglyphs are rock carvings that have perplexed historians, anthropologists, and tourists for many years. While some petroglyphs depict "early" humans undertaking aspects of their daily lives such as hunting and worshipping, many petroglyphs depict a vast array of unintelligible shapes, lines, and squiggles. Anthony Peratt has recently bridged together a range of disciplines, including archaeology, plasma physics, and anthropology, resulting in a plausible and informative explanation of elusive petroglyph data [19]. A recent concerted, worldwide effort brought pieces of information together presenting strong evidence that many petroglyphs are depictions of discharges in the recent past. In Peratt's first comprehensive review, he correlated the shape of intense, high current plasma discharges made in laboratories with those depicted in petroglyphs [19]. The discharges were performed on U.S. Department of Energy pulsed power facilities at Los Alamos National Laboratories and Sandia National Laboratories. Currents ranged from 100kA-150MA, with time scales from 10^{-8}-10^{-6} seconds. Various types of high speed imaging analyzed the discharges. Additionally, experiments have validated computer modeling of plasma columns.

In his studies, Peratt found that striking similarities existed among petroglyph patterns found in widely varying places around the world [20]. For instance, a columnar "caterpillar" design was found in the U.S. Southwest, Australia, Armenia, and South America. Likewise, the X-type patterns, or "separatrix" patterns, were also found worldwide, as was the famous "squatter" or "anthromorph". Perratt goes on to explain the complex but consistent non-anthropomorphic/non-animalistic petroglyphs like those mentioned above were often relegated ~~in~~ to the unknown in terms of interpretation. He then further explained how a columnar discharge event would take the shape of these polymorphs. Correlating the orientation of the petroglyphs with known z-pinch events, Perratt estimates the events to be sub-gigamperes [20]. It should be noted Gold calculated that such discharge events would be in the millions of amperes [9]. In Part II of the series, Perratt and coworkers assemble the hypothesized morphology of the z-pinch discharge event based on a multitude of petroglyphs from 139 countries [20]. The aspects of the petroglyphs accurately depicting columnar plasma discharges– even down to the proper number of columnar branches – is beyond coincidental. The work strongly suggests that many petroglyphs recorded extreme auroral plasma events early in human history. In the second paper, extensive GPS mapping in conjunction with petroglyph data locations was used to reconstruct what such events may have looked like at various locations about the globe. The images correlated with the modeling of a concentric, columnar discharge tube at both poles of the earth.

At this point, it should be emphasized that petroglyphs are a worldwide plethora of depictions made by early humans that date (secularly) in the range of 2,000-10,000 B.C., depending on the studied petroglyphs. Some researchers agree that many of the carvings depict celestial events, a field of research known as archeoastronomy. Some have correlated the markings with a complex archaeoastronomical calendar [21]. But there still exist many petroglyphs with the seemingly peculiar and abstract designs discussed and addressed in Perratt's work. The appearance and preservation of these stone messages, particularly in light of their exact representations and field of view orientations, are very likely depictions of extremely large plasma instabilities and possibly discharge events. This would only occur if we assume the sun to have varied in output in the recent past. This is not an altogether unreasonable assumption, since there are variable stars that exhibit up to 4-5 times in solar output with regular periodicity [22].

5. Fractal Dimensions of Electric Discharges

In some of the earlier work with electric discharges on dielectrics, the investigators utilized a variety of materials and discharge settings but failed to recognize the fractal nature of the patterns. Niemeyer recognized the fractal nature and studied discharges on a dielectric surface, obtaining fractal dimensions of the Lichtenberg patterns in the range 1.6-1.7 [11]. When high resolution computer simulations were performed the fractal dimension maximum leveled at about 1.6 [23]. Later work expanded on computer simulations. Experimental discharges in sulfur hexafluoride (SF_6) produced Lichtenberg patterns of fractal dimension 1.45, which, with increasing resolution, leveled off at 1.73 [24]. The magnitude of D was dependent on the number of streamers resolved, the electric field, and other experimental parameters. Other workers extended fractal analysis to lightening discharges in the atmosphere and have found D values of about 1.34 [25]. By increasing the photographic resolution and extending computation time on supercomputers, simulations resulted in D values as high as 1.85 for projections of lightning strokes onto two planes [26]. The lightning Lichtenberg patterns used in this paper as a "calibration" also show fractal dimensions 1.5-1.8 (Table III). These references and measurements present sufficient evidence that the ionized plasma of electrical discharge events possess fractal dimensions $D > 1.5$, whether from small, centimeter-size laboratory studies to mile-high lightning bolts. The fractal nature of electric discharge phenomenon has therefore been proven scalable from the millimeter to the kilometer level, which involves a difference of nearly 10^6 orders of magnitude, similar to the asserted scalability of Birkeland currents throughout the universe [27]. That plasma behaves the same predictable way regardless of the size further supports the proposition that the unknown data sets in this study are related to EDM events rather than fluvial processes. To the author's knowledge, fluvial events can only be simulated accurately from the centimeter to the meter level in a controlled laboratory environment, which is only 3 orders of magnitude. Observed fluvial events, such as Mount St. Helens, only span up to about 15 kilometers, which is the next observed level.

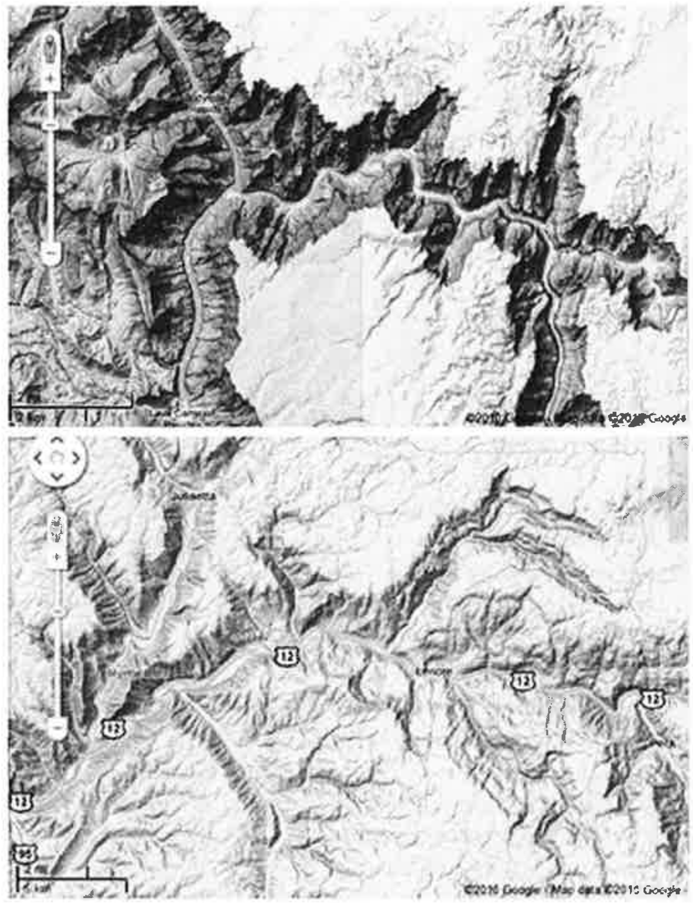

Fig 5. Two examples of river patterns not consistent with the morphology of eroded beds. The rivers, which are the most recently eroded structures, take on a smooth path despite being located in granite-type deposits, while the older structure and higher elevations of the canyons are stochastic but in softer sedimentary deposits. The opposite should hold true if water had eroded the higher elevations. Left is the Grand Canyon near Sixty Mile Rapids (36.194,-111.770) and the right is from near Lewiston, Idaho (46.523,-116.768).

6. Fractal Dimension of Riverbeds

It is well known that certain geologic landscapes exhibit fractal structure. Most often the coastlines of continents are cited [12]. But what of the fractal dimension of single geologic structures, such as riverbeds? In one extensive monograph, the author states there is not clear cause-effect link to fractal river basin structures and braided network rivers due to unknown starting conditions [16]. Even with later technological advances in imaging and fractal analysis, other authors acknowledge that self-affinity in braided river networks does not exist [17]. This is strong evidence that direction and branching of rivers is largely determined by their surroundings and landforms rather than the landforms being initially determined by the waterways. Fluvial aspects alone are not sufficient to explain how a stream or river creates complexities of extensive canyon networks that exhibit self affinity. Examples of this are shown in Fig. 5, in which the complex form of the hypothesized discharge event confines the sinusoidal, fluvial pattern of water erosion.

Incised, or entrenched, meanders are steep canyons cut into resilient rock whose streams are not surrounded by floodplains. Many of these empty into structures where little or no evidence of sedimentary deposits has been found [28]. If, indeed, the many dendritic tributaries formed the contours of the meanders, where did all the sediment go? Furthermore, the valleys of such systems seem to take on the course of the meandering stream and erosion softens the edges of the valley as would be expected with water flow (Fig. 6). The dendritic contours of the hills surrounding the Mississippi River floodplain clearly indicate they were present before fluvial events formed the floodplain. One geology textbook simply states *"the [dendritic] pattern is determined chiefly by the direction of the slope of the land"* [29].

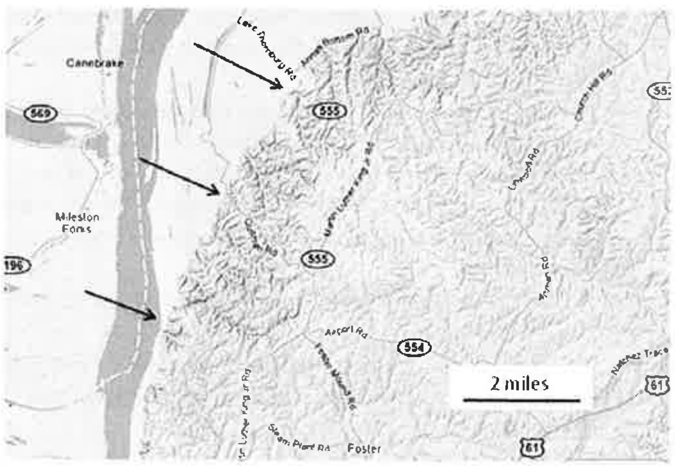

Fig 6. Eastern bank of the southern Mississippi River (34.967,-87.083). Note evident floodplain that runs up to dendritic patterns in foothills. All dendritic patterns are completely self-affine, which is a trait not found in braided systems such as the Mississippi. However, such a characteristic is found in electrical discharges.

However, upon close inspection of the terrain, the contour lines at the top of the patterns are all of the same elevation. They do not differ in steepness, orientation, or height. How did the dendritic patterns establish themselves without drainage? It should be noted that self-affinity of rivers only occurred when there were physical restraints placed upon the river, such as mountains and valleys, and when the rivers were not braided [17]. Thus, restraints on the river flow and basin must be present before the water arrives in order to promote self-affinity since no fluvial system exhibits self-affinity. Once constraints are placed on the river, it conforms to its surroundings. Furthermore, the patterns at different elevations follow the contours of the lowest points, which further supports the proposition that canyons were formed via a single discharge event and not from eons of flowing water. As seen with braided rivers, the water would have cut an even path if given fairly uniform elevation and directional forces.

7. Conclusion

Just as water flows and collects in the tire tracks of a mud road, it is the author's hypothesis that water on earth flowed into the remnants and the surfaces carved by electrical events in the recent past. Water flow does not appear to form structures with as many branches, particularly perpendicular branches, as do electrical events. While the mechanisms of discharge formation are still under study by those in the EU community, the current from the source must have been higher than it is today in the present auroras. The auroral process would have extended well beyond the current northern and southern locations, and once the atmosphere could not support the ionization it would break down in the form of electric discharges. The appearance of such events in the past is further supported by petroglyphs, computer modeling and laboratory experiments as described in this research.

The fractal dimensions D of the geological structures of this study were statistically dissimilar and higher than measured from fluvial events. From extensive literature on river systems, it was determined that river systems only form self-affine structures when geological restraints are present in the first place. Thus, the structures that hold present-day rivers and streams must have formed from another mechanism. In this study, it was shown that geologic structures possess fractal dimensions not statistically dissimilar to electrical phenomenon ($p = 0.0001$) but are dissimilar to known fluvial events ($p = 0.9022$). Further data from ancient petroglyphs, current electric universe proponents, and ancient recorded legends all support electrical discharges being part of the landscape one sees today. Analyzing the literature for clear examples and proof of rivers forming such dendritic, self-similar structures does not give any evidence of or support for the fluvial formation of landscapes. Rather, the mechanism of river and canyon formation should have proceeded as follows: First, canyons, riverbed and chasms were formed by immense electrical discharges. Then they fill with water, since water seeks the lowest point. This explains why many riverbeds possess sinusoidal, fluvial pathways at the base of chaotic and stochastic geological formations such as the Grand Canyon. Additionally, such a mechanism is consistent with many canyon systems missing the large amount of sediment that should be present. In light of such evidence, the mechanisms and theories of the electric universe proponents and catastrophism should be researched in terms of applications in earth's geological history.

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TABLE I

GEOLOGICAL STRUCTURES ANALYZED

Formation	Latitude/Longitude	D	Skel-D	Ratio D / Skel-D	Origin Category
Ethiopia A	8.497, 42.161	1.76	1.38	1.27	Unknown
Young's Corner, IN	39.361, -85.036	1.78	1.50	1.18	Unknown
Young's Corner, IN	39.206, -84.951	1.78	1.43	1.25	Unknown
Pleasant Valley, WA	45.858, -120.515	1.55	1.32	1.17	Unknown
Quebec	48.609, -64.827	1.69	1.47	1.15	Unknown
Ethiopia B	4.727, 39.058	1.61	1.36	1.18	Unknown
Manchester, IN	39.089, -85.001	1.68	1.52	1.11	Unknown
Armistad	29.469, -101.118	1.66	1.35	1.23	Unknown
Armistad (2x zoom)	29.469, -101.118	1.67	1.24	1.34	Unknown
Scablands, WA (5 mile)	47.424, -120.080	1.55	1.32	1.17	Unknown
Renovo, PA	41.323, -77.736	1.65	1.46	1.13	Unknown
Sixprong, WA	45.961, -120.128	1.71	1.64	1.04	Unknown
Grand Canyon	36.245, -112.931	1.77	1.41	1.26	Unknown
N Grand Canyon	36.600,-112.644	1.57	1.39	1.13	Unknown
Yemen	16.142, 48.190	1.78	1.68	1.06	Unknown

Locations and measured D-values from ImageJ analysis of various geological landforms.

TABLE II
FLUVIAL GEOLOGICAL STRUCTURES ANALYZED

Formation	Latitude/Longitude	D	Skel-D	Ratio D / Skel-D	Category
Mississippi	31.130, -91.616	1.40	1.05	1.33	Fluvial
Armistad (river trace only)	29.225, -100.792	1.54	1.15	1.34	Fluvial
Armistad (river trace only 2x zoom)	29.225, -100.792	1.59	0.98	1.61	Fluvial
Waimakariri River, New Zealand	-43.360, 172.077	1.68	1.12	1.50	Fluvial
Rakaia River, New Zealand	-43.537, 171.662	1.68	1.22	1.38	Fluvial
Canyon Lake, TX	29.858, -98.1961	1.55	1.18	1.32	Fluvial
Mt. St. Helens flood	46.296, -122.400	1.81	1.01	1.80	Fluvial

Locations and measured D-values from ImageJ analysis of various geological landforms that were known to arise from fluvial events.

TABLE III
ELECTRICAL STRUCTURES ANALYZED

Formation	Reference	D	Skel-D	Ratio D / Skel-D	Category
Lichtenberg pattern, polyethylene	http://www.chaos-101.com/?page_id=41	1.65	1.43	1.15	Electrical
Lichtenberg pattern, polyethylene	http://akiroom.com/redbook-e/collection2/tnk01.html	1.71	1.62	1.06	Electrical
Golf course lightning strike	http://www.cosmosvolts.com/	1.64	1.55	1.06	Electrical
Cement lightning strike	http://www.notjustrocks.com/	1.84	1.77	1.04	Electrical
Lightning	O. Mendes, 2003	1.50	1.29	1.16	Electrical
Dielectric discharge	N. Femia, 1993	1.57	1.25	1.26	Electrical
Dielectric discharge	L. Niemeyer,	1.32	1.08	1.22	Electrical
Lightning	A. A. Tsonis, 1991.	1.51	1.23	1.23	Electrical
Dielectric Breakdown	http://www.absoluteastronomy.com/topics/Electrical_treeing	1.48	1.35	1.09	Electrical

Locations and measured D-values from ImageJ analysis of various structures derived from actual electrical events.

TABLE IV
TUKEY-KRAMER HST RESULTS FROM ORIGIN CATEGORY ANALYSIS OF TABLES I-III.

Type – Type Comparison	Difference	Std Error	p-Value
Unknown – Fluvial	0.33105	0.06776	0.0001*
Electrical – Fluvial	0.30403	0.07460	0.0010*
Unknown – Electrical	0.02701	0.06241	0.9022

Results from statistical analysis of skeletonized fractal dimensions between different categories. The results show that at a 95% confidence interval the differences are not significant between unknown landforms and electrical events. There are significant differences between the unknown and electrical values when compared to fluvial values.