5. Earth Currents.

Between the magma cathode and the atmosphere the thermionic electric charges have to move through either the ocean, or the continental plates. In chapter 2 I discussed the passage of the charges through the ocean. In this chapter I discuss observations related to the movements through the crustal rock of the continents. This rock, apart from metallic veins in it, electrically belongs to the semiconductors. This means that it does conduct electricity, although to a lesser degree than a metal does. Rock differs from metals only quantitatively, the ratio of conductivity is a finite number however large, about 20 orders in magnitude. However, the difference between the ocean's water and the continents' rock is qualitative: the water conducts the positive ions while the rock does not conduct them at all. Physically an ion is just as large as a molecule, except that one or more of its outermost electrons are missing from their orbits as a result of ionization. Among the molecules of the solid crystallic rock there is no space for a molecule-size ion to move through, not even slowly. In the rock free electrons move only. However, rock has an important property which exists only to a small degree in water, and to a very small degree in metals; the ability to store electrons to a length of time. This property is actually the result of the slow propagation velocity of the electrons through the rock. An electron entering the crust at the magma surface spends a long time, possible several days, before it emerges on the surface and enters the atmosphere. In the ocean it is a few minutes, and in metal of the same thickness it would be about 15 microseconds.

The slow velocity of electrons in the crust in the vertical direction is also a slow spreading in the horizontal direction when there is a force for it. This is one of the factors which allows the first investigations into this matter. When the electron density is influenced in the crust by electric forces in the environment, the influence spreads over large areas, but it does not get equalized quickly with the uninfluenced areas. This slow equalization allows a potential gradient to develop which can be easily measured. Actually these gradients have been investigated for many years as "earth currents" (without finding an explanation for their existence). I present here an analysis of the phenomenon which shows that the earth currents are an integral part of the Earth's electric system.

Another factor which allows investigation into this matter is that free electrons in the crustal rock behave as a liquid in a conduit. The mutual repulsion force between the electrons is the same concept as the "hydrostatic pressure" in the liquid which results in a pressure acting evenly in all directions. For the electrons, this could be called "electrostatic pressure". The electrons in the crust are in a constant move as they flow outward. This, however, is not a free flow, the molecular density of the rock controls it. A controlled flow of liquids is described by Bernoulli's law which states that the total pressure in the system must be constant, and this value is the sum of the static and the dynamic pressures:

$$P = P_S + P_D$$

where

$$P_D = \frac{1}{2} \rho v^2$$

ρ is the density of the liquid, and v is its velocity. According to this equation the static pressure decreases and the dynamic pressure increases in a pipeline where the liquid goes through a constricted section. The decreased static pressure results in suction in an opening on the wall of the pipeline at the constricted section (Figure 5-1). This design is known as the Venturi tube, and is used, among others, in carburators and in flowmeters.

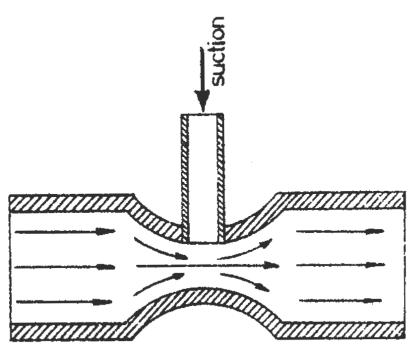

Figure 5-1

Vertical earth currents have been observed in the crust. A scientific encyclopedia summarizes and comments these:

> "Vertical Earth currents. This term is used to denote a phenomenon observed chiefly in mountains. According to one interpretation electric currents flow in the Earth from all sides of a mountain toward the top. No plausible explanation for such a phenomenon has been proposed, and consequently it has the attraction of a mystery. It is known that when two probes with the connecting wire are set along the slope of a mountain, current usually flows in the wire from the lower toward the higher point... The potential decreases with altitude at a rate of 0.2 volt/km change of altitude." [28]

The vertical Earth currents are the result of the Bernoulli effect on the upward flowing electrons in the crust where the molecular density decreases with the elevation. The molecular density is a measure of the constriction against the flow of electrons in the crust. In a mountain this constriction varies along the slope in such a way that at any point it is greater than at a point above it. Therefore, there is a differential constriction between any two points along the slope. Thus, it can be said that at the lower point the electron flow is constricted by the rock's increased density. According to Bernoulli's principle a negative pressure (suction) develops in the flowing liquid, in the electron field in this case, at the constricted section of the conductor. The negative pressure is lack of electrons, that is, a positive polarity. When this section is connected by a conductor to a section above, an electron flow results from the upper section to the lower one. According to definition the direction of current is opposite to the direction of electron flow, thus the current flows in the wire from the lower toward the higher point. The weight of the mass rapidly (non-linearly) decreases with elevation because of the usually conical shape of mountains. Thus the potential (difference) decreases with altitude.

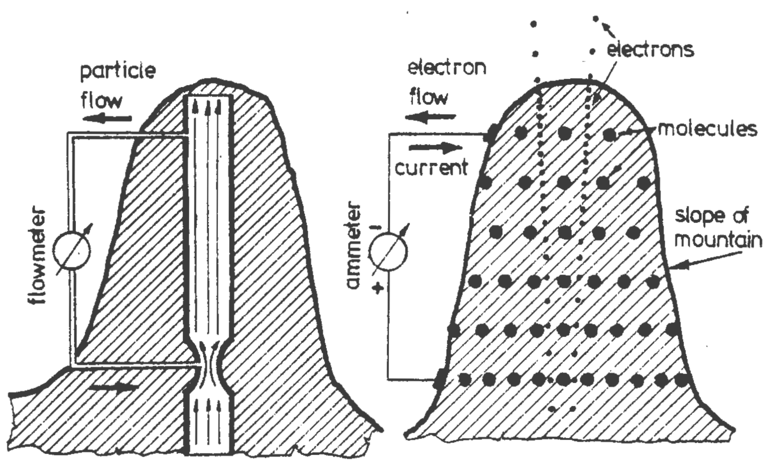

Figure 5-2

Figure 5-2 illustrates the application of Bernoulli's principle to a flowmeter in a vertically upward flowing liquid or gas in a pipeline, and its equivalent electric version for the vertically upward flowing electrons in a mountain where the molecule densities are shown by the varying horizontal distances between molecules at different elevations. The large dots are molecules of the rock, the small dots are emission electrons. The same amount of electrons move through the narrow gaps of molecules at the lower point than through the wider openings above, thus their velocity is faster, their static pressure is lower at the lower point than above. In both cases particles of the flowing matter flow from the upper to the lower point in the external bypass.

The most significant conclusion from this mechanism of the vertical Earth currents is that the crustal free electrons must be in the state of constant move in order to produce the Bernoulli effect. A "static charge" would not produce a permanent current in the wire between the electrodes. The electrodes with an ammeter in the connecting wire is an electric Venturi flowmeter which measures the thermionic electron emission of the Earth's magma cathode.

In its basic operation the ammeter indicates a current which is proportional to the electron emission of the magma cathode in that area. In its actual operation many other factors influence this current. These factors can be grouped into two parts. In one, there are the physical factors. The rock's molecular density depends on its chemical composition, thus it is different for granite than for dolomite, for example. It depends also on the shape of the mountain since the density at any point is influenced by the weight of the mass above. A sentence in the above quoted observation implies this:

> "This gradient has the same direction and has two-fifths the magnitude of that derived from the direct measurements of Earth potentials made in the mountains of Europe."[28]

In the second group there are the electric factors. The crustal free electrons can be influenced by electric forces, like Coulomb's repulsion force from a concentration of free electrons in the Earth's environment. The most impressive phenomena of this type are the horizontal Earth currents. They have been observed for more than 100 years by world-wide networks. Nevertheless, similarly to the vertical Earth currents, no plausible explanation had been proposed, and the large scale observations were abandoned in the 1940-s. I quote again the scientific encyclopedia:

> "Discovery of Earth currents. Soon after the first commercial telegraph came into use (1844), there appeared at times strange electric currents which intruded on the telegraph lines and occasionally interfered with the sending of messages. Because a single line was used which, when in operation, was connected to Earth at both ends, an additional channel was offered for the electric currents of the Earth. Close observation of the currents in lines of the British telegraph system led W.H. Barlow to conclude in 1847 that such currents come from the Earth and may be detected at any time but are usually not intense enough to interfere with the telegraph service."[28]

The most expressive representation of Earth currents is a hodogram (Figure 5-3). A typical recording apparatus [30] has three electrodes: one comon electrode (0), one electrode (W) at 90 km to the east of 0, and one electrode (M) at 60 km to the north. The potential difference is measured by galvanometers, between 0-W and between 0-M. Conventionally, the signs of the voltage gradients are such that flow of current toward the north or east is positive and flow toward the south or west is negative. In other words, a positive sign indicates that electrode 0 was positive with reference to electrode M or W as the case may be. The hodogram is formed by joining points which mark the successive positions of the end of the vectors defining the magnitude and direction of the potential gradient, for each hour of the day.

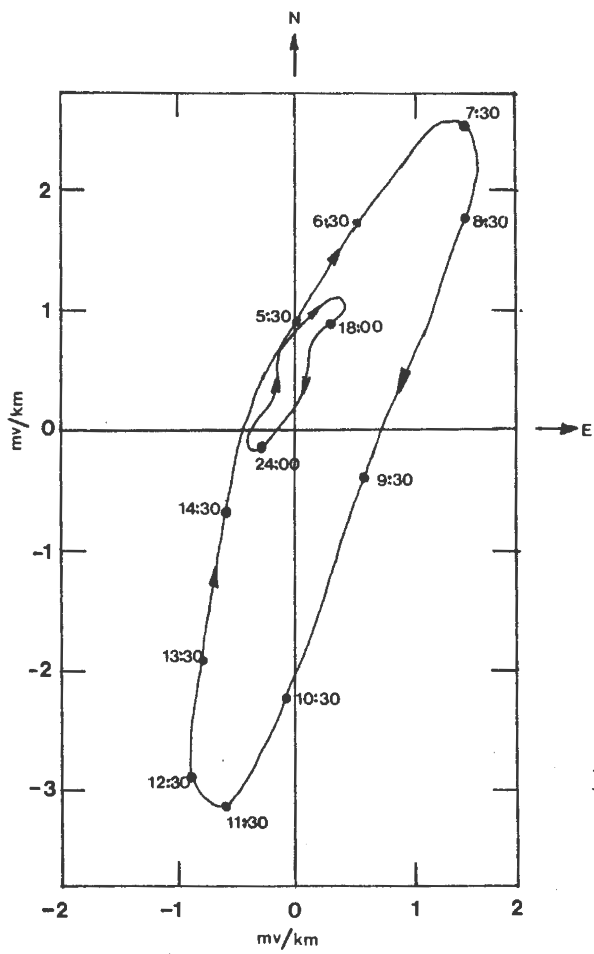

Figure 5-3

A diurnal hodogram is always a double loop, a large one for the daytime and a small one for the night-time. The voltages indicated are positive and increasing between both pairs of electrodes (0-W and 0-M) from 5:30 hours (Figure 5-3). At 7:30 hours both voltages reach their maximum values and start falling back. Voltage 0-W becomes zero at 10:25 and negative afterwards. Around 12:00 hours both are maximum negative. At 15:00 hours 0-M is zero again, and so is 0-W at 15:20. The hodogram turns now to the small loop. From 15:20 at first it runs close to the large loop, but later it deviates more and more. At 16:30 both voltages reach a small maximum and then turn back. At 24:00 hours they are at a small negative maximum. In the early morning hours the small loop approaches the large loop and at 5:30 it crosses it, and the voltage continues again on the large loop.

The horizontal Earth currents can be explained in the terms of piezoelectricity and electrostriction, together with an electric repulsion force which is coming from the direction of the Sun. I do not discuss here the possible origin of this force. I only tentatively assume that this is a free-electron concentration at the subsolar point of the magnetosphere. This charge concentration exerts a repulsion force on the thermionic free electrons still in the crust, and because of the very low propagation speed of the electrons here, the force transfers to the crustal shell of the crust. This force transfer is similar to that which exists between the wind and the sail of a sailboat. One can say that the propagation velocity of air molecules in the canvas of the sail is very low (in comparison to that in the atmosphere), therefore the force which drives the air molecules transfers to the sail. However, in the case of the sail this force acts only on the surface of the canvas. But in the case of the Earth the force acts throughout the entire volume of the crust because the rock, as a dielectric, is transparent to the repulsion force which then reaches all free electrons in it.

There are observable effects of this force on the crust. One is an electric phenomenon: electrification by the mechanical stress through electrostriction. This is observed as horizontal Earth currents. The other is a mechanical effect: tides, including both the earth tides and the ocean tides. (The tides caused by the Moon is opposite in sign: it is an attraction by gravitation). While the solid crust is transparent to the electric repulsion force, a solid metal is not, because an electric mirror-image of the force develops on its surface which counteracts the original force. Ionized matter behaves similarly in this respect to metals. However, if the degree of ionization is low, and the extent of ionization is limited (it is a thin layer, for example), ionized matter can be partially transparent (opaque) to the electric force. In other words, the electric force can act through such ionized matter at the cost of attenuation. The Earth's interior is partially molten, thus it is ionized to some degree. However, its extent must be seriously limited because the repulsion force from the direction of the Sun does act on the crustal shell on the night side with only a small attenuation. Both the related electrification and the tidal phenomena are observable there.

The force on the night side acts from inside, thus the crustal shell is loaded from the concave side. The strength of a shell structure is very limited from the concave side, and it tends to break first at its apex. In the case of the Earth this is the midnight point. This is why supernova storms have their maximum frequency of outbursts at midnight as I discussed it in Chapter 2. The force on the crust on the day side is from the outside, thus the crustal shell is loaded from the convex side. The strength of a shall structure is maximum from the convex side, and it tends to break last at its apex. Therefore, the supernova storms have a minimum frequency of outbursts at noon. Actually the ebb of the tide on the day side is not only a reflux of the ocean and the ground to their uninfluenced positions. The electric repulsion force is active downward, into the Earth, thus it is a compression. This makes the crust and the ocean floor stronger against forces from the interior, especially around the noonpoint, by pre-stressing in the opposite direction. The ocean floor and the continental crust are in non-stressed, or uninfluenced state on the morning and evening sides, around the 6:00 and 18:00 hours points. Figure 5-4 illustrates the stress states of the crustal shell.

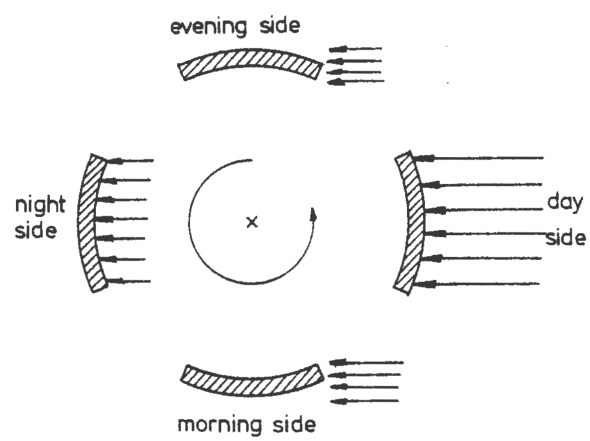

Figure 5-4

Electrification is another manifestation of the stress in the crust. I quote the description of piezoelectricity and electrostriction:

> "Piezoelectricity. Electricity, or electric polarity, resulting from the application of mechanical pressure on a dielectric crystal. The application of a mechanical stress produces in certain dielectric (electrically nonconducting) crystals an electric polarization (electric dipole moment per cubic meter) which is proportional to this stress. If the crystal is isolated, this polarization manifests itself as a voltage across the crystal, and if the crystal is short-circuited, a flow of charge can be observed during loading. Conversely, application of voltage between certain faces of the crystal produces a mechanical distortion of the

material. This reciprocal relationship is referred to as the piezoelectric effect. The phenomenon of generation of voltage under mechanical stress is referred to as the direct piezoelectric effect, and the mechanical strain produced in the crystal under electric stress is called the converse piezoelectric effect.

Piezoelectric materials are used extensively in transducers for converting a mechanical strain into an electric signal. Such devices include microphones, phonograph pickups, vibration-sensing elements, and the like. The converse effect, in which a mechanical output is derived from an electric signal input, is also widely used in such devices as sonic and ultrasonic transducers, headphones, loudspeakers, and cutting heads for disk recording...

The converse piezoelectric effect is a thermodynamic consequence of the direct piezoelectric effect. When a polarization P is induced in a piezoelectric crystal by an externally applied electric field E, the crystal suffers a small strain S which is proportional to the polarization P. In crystals with a normal dielectric behavior, the polarization P is proportional to the electric field E, and hence the strain is proportional to this field E. Superposed upon the piezoelectric strain S is a much smaller strain which is proportional to P^2 (or E^2). This strain is called the electrostrictive strain. It is present in any dielectric." [31]

"Electrostrictive transducer. The electrostrictive or ceramic transducer consists of a ceramic element having electrostrictive properties. A deformation of the ceramic leads to the generation of a voltage corresponding to the amplitude of the deformation (Figure 5-5). The impedance of

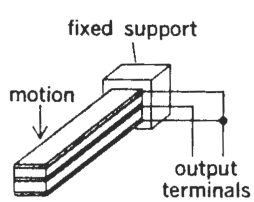

Figure 5-5

this type is due to the capacitance of the ceramic. When the electrostrictive transducer is connected to a load it may be considered to consist of the open-circuit voltage, the capacitance of the ceramic, and the electrical impedance of the load, all connected series. The ceramic transducer is reversible." [32]

In the Earth's crust mechanical deformation, earth tide, results in electrostrictive voltages. These voltages are picked up by the electrodes of a hodograph. The current which develops in the connecting wires is called the horizontal Earth current. The voltage at any point on the crust is a function of the rotation of the Earth with respect to the Sun. The hodogram of Figure 5-3 can be reduced to its eastward and northward components (Figure 5-6). Both graphs are of the same form. The graphs show negative peak voltages exactly at noon and midnight, and positive peak voltages at sunrise and sunset. The graphs are typical sinusoid waveforms of an alternating current (ac) with an attenuation between the day time and the night time part of it. Actually, for a person trained in electricity the hodograph itself appears as a Lissajous display on an oscilloscope, used to measure phase angles between two ac waveforms. Indeed, the crustal shell acts as an ac generator as it rotates with respect to a fixed force which exerts pressure on a limited area.

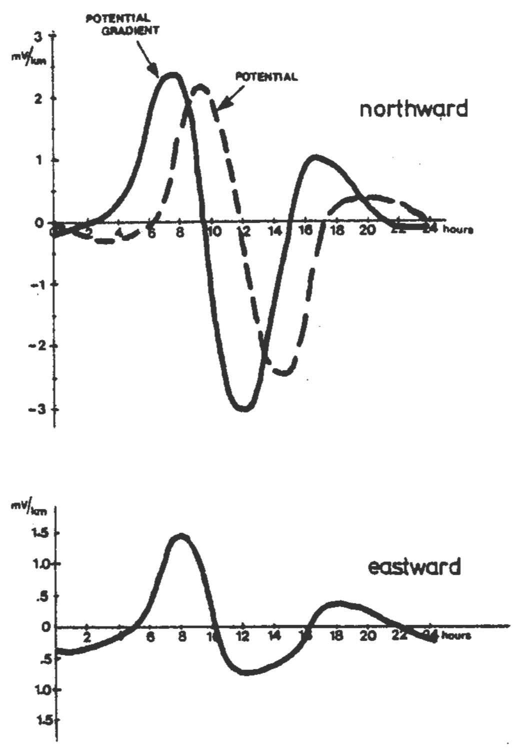

Figure 5-6

The word "polarization" in the description of piezoelectricity does not explain the phenomenon itself. It is literally a superficial description of the fact that upon a differential pressure a voltage with a positive - negative pair of polarity appears on the surface of a dielectric. There has been a vague attempt to explain the phenomenon by an assumed deformation of the electron orbits of the atoms in the dielectric. The mean position of all orbital electrons were supposed to move closer to the area which became negative, and the positive nuclei closer to the area which became positive. Also, no free electrons were supposed to be present in dielectrics. However, with the discovery of the transistor it became known that free electrons are present in semiconductors, and all dielectrics are semiconductors. This present theory explains polarization by the differential free-electron density as a result of differential pressure on the dielectric. As I calculate in the next chapter, a very little electron density is required to be present in the crust to account for all major electric effects in geophysics: only one free electron for each 10^{12} neutral atoms. In a uniform density crust the electrons are uniformly distributed. (More precisely, the electron distribution is centrally symmetrical. The distribution is not necessarily uniform radially, but this is irrelevant here). However, when pressure is applied at some place on the crust (which is both a dielectric and a semiconductor), the rock's density increases and an amount of free electrons are squeezed out from the compressed volume. Thus an electrode near to the surface in the crust indicates a different charge density with respect to another electrode where less or no pressure is applied.

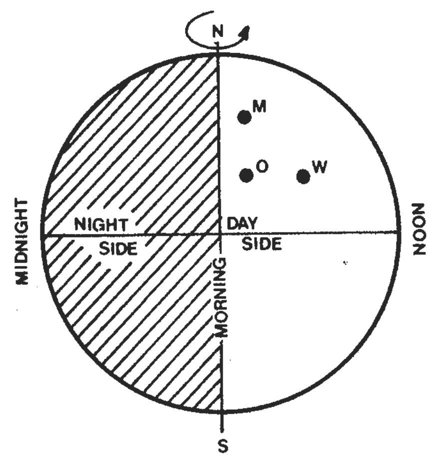

Figure 5-7

Figure 5-7 illustrates the electrode arrangement on the globe. Electrodes O-W are parallel with the equator, thus before noon W is closer to the noon meridian than O. The electrodes are very close together with respect to the Earth's dimensions, thus the voltage they measure is actually the time-differential (dE/dt) of the crust's electric potenital E, as the electrodes move ahead at constant velocity with respect to the stress-pattern on the crust, where this pattern is fixed in the solar space. The potential of the crust is the mathematical integral of the time differential. Since this latter one is basically a sinus function, Sin at, its integral is -(Cos at)/a. Figure 5-8 illustrates the eastward component of the potential gradient in a slightly idealized form, together with its integral, the potential.

The polarity of the crust's electric potential is in a direct relationship with the electric repulsion force coming from the direction of the Sun. From midnight till sunrise it is negative, and from sunrise till noon it is positive. This polarity appears to be reversing at noon. However, this is only an artifact stemming from the way the measurement is being implemented. We rotate the electrodes with the Earth, thus their orientation with respect to the Sun reverses 180° at noon and at midnight. Before noon W is closer 0 is farther, after noon 0 is closer and W is farther from the Sun. If we were carrying out the measurement from an aircraft touching down only momentarily to take samples of the voltage at different locations around the Earth, we could orient the electrodes always in the

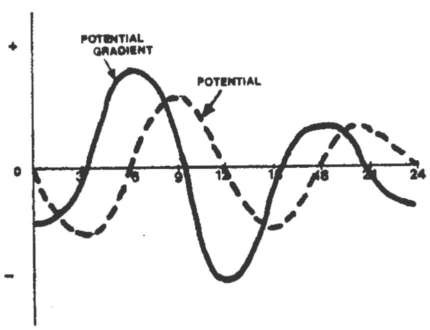

Figure 5-8

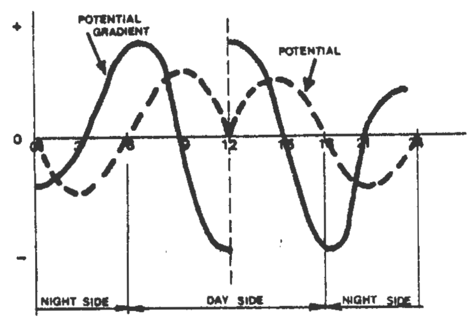

Figure 5-9

direction of the electric force, placing the same electrode always towards the Sun. Of course, we also can reverse the polarity on the present measurements at noon and at midnight which is equivalent to that of reversing the electrodes. Figure 5-9 shows this results for the potential and for the potential gradient. The conclusion is that the potential is positive on the entire sunlit side, and negative on the entire night side of the Earth. The reason for these opposite polarites is that the repulsion force acts on a convex shell on the dayside, causing a compression, and it acts on a concave shell on the night side, causing an expansion in the rock's density in accordance with Figure 5-4.

Consequently, the influence on the electron densities are also opposite on the two sides. One might think that the opposite polarities result from a pressure on the day side, and from the absence of the pressure on the night side. However, the hodogram and its eastward and northward components clearly indicate that the process is active on the night side at a voltage level with about 1:5 attenuation with respect to the day side.

The potential and its gradient also indicate the mechanical stress within the crustal shell in accordance with purely mechanical considerations. The stress has four maxima, indicated by the four maximum values in the electric potential gradient. At the 6:00 and 18:00 hour points there are shearing stresses locally upward before 6:00 and after 18:00 hours, and downward after 6:00 and before 18:00. At 12:00 hours the stress is a downward compression, but it has a morning-ward component before, and an evening-ward component after noon. This stress causes a dent of depression symmetrically around 12:00 hours. At midnight it is an upward expansion causing a bulge or protrusion of the surface symmetrically around the 24:00 hours meridian.

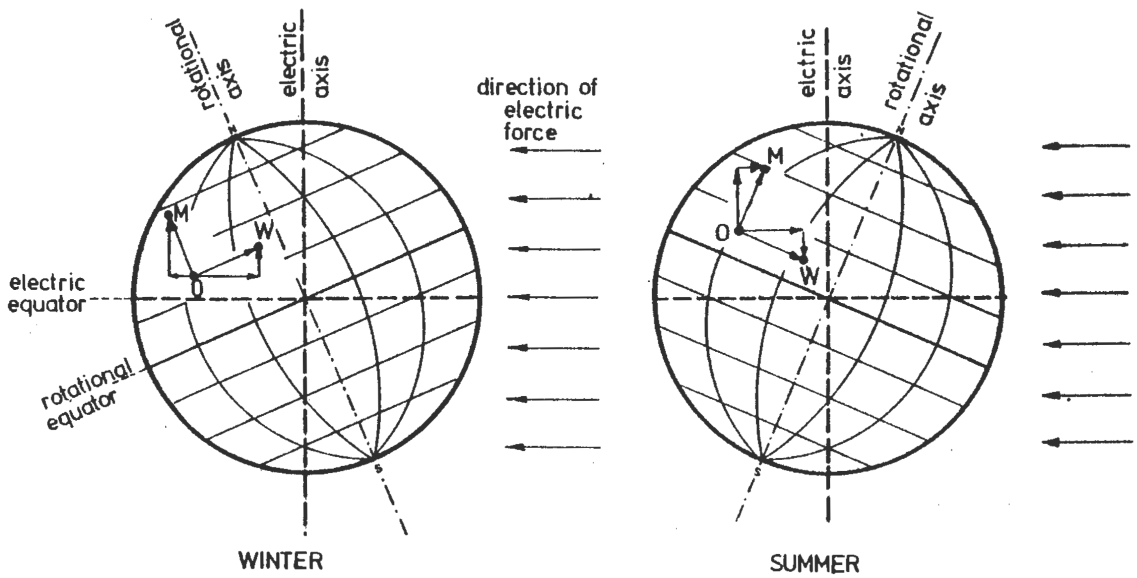

Figure 5-10

If the Earth were rotating always exactly in the plane of its orbit around the Sun, the northward component of its hodogram would be significantly smaller but not zero. In this case the northward component would be generated by the differential stress alone which exists along the meridians. In the extreme case electrode M would be at the north pole, 0 on the equator, and the electrostrictive voltage would be the result of the changing stress on the equatorial crust alone since the stress is not changing at the north pole. In the general case when the electrodes are much closer together somewhere along a meridian, the generated voltage is the difference between the larger potential at electrode 0 and the smaller potential at M.

A much larger voltage is generated on the 0-M electrodes by the fact that the Earth's plane of rotation is off (by 23.5°) from the plane of its orbit, and this produces a large eastward component in it.

Furthermore, the orientation of this rotation is continuously changing over a year. Figure 5-10 illustrates this geometry, and indicates that the frame of reference of the voltages is fixed in the solar plane. In this frame an "electric axis" and an "electric equator" can be defined, and the Earth's rotational axis describes a cone around the electric axis over a year. The extreme cases of the voltage vectors are illustrated on the winter and summer positions. The large eastward component on the O-M voltage, and the large northward component on the O-W voltage cause the two voltages to behave nearly identically.

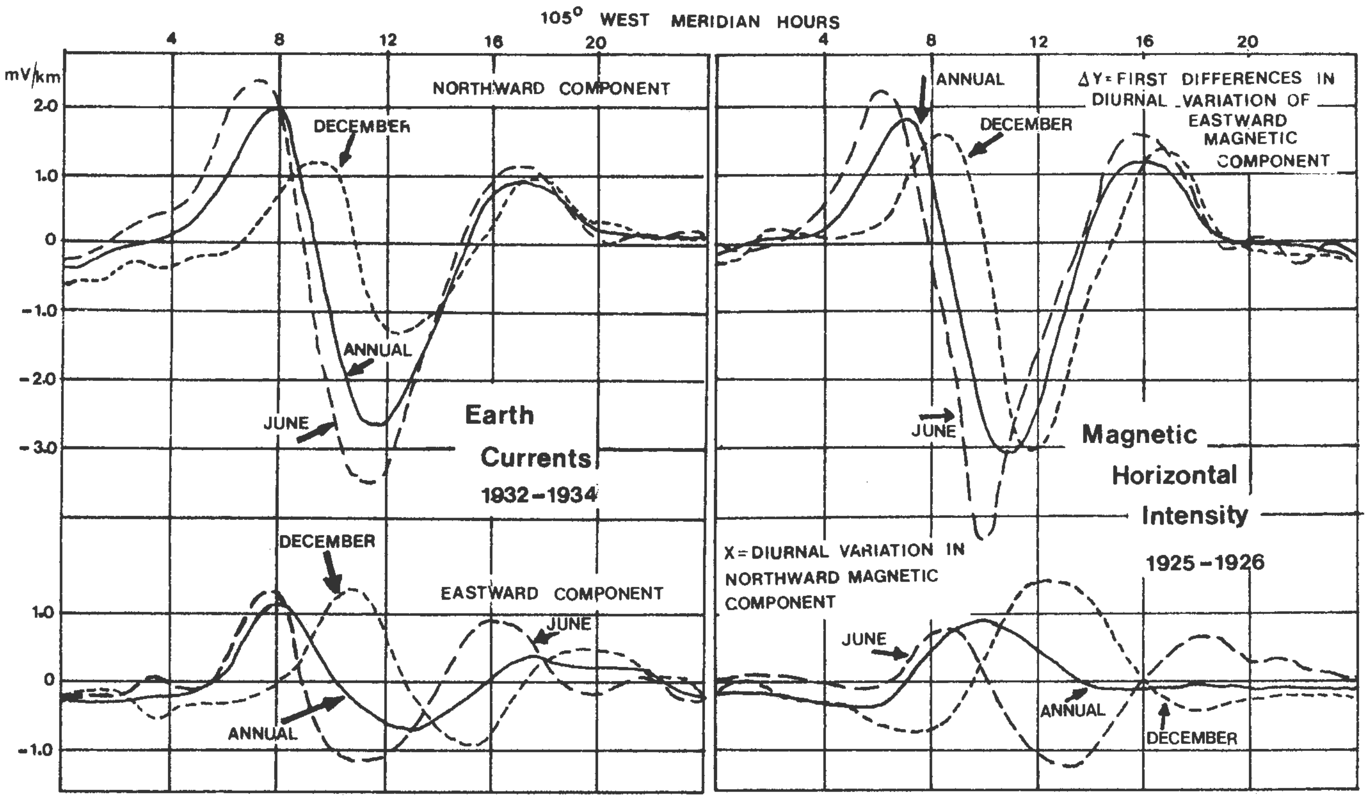

Figure 5-11

The crust's electron content is a source of many other major electric phenomena, thus changes in the electron density show up in them. For example, the geomagnetic field is generated (according to this theory) by the co-rotation of the crustal electrons with the Earth. Thus, changes in the Earth currents result in simultaneous changes in the intensity of the geomagnetic field. Figure 5-11 is the "Calm day diurnal variation in June and December at Tucson Magnetic Observatory, showing parallel changes in earth-current potential gradient and magnetic horizontal intensity." [30]

Solar acitivities, flares, also show up in Earth current data, as well as in geomagnetic data. This is a more involved phenomenon, but I attempt here a short explanation. The Earth's magnetosphere is generated by the Earth's thermionic emission as it fills a volume of the space around the Earth with these charges. The charges have a radial velocity (modified by the deflecting action of the geomagnetic field). The Sun is also producing a thermionic charge emission, called solar wind or solar plasma. The Earth's plasma appears as a bubble in the vast field of the solar plasma. The boundary between the two plasmas is where the kinetic energies of the two plasmas are zero by cancelling their velocities in collisions.

The radius of this bubble is about 10 Earth-radius in the direction of the Sun where these particles move toward one another. The radius is rapidly increasing to infinity on the night side, towards midnight, because instead of colliding, the terrestrial particles merge into the solar wind showing no definite border, the velocities do not cancel in collisions. Thus the size of the bubble is determined by both the intensity of the solar emission and by that of the terrestrial emission. When either of them changes, the size of the bubble changes. When the Earth's emission increases, the size of the bubble grows, but this has a negligible effect on the Sun, even though the output impedance of the solar generator, that is, the impedance of its environment, changes.

However, when the solar output changes, it has a greater effect on the terrestrial generator. An increase in the solar output increases the velocity of the solar wind, that is, the kinetic energy of these particles increases. This results in the decrease of the size of the magnetospheric bubble because the more powerful solar wind compresses it to a smaller size, increases its internal pressure, and the cancellation of kinetic energies take place at greater velocities. The increased pressure in the Earth's plasma spreads in its entire volume, thus it reaches the crust, too.

The increased pressure results in a changing electron density, consequently, this change shows up in the Earth-current data. This mechanism also explains the duality of the phenomenon in which all solar outbursts and sunspot activity influence the Earth currents as a magnetic storm, but not all magnetic storms has a counterpart in solar activity. It is a fact that while both the magma cathode and the solar surface are active and varying thermionic cathodes, the Earth-current electrodes sense the changes of both, but changes in the terrestrial emission obviously do not cause visible disturbance on the surface of the Sun.

The interaction between the solar plasma (solar wind) and the terrestrial plasma (the Earth's cathode emission) manifests that these substances are of the same kind, only their sources are different. The terrestrial plasma also appears to be different, especially in the lower atmosphere, because it is diluted, mixed, with the air. This plasma is further affected in the crust which acts as a filter by separating the positive and negative charges. In contrast, the atmosphere allows the concentration of the positive charges (in the form of the cyclonic storms) and also the negative ones (anticyclones). These features make the terrestrial plasma look different to the more uniformly acting solar wind. Nevertheless, the terrestrial plasma carries all the necessary features which qualify plasmas: The presence of positive and negative charges in equal quantity on macroscopic scales.

It appears to me that we have not recognized the presence of this plasma here because we live in it, and on human scales the charge separations are far too great. Furthermore, the speed and movements of this plasma on the Earth is much more complicated than those of the solar wind which spreads radially at hundreds of kilometres per second. This speed in the atmosphere is thousands times less, and in the crust it is millions times less. The direction of the charge movement in the atmosphere (and in the crust) has an eastward component for the negative charges, and a westward component for the positive ones, but both converge towards the poles where they move upward in narrow channels. Even here the overall linear movement is veiled by the frequent collisions between the slow and fast particles which result in a rain of scatter in all possible directions. No wonder meteorologists have failed to see the macroscopically radial and constant electric charge emission of the Earth.

The interaction between the solar and terrestrial plasmas, and the appearance of solar activity in the Earth currents manifest that these plasmas are a medium in which the propagation of the activity itself takes place. The two plasmas are a single medium in spite of their two sources. In this medium the activity propagates, not an information about it, as in radio waves, for example. Thus, when the overall intensity of the Sun increases, the energy content of the solar plasma increases, and this extra level of energy travels with the velocity of the plasma to the boundary of the magnetosphere. Here it enters the terrestrial plasma, and travels down to the magma cathode. On its way this energy increase enters the crust, too, and alters its electron density which is indicated by the changing Earth currents.

However, the soil, the cropland, is also part of the crust. A remarkable conclusion can be drawn here. It has been observed that certain aspects of the agricultural yield show a correlation with the 11-year solar cycle, and especially with the sunspot activity. My conclusion is that the soil's electron density directly affects these aspects of the yield. Since the density of the electrons can be influenced not only by the Sun, but also by the magma cathode, it would be possible to artifically influence it, locally, for the benefit of the yield.

The orbiting Moon around the Earth is also causing variations in the Earth-current potentials, and in the geomagnetic field. The variations in the northward and eastward components, and in the resulting hodogram are very similar to those of solar origin, when the lunar variations are displayed in lunar hours (Figure 5-12). However, there are two important differences. One is, that the amplitude of the lunar Earth-currents is only 20% of the solar one. The other is that the night time amplitude of the lunar variation is of the same value as its daytime amplitude. These indicate that the mechanism by which the Moon affects the Earth's crustal shell on the night side, through the bulk of the Earth, is not attenuated by the ionized magma layer of the interior. This means that the mechanism is not electrical. Considering the closeness of the Moon, the mechanism should be gravitational.

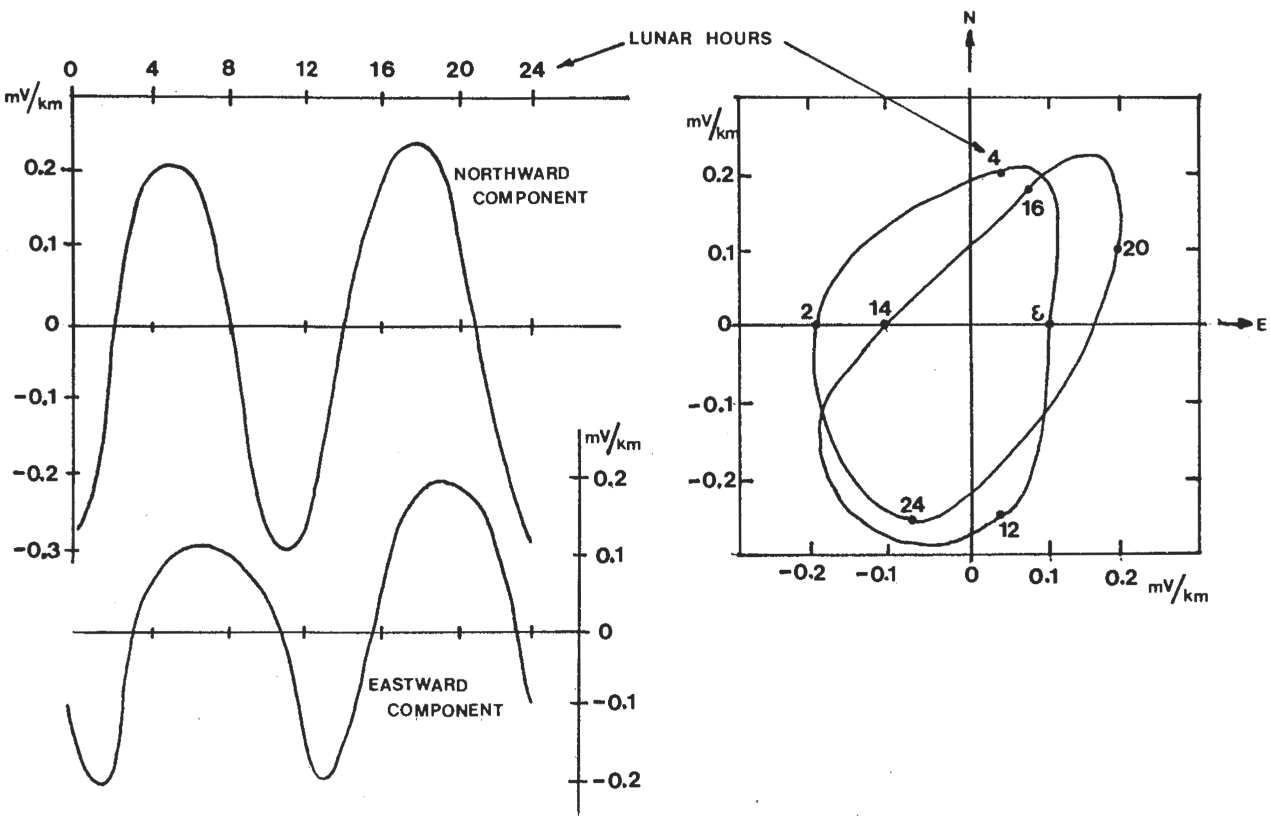

Figure 5-12

Gravitational attraction acts in the opposite direction to the electrical repulsion, thus its effect is that its force subtracts from the solar force during new moon at noon, and adds to it during full moon at midnight. These two cases are the extremes in the angular directions between the two forces. Generally, they add vectorially where the angle varies between them in three dimensions because the plane of the Moon's orbit, the Earth's plane of rotation, and the Earth's orbital plane are differently oriented. This leads to a rather complicated relationship. The opposite directions of these forces, and the difference in their attenuation through the Earth of course have not been taken into account in the theories of the tides of the ocean. This is why these theories do not explain, and do not predict these tides correctly.

The existence of Earth currents in the view of the above described explanation is a significant evidence for the thermionic charge emission of the Earth's cathode. The electric potential gradient of the crust manifests that the crust is infused by free electrons. This discovery immediately warrants an investigation on other possible effects of the crustal free electrons. I investigate its magnetic effect in the next chapter because this makes it possible to establish a numerical value for the electron density in the crust.

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