TENERIFE 2019 EVENT : Piezoelectric and Earth Lightning Volcano Effects *

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Abstract

The paper presents two newly geophysical effects from Volcano activity not yet described that aids to explain a Zero Energy occurred at Tenerife (Canary Islands) on September 29, 2019 . This day at 13 hours 11 minutes 35.508 seconds an initial spiking signal was recorded at the Magnetotelluric station installed within the Teide Volcanic Caldera in Las Canadas. It is a well-exposed caldera depression in which the active \Teide-Pico Viejo" complex stands. The first spike was followed by two other signals at 13:11:36.914 and 13:11:38. The signals were getting more powerful from the first, weakest, to the last, the strongest one. Same day at 13:11:47.320 a first failure occurred in one of the power distributions bars of the Granadilla Power Plant located at 26 Km from the Magnetotelluric station followed by a second disastrous failure of the second bar at 13:11:48:406. From these signals and events, we can see a strong correlation between the second and third signals in the magnetotelluric instrument and the events that burn out the bars at the distribution centre of the power plant. We have in both cases a time difference of 1.086 seconds. In the present paper we will present an explanation of these events based on; i) a piezoelectric effect caused by a thermal instability deep in the volcano structure that generated an extremely high electrical potential that was initially recorded in the surface (point approximate in the vertical) by the magnetotelluric instruments; ii) and later on via a phenomena that we named as an Earth Lightning the knocking of the power plant's distribution park.

TENERIFE 2019 EVENT : Piezoelectric and Earth Lightning Volcano Effects*

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CONTENTS

I. INTRODUCTION.

On 29th September 2019 at 13 hours 11 minutes 35.508 seconds an initial spiking signal was recorded at the Magneto telluric station installed within the Teide Volcanic Caldera in “Las Cañadas”. “Las Cañadas” caldera in Tenerife (Canary Islands) is a well-exposed caldera depression in which the active “Teide-Pico Viejo” complex stands.

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II. TEIDE VOLCANO PROVINCE

A. Introduction [1]

Tenerife Island takes part of the Canary Islands Archipelago, at latitude 28–29°N and longitude 16–17°W, with an area of 2,040 km^3, it is the largest

* Newly described Geophysical effects

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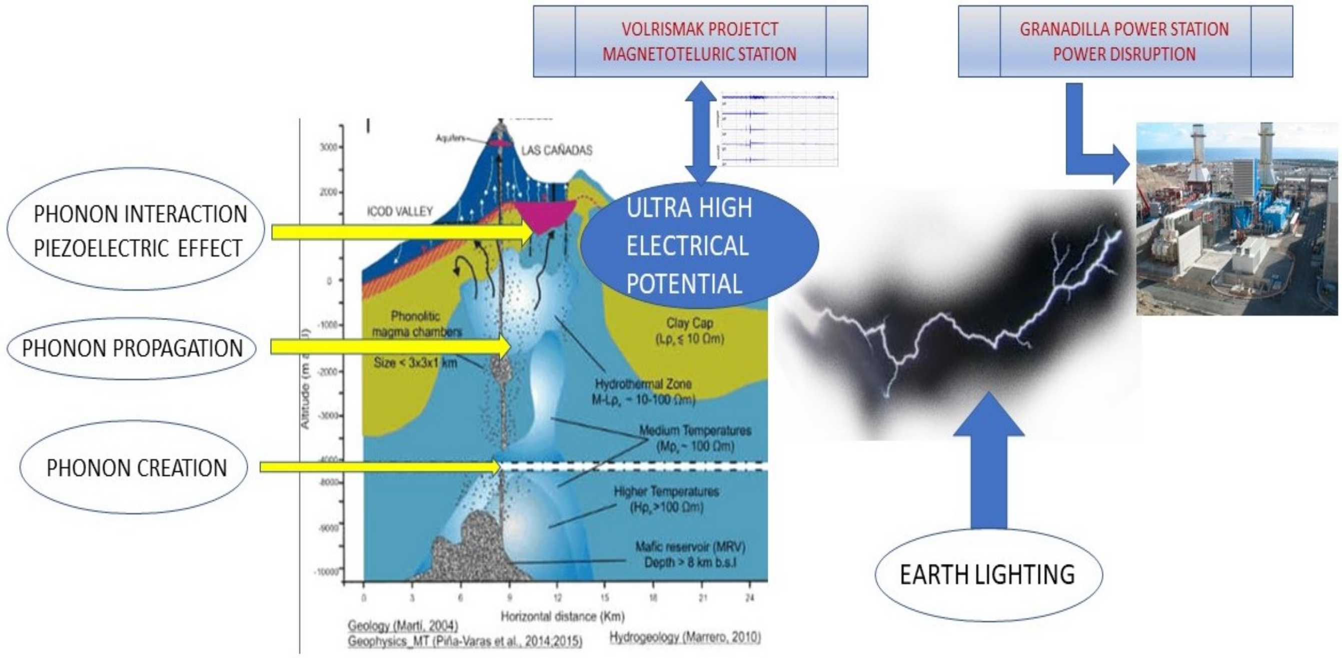

FIG. 1. Tenerife 2019 Event

of the Canary Islands, with a summit height (Teide Volcano) of 3.718 Km asl which is part of the Teide-Pico Viejo (TPV) volcano system. Tenerife island and the TPV volcano complex are a highly active volcano system which dormant state has been altered in 2004 and from October 2016 until now. [6].

Tenerife island has a complex geology structure due to the mixture of the basaltic, phonolitic and felsic(high explosive) eruptions, the dominant volcano complex in the island is the stratovolcano Teide-Pico Viejo and Las Cañadas Caldera in the center of the island, las Cañadas caldera has an elliptical form (16 x 9 Km) situated at 2.000 m asl. The geological age of Tenerife Island is about 13 Ma, with geological dated eruptions from the Miocene period (mainly basaltic in origin) that have changed during the geological time to a more evolved magma (phonolitic , felsic and basaltic) of the more recent eruptions.

B. Volcano last events

The last highly-explosive felsic eruption in the central volcanic complex was that of Montaña Blanca in the south-eastern flank of Teide, dated at $\sim$ 2000 BP (Ablayetal.,1995; Villasante-Marcos, 2017). The last eruption in the central volcanic complex, the Narices del Teide phono-tephritic eruption, was a historic alone (1798 AD) in the southwestern flank of Pico Viejo.

The explosive eruptions implies shallow phonolitic magma chambers developed in the centre of the island below the Cañadas and Teide Pico Viejo Complex, CTPVC, (Mitjavila and Villa 1993; Martí et al. 1994; Bryan et al. 1998; Marti and Gudmundsson 2000; Wolff et al.2000; Edgar 2003, Piña-Varas et al 2018). Petrological evidence suggests that the region where the phonolitic magmas are stored would not be constitute of a single chamber but rather, several coexisting isolated reservoirs (Ablay et al. 1998; Martí and Geyer 2009; Andújar and Scaillet 2012; Andújar et al. 2013, Piña-Varas et al 2018).

The location of these phonolitic chambers has varied significantly during the evolution of the CTPVC (Andújar 2007). Thus, Teide–Pico Viejo phonolites were stored at depths of about 1–2 km below sea level (b.s.l) (Ablay and Martí 2000; Andújar 2007; Andújar et al. 2010, Piña-Varas et al 2018), while the storage depth for Montaña Blanca and Roques Blancos would be shallower, around 1 km above sea level(a.s.l); Andújar and Scaillet 2012; Andújar et al.2013, Piña-Varas et al 2018).

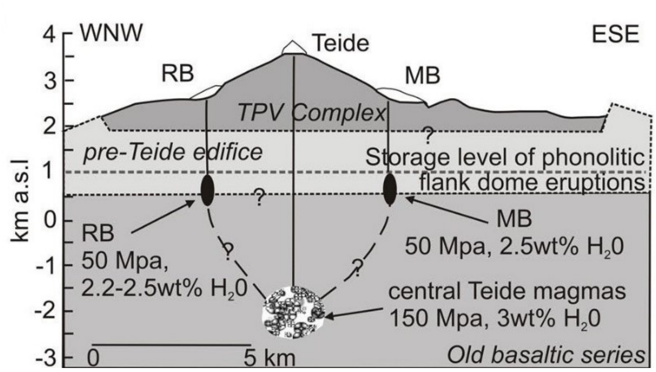

FIG. 2. Phonolitic Chambers [7]

Regarding the basaltic magmas in Tenerife, some geological and geophysical data (Canales 1997; Watts et al. 1997; Ablay et al. 1998; Neumann et al. 1999; Ablay and Kearey 2000; Dañobeitia and Canales 2000, Piña-Varas et al 2018) point to the periodical accumulation of the basaltic magmas into large bodies located in three major discontinuities, the base of the elastic lithosphere (30 km depth), in the MOHO discontinuity (14–16 km depth) and the contact ocean basement base of the Teide volcano (7–8 km depth; Martí and Gudmundsson 2000). According to Piña-Varas et al 2018, Magnetotelluric data provide information about the depth of this deep mafic reservoir. The geological and geophysical data suggest that the magma is stored in a large-scale deep mafic reservoir. According to the study of Piña-Varas et al 2018, a reservoir with such characteristics should be located at depths greater than 8 km b.s.l..

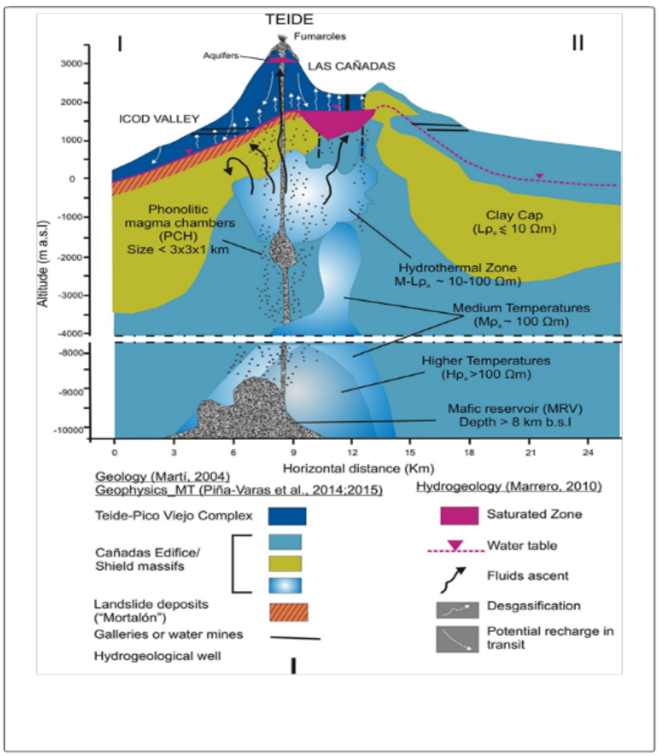

FIG. 3. Teide Volcano Morphology[8]

III. PIEZOELECTRIC EFFECT

A. Introduction (Ref:[2])

The word piezoelectric is derived from the Greek words;"$\eta\lambda\epsilon\kappa\tau\rho o\nu$" *elektron*, which means amber, an ancient source of electric charge, and "$\pi\iota\epsilon\zeta\epsilon\iota\nu$" *piezein*, which means to squeeze or press. In modern times the effect was discovered by the Curie brothers, Pierre and Jacques in 1880.

They demonstrated that an electric potential was generated when crystals were compressed. If a piezoelectric crystal is subjected to stress or mechanical pressure in certain directions relative to the crystal faces, the crystal becomes electrically polarized with an electric moment of magnitude proportional to the applied stress. Depending on the pressure applied and the nature and size of the piezoelectric material, electric potentials ranging from a fraction of a volt to many thousands, see millions, of volts can be obtained.

B. Historical and Field Evidences (Ref:[3])

Since the Russian study in which a detonation induced a piezoelectric field in a quartz vein [Volarovich et al., 1959], piezoelectric polarization in rocks has been attributed to seism electric phenomena.

For example, Finkelstein and Powell [1970] explained earthquake lightning as piezo-induced electromagnetic phenomena. However, they later withdrew the proposal because charge carriers bound the piezoelectric polarization in the conductive earth.

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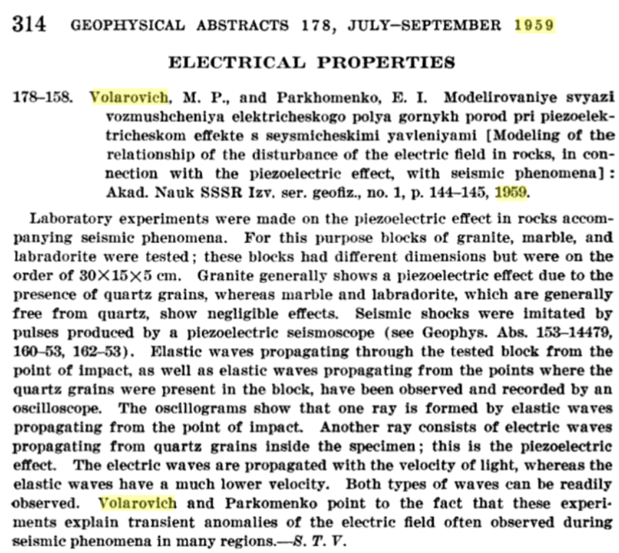

314 GEOPHYSICAL ABSTRACTS 178, JULY–SEPTEMBER 1959

ELECTRICAL PROPERTIES

178–158. Volarovich, M. P., and Parkhomenko, E. I. Modelirovaniye svyazi vozmushcheniya elektricheskogo polya gornykh porod pri piezoelektricheskom effekte s seysmicheskimi yavleniyami [Modeling of the relationship of the disturbance of the electric field in rocks, in connection with the piezoelectric effect, with seismic phenomena]: Akad. Nauk SSSR Izv. ser. geofiz., no. 1, p. 144–145, 1959.

Laboratory experiments were made on the piezoelectric effect in rocks accompanying seismic phenomena. For this purpose blocks of granite, marble, and labradorite were tested; these blocks had different dimensions but were on the order of 30×15×5 cm. Granite generally shows a piezoelectric effect due to the presence of quartz grains, whereas marble and labradorite, which are generally free from quartz, show negligible effects. Seismic shocks were imitated by pulses produced by a piezoelectric seismoscope (see Geophys. Abs. 153–14479, 160–53, 162–53). Elastic waves propagating through the tested block from the point of impact, as well as elastic waves propagating from the points where the quartz grains were present in the block, have been observed and recorded by an oscilloscope. The oscillograms show that one ray is formed by elastic waves propagating from the point of impact. Another ray consists of electric waves propagating from quartz grains inside the specimen; this is the piezoelectric effect. The electric waves are propagated with the velocity of light, whereas the elastic waves have a much lower velocity. Both types of waves can be readily observed. Volarovich and Parkomenko point to the fact that these experiments explain transient anomalies of the electric field often observed during seismic phenomena in many regions.—*S. T. V.*

FIG. 4. Volarovich paper

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Later, J. F. Barrie presented a Thesis at the University of British Columbia (1977) with an investigation of the piezoelectric effect of quartz rich rocks, both in the laboratory and in the environment.

The later were the most significant and we will use some of their results in our paper. The underground trials were conducted at the Con Mine in Canada [9].

The experiment was carried on in a pit of the mine containing a vein of quartz placing electrodes at 20-55 meters and generating stress via hammer knocks on the walls of the pit.

Clear piezoelectric signals were observed for source-target distances as large as 55 m and electrode-target distances out to 20 m Piezoelectric signals were generated after hammer impact of both compression and shear seismic waves with the exposed quartz vein

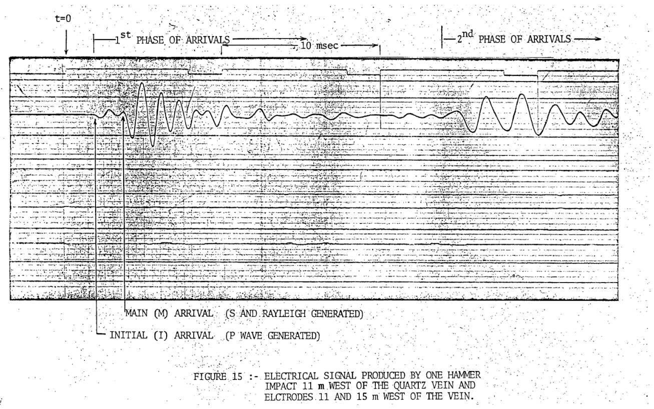

FIG. 5. Con Mine experimental Data

Main result that we can see is the two train of signals generated by piezoelectric effect from the difference in time arrival to the quartz vein of the compression (P) and shear (S) waves generated by the hammer impact.

Also it was experimentally determined that the speed (based on the time arrival of the trains) of the signals were 2,7 Km/sec.

C. Laboratory Experiences (Ref:[4])

Piezoelectricity in quartz-bearing rocks has also been measured in laboratory experiments. The main goal of some of these experiments was to clarify the presence of piezoelectric fabrics caused by preferred orientation of a quartz grains [Tuck et al., 1977: Nikitin and Parkhomcnko 1982; Ghomshani and Templeton 1989].

In general, the results supported the presence of piezoelectric fabrics, though the piezoelectric effects for granite obtained by Tuck et al. [1977] were smaller than the background fluctuations. They concluded quartz grains in their samples were paired or twinned. Here we can suggest that the low piezoelectric fields observed by Tuck et al. [1977] resulted from of cancellation of piezoelectric polarization by charge carriers. To our knowledge, there are no published results on the behaviour of bound charges in rocks.

In the laboratory experiments carry on by H. Sasaoka et al (1998), electric field variation appear at stress change; in case of unloading, piezoelectric polarization in granite reduce promptly, then the charge carriers that compensated the piezo-polarization diffuse with a certain relaxation time, considering the mobility of charge carriers. To quantify this role, they measured the electric fields that were induced by bound charges in granite after unloading stress, from which we obtained the apparent piezoelectric constant of an unheated granite sample and the relaxation time of bound charges.

The samples, cubic sample (10x10x10cm3) grain-size of minerals in granite ranges from 0.5 to 3mm (average 1.5 mm) and the quartz content is about 30 volume percent of granite. Apparatus utilized, and the measurements obtained are presented below:

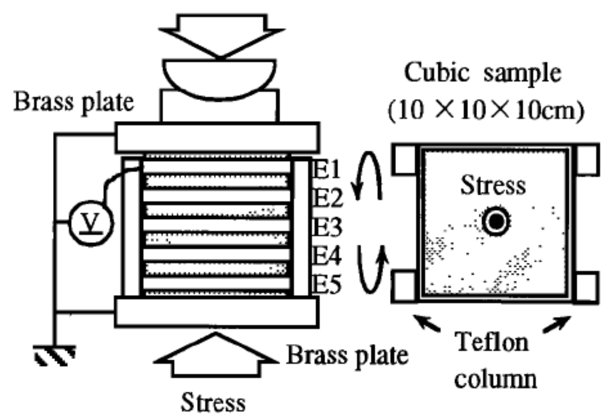

FIG. 6. Schematic diagram of the experimental apparatus. The electric potential measurement is made near a specimen surface with an electrometer having an input impedance more than $10^{13}\Omega$. The hydraulic compression machine is electrically grounded, and the system is in an electrostatic shielding box, Copper electrodes (E1$\rightarrow$ E5) are insulated by Teflon columns.

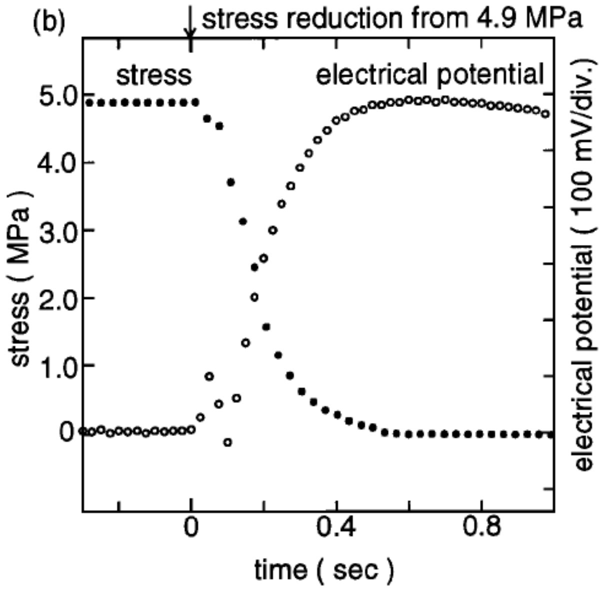

FIG. 7. Comparison of stress reduction and electrical potential rise

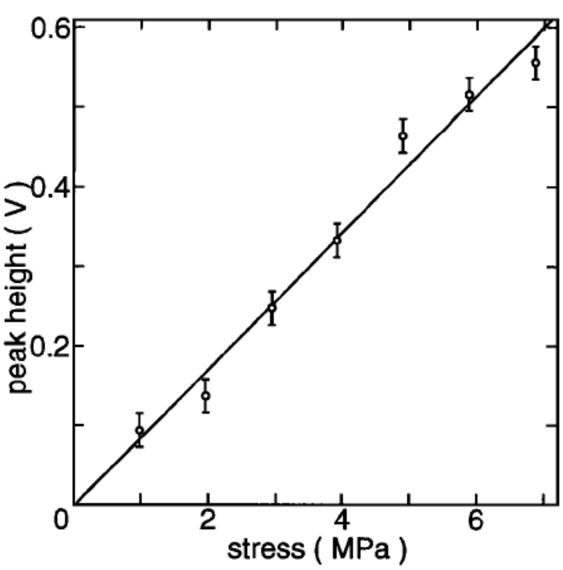

FIG. 8. Plot of the peak height in the electric potential obtained by releasing stress on the granite sample. The line fit by least square gives an apparent piezoelectric coefficient.

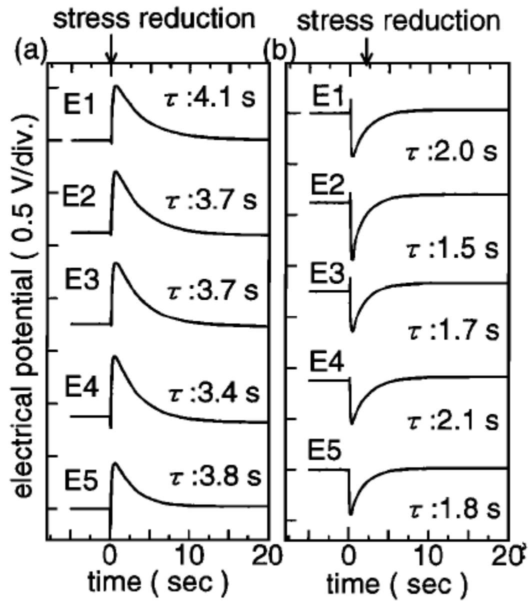

FIG. 9. Electric potential variation at several electrodes in Figure 4 when the same sample was compressed along different directions.

In Figure 7 the potential rise corresponds to the fall in stress. The electric potential variation will be correlated to piezoelectricity of quartz in granite because the basalt. sample without quartz grains did not show such the variation.

In Figure 8. The apparent piezoelectric constant α_{eff} can be estimated to be $1.4{*}10^{-15}$ C/N from the variation of the electric potential (about $7*10^{-4}$ times of that of a single crystalline quartz) assuming that the electrostatic field was due to charges related with piezoelectricity. The value is in good agreement with previous data (Kondrashev1980)

D. Stress Generation (Ref:[5])

In our model heat carried from the deep layers of the volcano will be the energy source that will create the stress needed to blow up the piezoelectric effect introduced earlier.

To understand how heat spreads through a material, any material, consider that heat — as well as sound — is the motion or vibration of atoms and molecules: Low-frequency vibrations correspond to sound, while higher frequencies correspond to heat. At each frequency, quantum mechanics principles dictate that the vibrational energy must be a multiple of a basic amount of energy, called a quantum, that is proportional to the frequency. These basic levels of energy are called phonons as a kind of pseudo particle. Then, we can consider the “phonon” just as a particle of heat.

When a material is heated, the atoms can oscillate at specific frequencies. The bonds between the individual atoms behave essentially like springs. When one of the atoms gets pushed or pulled, it sets off a wave (or phonon) travelling through the material, just as sitting down on one edge of a trampoline can set off vibrations through the entire surface. When working on applied physics relating to the transfer of heat within solids, thinking in terms of phonons has proved to be especially useful.

In practice, most materials are filled with a chaotic mix of phonons that have different frequencies and are traveling in different directions, all superimposed on each other, in the same way that the seemingly chaotic movements of a choppy sea can (theoretically) be untangled to reveal a variety of superimposed waveforms of different frequencies and directions.

Just as photons (the particles that carry light or other electromagnetic radiation) of a given frequency can only exist at certain specific energy levels — exact multiples of the basic quanta —so, too, can phonons. But unlike photons, which generally do not interact at all if they have different wavelengths, phonons of different wavelengths can interact and mix when they bump into each other, producing a different wavelength. This makes their behaviour much more chaotic and thus difficult to predict and control. Phonons in solids can usually be described as harmonic oscillators.

From the point of view of Quantum mechanics treatment, phonons are Goldstone modes, corresponding to the breaking of translation and rotation symmetries by a crystal structure.

The first and second quantization of the phonon are well known, and, in the Appendix, we present the phonon-electron interaction with the piezoelectric effect development

E. Phonon Creation

Thermal phonons can be created and destroyed by random energy fluctuations. In the language of statistical mechanics this means that the chemical potential for adding a phonon is zero. This behaviour is an extension of the harmonic potential into the anharmonic regime. The behaviour of thermal phonons obeys the Bose–Einstein statistics: in thermal equilibrium and within the harmonic regime, the probability of finding phonons in each state with a given angular frequency is:

$$n(\omega_{k,s}) = \frac{1}{\exp(\frac{\hbar\omega_{k,s}}{k_B T}) - 1} \tag{1}$$

Where $\omega_{k,s}$ is the frequency of the phonon's state,k_B is the Boltzmann constant, and T is the temperature.

This equation and the ones presented in the appendix define analytically the effect (Electric Potential creation) that we are proposing.

Analytical solutions of the model would be carried on by Effective Field Theories. Anyway, due to the highly anisotropic conditions of the materials set up as well as the non-determination of the most significant parameters of the model it is understood that simulations are the only current practical approach to the problem.

Numerical calculations mean the knowledge of the parameters involved in the problem that in a summary form are:

1. Temperature of the region where the phonons are created.

2. Boundary conditions of the transport region for the phonons.

3. Characteristics of the materials that support the piezoelectric process.

Any of these general parameters are known, and our approach would be more experimental (factual) based than purely quantitative quantum mechanics that for the moment is out of the scope.

One of the Authors is currently working on simulations using Holographic models that geometrize the renormalization group flow of the Effective Field Theory by means of dual gravitational fields. The setup is implemented in a computational model using Holographic Neural Networks.

IV. ELECTRICAL BREAKDOWN

A. Introduction

Materials are often classified as electrical conductors or electrical insulators based on their resistivity. A conductor is a substance which contains many mobile charged particles called charge carriers which are free to move about inside the material. An electric field is created across a piece of the material by applying a voltage difference between electrical contacts on different sides of the material.

In general, high-voltage breakdown is most likely to occur where the electric field is the highest, but this depends on various factors. Different insulating materials under different conditions will break down at different electric field strengths. The electric field where a material breaks down is called the material's dielectric strength and is expressed in the same units as electric field.

Solid insulators generally have a much greater dielectric strength than gaseous ones. Gaseous and liquid insulators generally recover after breakdown, whereas breakdown of solid insulators usually causes irreversible damage.

The force of the field causes the charge carriers within the material to move, creating an electric current from the positive contact (electrode) to the negative contact. For example, in metals one or more of the negatively charged electrons in each atom, called conduction electrons are free to move about the crystal lattice. An electric field causes a large current to flow, so metals have low resistivity, making them good conductors. In contrast in materials like rocks all the electrons are tightly bound to atoms, so under normal conditions there are very few mobile charge carriers in the material. Applying a voltage causes only a small current to flow, giving the material a remarkably high resistivity, and these are classed as insulators.

However, if a strong enough electric field is applied, all insulators become conductors. If the voltage applied across a piece of insulator is increased, at a certain electric field the number of charge carriers in the material suddenly increases enormously and its resistivity drops, causing a strong current to flow through it. This is called **electrical breakdown**.

Breakdown occurs when the electric field becomes strong enough to pull electrons from the molecules of the material, ionizing them. The released electrons are accelerated by the field and strike other atoms, creating more free electrons and ions in a chain reaction, flooding the material with charged particles. This occurs at a characteristic electric field strength in each material, measured in volts per centimetre, called its dielectric strength.

The geometry of the electrodes plays a critical role in the type of discharge produced and the overall breakdown voltage. Electrode characteristics can also reduce the voltage at which a system breaks down by causing localized field enhancements on a microscopic level.

When a voltage is applied across a piece of insulator, the electric field at each point is equal to the gradient of the voltage. The voltage gradient may vary at different points across the object, due to its shape or local variations in composition. Electrical breakdown occurs when the field first exceeds the dielectric strength of the material in some region of the object. Once one area has broken down and become conductive, that area has almost no voltage drop and the full voltage is applied across the remaining length of the insulator, resulting in a higher gradient and electric field, causing additional areas in the insulator to break down.

The breakdown quickly spreads in a conductive path through the insulator until it extends from the positive to the negative contact. The voltage at which this occurs is called the *breakdown voltage* of that object. **Breakdown voltage** varies with the material composition, shape of an object, and the length of material between the electrical contacts.

Breakdown voltage is a characteristic of an insulator that defines the maximum voltage difference that can be applied across the material before the insulator conducts. In solid insulating materials, this usually creates a weakened path within the material by creating permanent molecular or physical changes by the sudden current. Within rarefied gases found in certain types of lamps, *breakdown voltage* is also sometimes called the *striking voltage.*

The **breakdown voltage** of a material is not a definite value because it is a form of failure and there is a statistical probability whether the material will fail at a given voltage. When a value is given it is usually the mean breakdown voltage of a large sample. Another term is also withstanding voltage, where the probability of failure at a given voltage is so low it is considered that the material will not fail at this voltage.

B. Gas discharge (Air Lightning)

In standard conditions at atmospheric pressure, air serves as an excellent insulator, requiring the application of a significant voltage of 3.0 kV/m before breaking down (e.g., lightning, or sparking across plates of a capacitor, or the electrodes of a spark plug).

In a gas, the breakdown voltage can be determined by Paschen's law and in a partial vacuum is represented as:

$$\mathbf{V}_b = \frac{B\ p\ d}{\ln(A\ p\ d) - \ln[\ln(1 + \frac{1}{\gamma_{se}})]} \tag{2}$$

where $\mathbf{V}_b$ is the breakdown potential in volts DC, A is the saturation ionization in the gas at a particular E/ p (electric field/pressure), and B is related to the excitation and ionization energies, p represents the pressure of the surrounding gas, d represents the distance in centimetres between the electrodes, and γ_{se} represents the Secondary Electron Emission Coefficient.

As presented, the gas breakdown is a well-known and studied phenomena, but the Nature occurring disruption of Air, the air lightning is as today not fully understood, even if the earliest recorded observations of volcanic lightning are from Pliny the Younger, describing the eruption of Mount Vesuvius in 79 AD, "There was a most intense darkness rendered more appalling by the fitful gleam of torches at intervals obscured by the transient blaze of lightning."

C. Rock discharge (Earth Lightning)

Considering now the discharge in solid materials (Rocks), the father of the theories of dielectric breakdown in solids is Herbert Fröhlich, a German physicist who decided to engage himself in the physical understanding of phenomena like the dielectric breakdown which appeared at that time governed by empirical facts. The review 'Dielectric breakdown in solids' of 1939 [5] still remains a milestone for both scientific merit and clarity. We cannot help providing an extraction of his brilliant introduction below:

"Owing to its great technical importance, the dielectric breakdown in solids has for many years been a subject of experimental and theoretical investigations. Nevertheless, only in recent years has it been possible to come to a closer understanding of this phenomenon. It is the aim of this article to give an account of these recent developments. One of the most important results of recent

research has been the experimental proof of the existence of an intrinsic electric strength. This means that at a given temperature a maximum breakdown strength exists for each dielectric substance which is a constant of this substance, and which is obtained under ideal conditions (homogeneous field, uniform material without weak spots. etc.). Therefore, it should be, and has been, possible to calculate this intrinsic electric strength from simple physical constants of the material. In this Report we shall deal mainly with the intrinsic electric strength. There exists also a quite different type of breakdown, the so-called breakdown through thermal instability. This type of breakdown is of importance only in special conditions such as high temperature. We shall give only a very short account of the thermal breakdown, since several reports on it have been published already. In addition, there are the various complex forms of breakdown which occur in industrial insulation; but these, although of great engineering importance, usually reduce finally to one of the two fundamental types considered. The description of industrial breakdowns would be lengthy and is related to the properties of complicated substances. Since, also, there is an extensive engineering literature on the subject, it will not be treated here"

The two fundamental types of breakdown mentioned by Fröhlich are:

1. the electronic breakdown. With a sufficient energy (above a critical electric field) can cross the forbidden gap from the valency to the conduction band, eventually producing collisions with other electrons and leading to breakdown.

2. the avalanche breakdown. As in gases, with sufficient energy (above a critical field) conduction electrons gain enough energy to liberate electrons from the lattice atoms by collisions.

In both cases the breakdown permanently modifies the matter of the failing path.

Dealing with the phenomena that we are studying that is the breakdown over long distances in rock materials the electric field of a 'needle-to-plane' electrodes configuration at the needle tip can be characterized by the formula:

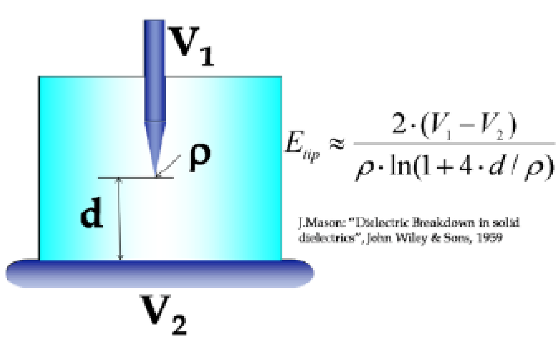

FIG. 10. Generic Electrical Field

In practice the electrical breakdown appears below, sometimes much below, the intrinsic limit of the materials involved (Rocks) due to potential conductive parts within and so directly affecting the dielectric strength.

A discharge that propagates within the earth would be referred to as 'treeing' because it could leave burned - or fern- like tracks on the insulator part. A "Treeing" in a block of Plexiglas. (Bert Hickman©) could be seen in the figure below. The paths left by high-voltage discharges can be quite beautiful.

FIG. 11. "Treeing" in a block of Plexiglas

The laboratory measurements of electrical properties of earth's forming rocks and minerals have played an important role in developing electrical and electromagnetic prospecting method of mineral exploration so dielectric constant has been tested for a lot of materials worldwide.

One especially important aspect of the earth lightning phenomena would be the lightning-induced remnant magnetization (LIRM). This is an effect studied in the case of air lightning knocking the terrain and has been documented in soil, rock, brick, and concrete in the vicinity of lightning strikes (Cox, 1961; Graham, 1961; Dunlop et al., 1984; Sakai et al., 1998; Verrier and Rochette, 2002). LIRM is an isothermal remnant magnetization that occurs within a few meters of a lightning strike.

The magnetic field created by the lightning discharge current can impart a secondary magnetization, overprinting the natural remnant magnetization (NRM) of the materials in the immediate vicinity. A lightning overprint is usually recognizable by its extreme intensity compared to the (Natural Remnant Magnetization) NRM that it replaces.

As a conclusion it comes as no shock that a potentially new type of volcanic lightning, an Earth Lightning could happen and had long time eluded scientists. Still, it is hard to say if the dielectric discharge presented here represents a new type of lightning. That is because lightning (basically any discharge of electricity) has no scientific definition. Indeed, any spark, from the static shock you get from touching a doorknob to the giant bolts that light up Jupiter's turbulent atmosphere, could be considered lightning.

V. TENERIFE EVENT

A. The Event

On 29th September 2019 at 13 hours:11 minutes:35.508 seconds an initial spiking signal was recorded at the Magnetotelluric station installed within the Teide Volcanic Caldera in "Las Cañadas". "Las Cañadas" caldera in Tenerife (Canary Islands) is a well-exposed caldera depression in which the active "Teide-Pico Viejo" complex stands.

This station was installed in the framework of the program VOLRISKMAC (MAC/3.5b/124) co-financed by European Union under Interreg MAC 2014-2020. The program has as principal research institution the "Instituto Vulcanological of Canarias (INVOLCAN)" and they have as partner the Barcelona University.

The registry of the station for the time lapse between 13:11:30 to 13:12:00 is shown below:

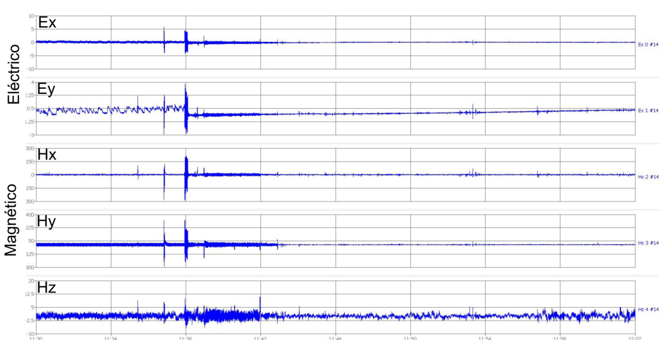

FIG. 12. Registry of Magnetotelluric Station

The first spike that involved the electric field component, E_y and its induced magnetic field components H_x and H_z , was followed by two other signals at 13:11:36.914 and 13:11:38 with full components of the Electrical and Magnetic fields. The signals were getting more powerful from the first, weakest, to the last, the strongest one.

Same day at 13:11:47.320 a first failure occurred in one of the power distributions bars of the Granadilla Power Plant followed by a second disastrous failure of the second bar at 13:11:48:406.

Granadilla power station is owned by Endesa (Unelco) and has two combined cycles. The first of them was inaugurated in 2006 while the second one in 2011. Granadilla power station reach a total of 743 Mw.

Distribution lines are at 66Kv and are managed by Red Electrica Española.

FIG. 13. Granadilla Power Station

From these signals and events, we can see a strong correlation between the second and third signals in the magnetotelluric instrument and the events that burn out the bars at the distribution centre of the power plant. We have in both cases a time difference of 1.086 seconds.

The Central as shown in the below map is located at 25,86 Km (16.07 mi) from "Las Cañadas", the location of the magnetotelluric instrument previously described.

FIG. 14. Tenerife map with distance between Magnetotelluric instrument and Power Plant

B. Event Explanation

Taking in consideration the phenomena described in the previous chapter we could inferred that a piezoelectric effect caused by a thermal instability deep in the volcano structure generated an extremely high electrical potential that was initially recorded in the surface (point approximate in the vertical) by the magnetotelluric instruments and later on, via the phenomena that we have described as an Earth Lightning, there was a knock out of the distribution park bars of the power plant.

Regarding numerical considerations and remembering the experimental data obtained at the Con Mine:

1. We have three signals of electrical disturbance separated by 1-1.5 sec, approximately, the first one very weak and the last two extraordinarily strong. Vibrational model of phonons in the three spatial axes travelling at different but coherent speeds would be responsive of these time differences. Considering the seismic waves (P and S) a special case for phonons (elastic ones) the difference of the speed between these waves in the transport tube material between the phonolitic chambers, and always talking in a rough approximation, is about 1,5 - 2 Km/s. So, a first result that we can obtain from the time difference of 1 sec between signals is that the source of phonons was located 4,5 - 6 Km deeper than the piezoelectric effect zone.

   This result is in accordance with the current observations, introduced in section II of the phonolitic chambers above and below the sea surface that would have been responsible for the effect.

2. Second result, and more significance, is the time of arrival to the power plant of the lightning. Taking in account the 10.406 sec delay between registries in the magneto telluric device and the failures at the power plant for the 25.86 Km distance between them, represents a "earth lightning" speed of 2.485 Km/s. If we remember the 2.7 Km/s obtained experimentally in the mine as the speed of the piezoelectric effect arrival to the measurement electrode, we are in a minus 10% conformance from this data.

3. The third result is linked to the necessary potential of the piezoelectric effect that could cause the accident at the power plant. In this case and by comparison with events that could be atmospherically comparable, the potential required at these distances (around 30 Km) must be >100 million volts. If now we remember the laboratory measurements for rocks and results that could fit with the phenolytic (SiO_2) we can roughly consider a generated electrical potential of 1 volt per bar of pressure and cubic decimetre. So, for a volume of 10x10x10 metres and 1000 bars, electrical potential is 10^9 volts. Well above the limit required for cause a big damage

VI. CONCLUSIONS AND FURTHER WORK

We have presented the event occurred at the Tenerife Island 29 September 2019 that caused a Zero energy situation and nearly a million people were left without electricity after a major power outage in Tenerife.

Till now any explanation for the event has been given and this paper advances a potential chain of phenomena that could solve this lack of explanation.

Further work must be done with the aim to.

1. Confirm the Earth lightning via magnetic measurements of the terrain near the Granadilla power plant.

2. Study historical series of events like the one studied in the Tenerife Island that are not explained as today and could be caused by the same phenomena.

3. Protect the power plants for future events of similar characteristics.

4. Develop deeper studies with the scientific community related to the new phenomena.

A. Disclaimer

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Appendix A: ELECTRON PHONON INTERACTIONS

The interaction Electron-Phonon is responsible for the superconductivity effects in metals and influences the transport properties in metals. In semiconductors and ionic solids electron-phonon interaction usually dominates transport properties. For the Electron-Phonon interaction and Quantum Mechanics treatment of the Piezoelectric effect you can read chapter 1 pages 26-36 of [10]. More developed theory is contemplated in chapter 7. There Fröhlich Hamiltonian is developed in pages 433-448.

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[7] By Piña-Varas et al 2018, used under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/). Without any change made to the figure.
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[9] The Con Mine (1938-2003) was the first gold mine developed in the Northwest Territories, Canada, just south of Yellowknife.[1] The property was staked by Consolidated Mining and Smelting Company of Canada (Cominco).
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