Stable motion Path of airborne charged Particles by large Charges on the Earth's surface （ Formation of two type Seismic Clouds ）

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Introduction

Phenomena that occur before an earthquake : 1) Ground elevation, horizontal distortion, and inclination 2) Abnormalities in seismic activity (foreshocks, blank areas, etc.) and changes in seismic activity areas 3) Changes in seismic wave velocity 4) Changes in geomagnetism, ground current, electric field, and electrical resistance 5) Changes in well water (spring water volume, pollution, fine sand contamination, etc.) and changes in the amount of spring water in tunnels 6) Changes in radon concentration and chlorine content in groundwater 7) Abnormalities and luminescence phenomena of electromagnetic radiation 8) Abnormal behavior of animals, birds and beasts, and insects 9) Celestial conditions (temperature, pressure, weather, tides, soil pressure, water pressure, rainfall, etc.) It seems that events such as are occurring.[1] [2]

As a factor in luminescence phenomena and changes in geomagnetism, ground current, and electric fields, which are precursors to large-scale earthquakes, a mechanism has been proposed in which a free charge is generated in the crust when pressure is applied to the bedrock of the earth's crust, which appears on the ground surface and generates a ground surface charge, which also has an electrical impact on the sky. [3] [4] [5] Thus, it is clear that a large charge on the earth's surface exerts a Coulomb force on charged particles suspended in the air, and the stable motion path of airborne charged particles (water vapor) is elucidated based on the principle of minimum mechanical energy, and the formation of seismic clouds is studied.

1. Coulomb force of point charge

1-1. Equations of motion of charged particles

The earth's surface is defined as the x-y plane, the downwind direction of the horizontal wind is the x axis, the vertical direction is the z axis, the coordinates of the particles is (x, y, z), the wind speed is $(V_x,\ 0, V_z)$, there is a large charge Q' at coordinate origin, and the charge of the airborne charged particles is defined q . The equations of motion in the x,y,z directions of a charged particle taking into account the inertial force, viscous drag, Coulomb force, gravity and buoyancy acting on relative motion particles in the air flow are as follows.

However, the viscous drag D of air is expressed as proportional to $\mathbf{v}^{\mathrm{n}}$ or $f(\mathbf{v})$ here, because there are Stokes' law D= $3\pi\mu\,\mathbf{v}\,\mathrm{d}$, which holds for the small Reynolds number（Re= v d/ν） of the particle and the fluid drag D=$C_D \cdot 1/2\rho\,\mathbf{v}^2$A. (The drag coefficient C_D depends on Re. Fig. 1). Note that the induced mass of an object moving at an accelerated motion in a fluid is ignored.

$$m\frac{d}{dt}\left(\frac{dx}{dt}-V_x(z)\right)+\ C(z)\left(\frac{dx}{dt}-V_x(z)\right)^n+\frac{Q'q}{4\pi\varepsilon_o\varepsilon_r}\cdot\frac{\partial}{\partial x}\left[\frac{1}{\sqrt{x^2+y^2+z^2}}\right]=0$$

$$m\frac{d^2y}{dt^2}+C(z)\left(\frac{dy}{dt}\right)^n+\frac{Q'q}{4\pi\varepsilon_o\varepsilon_r}\cdot\frac{\partial}{\partial y}\left[\frac{1}{\sqrt{x^2+y^2+z^2}}\right]=0$$

$$m\frac{d}{dt}\left(\frac{dz}{dt}-V_z(z)\right)+\ C(z)\left(\frac{dz}{dt}-V_z(z)\right)^n+\left(m-\frac{4\pi r^3\rho(z)}{3}\right)g+\frac{Q'q}{4\pi\varepsilon_o\varepsilon_r}\cdot\frac{\partial}{\partial z}\left[\frac{1}{\sqrt{x^2+y^2+z^2}}\right]=0$$

If the symbol is simplified as follows, the equations of motion in the direction x, y, z are (Eq. 1) ~ (Eq. 3).

$$Q = \frac{Q' q}{4\pi\varepsilon_0\varepsilon_r}, \quad G(z) = \left(m - \frac{4\pi r^3 \rho(z)}{3}\right) g \ , \quad R = \sqrt{x^2 + y^2 + z^2}$$

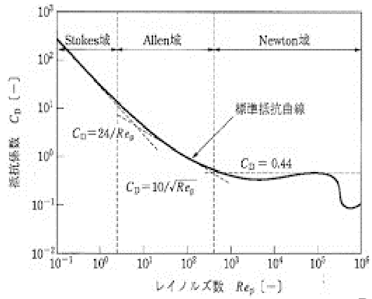


Fig. 1 Drag coefficient of sphere Re

(1) $$m\frac{d}{dt}\left(\frac{dx}{dt} - V_x(z)\right) + C(z)\left(\frac{dx}{dt} - V_x(z)\right)^n - Q \cdot \frac{x}{R^3} = 0$$

(2) $$m\frac{d^2 y}{dt^2} + C(z)\left(\frac{dy}{dt}\right)^n - Q \cdot \frac{y}{R^3} = 0$$

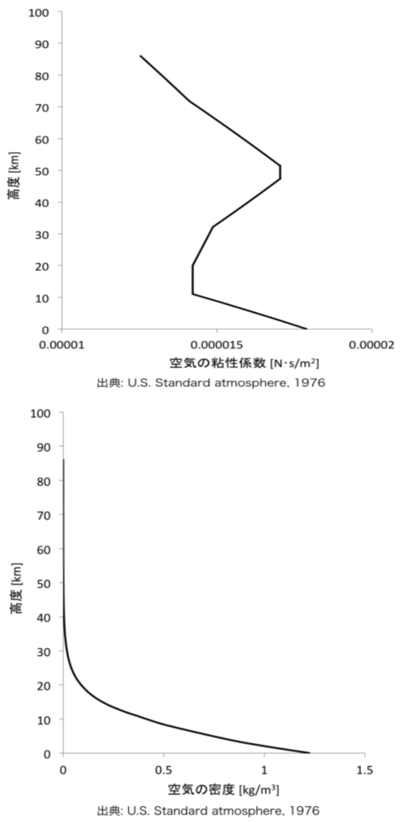
(3) $$m\frac{d}{dt}\left(\frac{dz}{dt} - V_z(z)\right) + C(z)\left(\frac{dz}{dt} - V_z(z)\right)^n + G(z) - Q \cdot \frac{z}{R^3} = 0$$

The above equations are two-order ordinary differential equations of a three-way coalition, and it is considered realistically difficult to solve analytically using algebra.

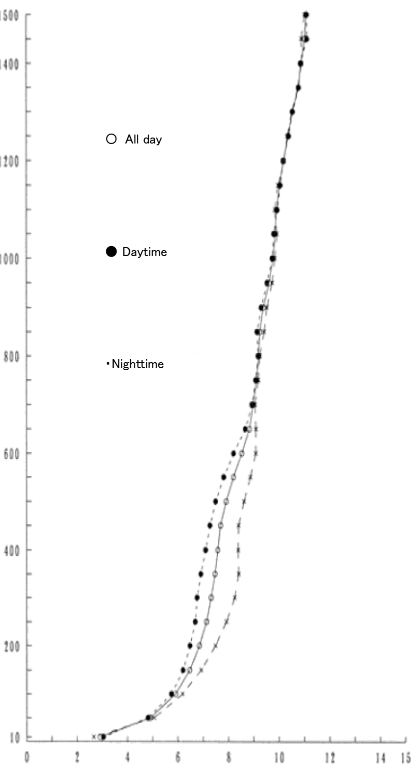
Measurement examples of altitude changes in viscosity μ, density ρ, and wind speed V_x are shown in (Fig. 2) ~ (Fig. 4).

Altitude

Altitude



Altitude m



·Wind speed m/s

Fig. 2, 3 Viscosity μ and density ρ of air vs altitude [6]

Fig. 4 Wind speed distribution by altitude [7]

Since the air density ρ is a function of the altitude z, the viscosity term $C(z)$ and the gravity term $G(z)$ are first approximated. The same applies to wind speed and adopt the coefficients according to altitude.

$C(z) = -az + b$, $G(z) = \alpha z + \beta$ $(a, b, \alpha, \beta > 0$ 、$z < 10{,}000\text{m})$

$V_x(z) = \varepsilon z + V_{x0}$, $V_z(z) = -\eta z + V_{z0}$ $(\varepsilon, \eta > 0)$

If it examines the equation of motion of (Eq. 1) ~ (Eq. 3)

① From (Eq. 2) it is an even function of y in case of n=1,3,5 . （y=−Y is the same function as (Eq. 2)）
From (Eq. 2) **y=0 is a singular solution.（y=0 holds for all domains of t ）**

② From (Eq. 1) in case of t=∞, it becomes $x = V_x\, t$

From (Eq. 2) in case of t=∞, it becomes $y = k_y$

From (Eq. 3) in case of t=∞, since z is in equilibrium $dz/dt = 0$, it becomes $\boldsymbol{C(z_e)V_z(z_e) = G(z_e)}$.

The equilibrium height z_e is the solutin of $a\eta\, {z_e}^2 - (aV_{z0} + b\eta + \alpha)\, z_e + (bV_{z0} - \beta) = 0$

If the solution of simultaneous differential equations are $x = x(\mathrm{t}, k_1, \ldots, k_6)$, $y = y(\mathrm{t}, k_1, \ldots, k_6)$ and $z = z(\mathrm{t}, k_1, \ldots, k_6)$, any integral constant k_i are determined by the initial positions and initial velocities etc. of the particle. Among the countless paths, ① and ② alone do not determine a specific energy stable path. Singular solutions of differential equations are also one of the countless paths.

1-2. Mechanical energy and dissipation energy

The dissipation energy E_D by air viscosity consumed from time to moment is expressed as follows.

$$E_D = \int C(z)\left(\frac{dx}{dt} - V_x(z)\right)^n \left(\frac{dx}{dt} - V_x(z)\right)dt + \int C(z)\left(\frac{dy}{dt}\right)^n \frac{dy}{dt}dt + \int C(z)\left(\frac{dz}{dt} - V_z(z)\right)^n \left(\frac{dz}{dt} - V_z(z)\right)dt$$

Mechanical energy E_M is expressed as (Eq. 4).

$$(4) \qquad E_M = \frac{m}{2}\left[\left(\frac{dx}{dt} - V_x(z)\right)^2 + \left(\frac{dy}{dt}\right)^2 + \left(\frac{dz}{dt} - V_z(z)\right)^2\right] + \int G(z)dz + Q/\sqrt{x^2 + y^2 + z^2}$$

Since the motion of an object is based on the principle of mechanical energy minimum (in other words, maximum dissipation energy and increase in thermodynamic entropy), objects with unstable energies deviate from their paths due to slight disturbances and gradually become close to paths with low energy.

From the mechanical energy equation, it can say the following.

③ From (Eq. 4) it is an even function of y. （y=−Y is the same function as (Eq. 4)）

④ To minimize E_M, always x=constant, y=constant and R=small/large (Q=−/+) are advantageous. As a result of ①～④, **the mechanical energy stable path is singular y=0**. Also $\boldsymbol{x = V_x\, t}$, $\boldsymbol{z = z_e}$ **at t=∞.**

Since y=0, if the solution of the differential equation (Eq. 1) and (Eq. 3) are $x = x(\mathrm{t}, k_1, k_2, k_5, k_6)$, $y = 0$, $z = z(\mathrm{t}, k_1, k_2, k_5, k_6)$ then, any integral constant k_i is determined by the initial positions and initial velocities etc. of the particle, and there are an infinite number of paths. On the other hand, if the initial conditions in the mechanical energy stable path are $x = x_0$, $dx/dt = v_{x0}$, $z = z_0$, $dz/dt = v_{z0}$ at $t = t_0$, then, it is expressed that the solutions of (Eq. 1) and (Eq. 3) are $x = x(\mathrm{t}, x_0, v_{x0}, z_0, v_{z0})$, $y = 0$, $z = z(\mathrm{t}, x_0, v_{x0}, z_0, v_{z0})$. The minimum mechanical energy conditions are as follows.

$$\frac{\partial E_M(t_0)}{\partial v_{x0}} = 0\ ;\quad 2\,m(v_{x0} - V_x(z_0))\frac{\partial(v_{x0} - V_x(z_0))}{\partial v_{x0}} + 2m(v_{z0} - V_z(z_0))\frac{\partial(v_{z0} - V_z(z_0))}{\partial v_{x0}} + \frac{\partial}{\partial v_{x0}}\int G(z_0)dz_0 + \frac{\partial}{\partial v_{x0}}Q/\sqrt{{x_0}^2 + {z_0}^2} = 0$$

$$\frac{\partial E_M(t_0)}{\partial v_{z0}} = 0\ ;\quad 2\,m(0 + v_{z0} - V_z(z_0)) + 0 + Q\cdot 0 = 0$$

$$\frac{\partial E_M(t_0)}{\partial x_0} = 0\ ;\quad 2\,m(v_{x0} - V_x(z_0))\frac{\partial(v_{x0} - V_x(z_0))}{\partial x_0} + 2m(v_{z0} - V_z(z_0))\frac{\partial(v_{z0} - V_z(z_0))}{\partial x_0} + \frac{\partial}{\partial x_0}\int G(z_0)dz_0 + \frac{\partial}{\partial x_0}Q/\sqrt{{x_0}^2 + {z_0}^2} = 0$$

$$\frac{\partial E_M(t_0)}{\partial z_0} = 0\ ;\quad 2m(0 + 0) + G(z_0) - Qz_0/({x_0}^2 + {z_0}^2)^{3/2} = 0$$

Consequently

$$v_{x0} = V_x(z_0)\ ,\quad v_{z0} = V_z(z_0)$$

$$x_0 = 0\ ,\qquad G(z_0)\,{z_0}^2 - Q = 0\quad (\alpha\,{z_0}^3 + \beta\,{z_0}^2 - Q = 0.\ \text{here, approximate to } G(z) = \alpha z + \beta\ )$$

From the above, **the stable path of the seismic cloud** which has the least mechanical energy, **is passing through $\boldsymbol{x_0 = 0}$, $\boldsymbol{y_0 = 0}$, $\boldsymbol{z_0}$** (z_0; solution of $2\alpha\,{z_0}^3 + \beta\,{z_0}^2 - Q = 0$) and **at $t \to \pm\infty$ $\boldsymbol{x \to V_x(z_e)t \to \pm\infty}$, y=0, $\boldsymbol{z \to z_e}$** (z_e; equilibrium height solution of $C(z_e)\left(-V_z(z_e)\right)^n + G(z_e) = 0$)

1-3. Equations of motion at the time of calm

In the morning and evening when the weather is nice, the sea breeze and mountain breeze subside, so temporarily, it is $V_x = V_y = 0$. The equation of motion at the time of calm is as follows in polar coordinates, but it is difficult to solve rigorously.

$$\text{radius } \rho \text{ direction} \quad m\frac{d^2\rho}{dt^2} + C(z)\left(\frac{d\rho}{dt}\right)^n - Q\cdot\frac{\rho}{R^3} = 0 \qquad \rho = \sqrt{x^2+y^2}, \quad R = \sqrt{x^2+y^2+z^2}$$

$$z \text{ direction} \quad m\frac{d}{dt}\left(\frac{dz}{dt} - V_z(z)\right) + C(z)\left(\frac{dz}{dt} - V_z(z)\right)^n + G(z) - Q\cdot\frac{z}{R^3} = 0$$

However, according to mathematical singular consideration, if there is no wind in the horizontal direction, the energy stable path is $x = y = 0$ $(\rho = 0)$ and becomes a straight line rising vertically from the origin.

By balancing static forces in the z-axis direction, the equilibrium height z_e of the path is the solution of the following equation. If each coefficient is a first-order approximation and n = 1, it becomes a fourth-order equation of z_e. $\quad C(z_e)\left(-V_z(z_e)\right)^n + G(z_e) - Q/{z_e}^2 = 0$

1-4. Equations of motion at a distance

The approximate equation of motion at coordinates far from the origin ($|x| \gg z$, $y = 0$) is as follow. However, assuming that the change range z is small, $n = 1$, $C(z)$, $V_x(z)$, $V_z(z)$, $G(z)$ let to be constant.

$$m\frac{d^2x}{dt^2} + C\left(\frac{dx}{dt} - V_x\right) - Q\cdot\frac{1}{x^2} = 0 \qquad m\frac{d^2z}{dt^2} + C\left(\frac{dz}{dt} - V_z\right) + G - Q\cdot\frac{z}{x^3} = 0$$

Even in the above equation, since solving algebraically is a great amount of work [8], it can be solved by further omitting the Q term by micro-omission.

$$m\frac{d^2x}{dt^2} + C\left(\frac{dx}{dt} - V_x\right) = 0 \quad , \qquad m\frac{d^2z}{dt^2} + C\left(\frac{dz}{dt} - V_z\right) + G = 0$$

$$x = k_1 \exp\left(-\frac{Ct}{m}\right) + V_x t + k_2 \quad , \qquad z = k_5 \exp\left(-\frac{Ct}{m}\right) + \left(V_z - \frac{G}{C}\right)t + k_6$$

Thus, when t is larger, it is a horizontal strip of $x = V_x t + k_2$, $z = k_6$ and conforms to the result of §1-2.

2. Coulomb force of axisymmetric charge distribution

2-1. Equations of motion and mechanical energy of charged particles

Since the ground surface charge spreads with charge distribution on the ground surface rather than point charge Q', consider an axisymmetric charge distribution $\sigma'(r)$ like a normal distribution curve or a water surface pattern falling water droplet. In this case, the equations of motion of the charged particle are (eq. 1') ~ (eq. 3'), and the mechanical energy is (eq. 4').

$$(1') \quad m\frac{d}{dt}\left(\frac{dx}{dt} - V_x(z)\right) + C(z)\left(\frac{dx}{dt} - V_x(z)\right)^n - \int_0^{\infty} dr \int_0^{2\pi} \frac{x\,\sigma(r)\,r\,d\theta}{[(x - r\cos\theta)^2 + (y - r\sin\theta)^2 + z^2]^{3/2}} = 0$$

$$(2') \quad m\frac{d^2y}{dt^2} + C(z)\left(\frac{dy}{dt}\right)^n - \int_0^{\infty} dr \int_0^{2\pi} \frac{y\,\sigma(r)\,r\,d\theta}{[(x - r\cos\theta)^2 + (y - r\sin\theta)^2 + z^2]^{3/2}} = 0$$

$$(3') \quad m\frac{d}{dt}\left(\frac{dz}{dt} - V_z(z)\right) + C(z)\left(\frac{dz}{dt} - V_z(z)\right)^n + G(z) - \int_0^{\infty} dr \int_0^{2\pi} \frac{z\,\sigma(r)\,r\,d\theta}{[(x - r\cos\theta)^2 + (y - r\sin\theta)^2 + z^2]^{3/2}} = 0$$

$$(4') \quad E_M = \frac{m}{2}\left[\left(\frac{dx}{dt} - V_x(z)\right)^2 + \left(\frac{dy}{dt}\right)^2 + \left(\frac{dz}{dt} - V_z(z)\right)^2\right] + \int G(z)dz + \int_0^{\infty} dr \int_0^{2\pi} \frac{\sigma(r)\,r\,d\theta}{\sqrt{(x - r\cos\theta)^2 + (y - r\sin\theta)^2 + z^2}}$$

It transforms (Eq. 1') and (Eq. 2') to (Eq. 1'') and (Eq. 2''), here $sin\Phi = y/\sqrt{x^2+y^2}$

$$(1'') \quad m\frac{d}{dt}\left(\frac{dx}{dt} - V_x(z)\right) + C(z)\left(\frac{dx}{dt} - V_x(z)\right)^n - \int_0^{\infty} dr \int_0^{2\pi} \frac{[\,x - r\,cos\Phi\,cos(\theta-\Phi)\,]\,\sigma(r)\,r\,d\theta}{[x^2+y^2+z^2+r^2-2r(x^2+y^2)^{1/2}\,cos(\theta-\Phi)]^{3/2}} = 0$$

$$(2'') \quad m\frac{d^2y}{dt^2} + C(z)\left(\frac{dy}{dt}\right)^n - \int_0^{\infty} dr \int_0^{2\pi} \frac{[\,y \quad Þ\,cos(\theta-\Phi)\,]\,\sigma(r)\,r\,d\theta}{[x^2+y^2+ \;4 \quad -2r(x^2+y^2)^{1/2}\,cos(\theta-\Phi)]^{3/2}} = 0$$

If the singular solution is y=0 $$(2'') \quad m\frac{d^2 0}{dt^2} + C(z)\left(\frac{d0}{dt}\right)^n - \int_0^{\infty} dr \int_0^{2\pi} \frac{[\,0 - r\,sin0\,cos(\theta-0)\,]\,\sigma(r)\,r\,d\theta}{[x^2+0^2+z^2+r^2-2r(x^2+0^2)^{1/2}\,cos(\theta-0)]^{3/2}} = 0$$

As a feature of these equations, although the singular solution y=0 of the mechanical energy stable path holds, it is no longer an even function of y. Also, $\boldsymbol{x = V_x\,t}$, $\boldsymbol{y = 0}$, $\boldsymbol{z = z_e}$ **hold at** $\boldsymbol{t=\infty}$ and **it passes through the origin point (0, 0,** $\boldsymbol{z_0}$**).**

(z_e is the solution of $C(z_e)\left(-V_z(z_e)\right)^n + G(z_e) = 0$)

(z_0 is the solution of $z_0 \int_0^{\infty} dr \int_0^{2\pi} \frac{\sigma(r)\,r\,d\theta}{[(r\,cos\theta)^2 + z_0^2]^{3/2}} = G(z_0)$)

As a result, **the stable path is a horizontal straight line at down-wind and upwind locations far from the origin.**

Photo 1: Seismic clouds extending eastward over Nara City on January 12, 1978, two days before the Izu Oshima Island Earthquake (M7.0), 330km away upwind. (Photo by Chuzaburo Kamata)

2-2. Equations of motion at the time of calm

At the time of calm, it is temporarily $V_x = V_y = 0$, and the equation of motion at the time of calm is as follows in polar coordinates.

radius ρ direction $$m\frac{d^2\rho}{dt^2} + C(z)\left(\frac{d\rho}{dt}\right)^n - \int_0^{\infty} dr \int_0^{2\pi} \frac{\rho\,\sigma(r)\,r\,d\theta}{[\rho^2+z^2+r^2-2\rho r cos(\theta-\varphi)]^{3/2}} = 0$$

circumferential angle φ direction $$m\rho\frac{d^2\varphi}{dt^2} + C(z)\left(\rho\frac{d\varphi}{dt}\right)^n = 0$$

z direction $$m\frac{d}{dt}\left(\frac{dz}{dt} - V_z(z)\right) + C(z)\left(\frac{dz}{dt} - V_z(z)\right)^n + G(z) - \int_0^{\infty} dr \int_0^{2\pi} \frac{z\,\sigma(r)\,r\,d\theta}{[\rho^2+z^2+r^2-2\rho r cos(\theta-\varphi)]^{3/2}} = 0$$

According to mathematical considerations, when there is no wind in the horizontal direction, **the mechanical energy stable path is the singular solution** $\boldsymbol{x = y = 0}$ ($\boldsymbol{\rho = 0}$), **a vertical line.**

By balancing static forces in the z-axis direction, the equilibrium height z_e of the path is the solution of the following equation.

$$C(z_e)\left(-V_z(z_e)\right)^n + G(z_e) - 2\pi\,z_e \int_0^{\infty} \frac{\sigma(r)\,r\,dr}{[\,z_e^2 + r^2]^{3/2}} = 0$$

Photo 2 ; Upright cloud occurred on the evening of Jan.9,1995 taken directly above Akashi-Kaikyo Bridge in the epicenter vicinity one week before the Hyogo South Earthquake (M7.3), (Courtesy of Ms.T. Sugie, NEWS Post Seven) 〔9〕

3. Formation of seismic clouds

Although the charge behavior in the ground and on the surface is not yet clear, according to the internet "A Study on Electrostatic Phenomena and Short-Term Prediction of Earthquakes", the charge on the surface can be interpreted as follows.

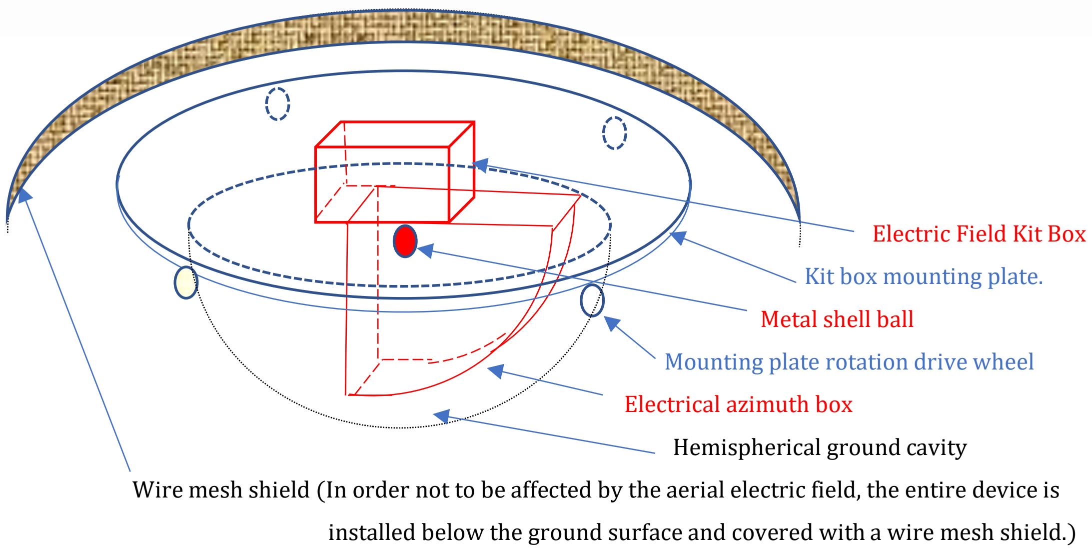
The charge can only exist on the surface of the conductor so as to keep the potential inside the conductor constant. When contact friction charging occurs due to continuous deformation strain of the bedrock or fluid friction charging due to the entry of high-pressure fluid into the bedrock (crack) deep underground, positive and negative static electric charge is generated continuously for time. Since the earth's crust can be regarded as a conductor with resistance, both bedrock and fluid conduct electricity and the charge of a conductor generated in the ground can only exist on the surface (when free electrons are stationary) and then the charge rises, and the charge distribution continuously appears on the surface.

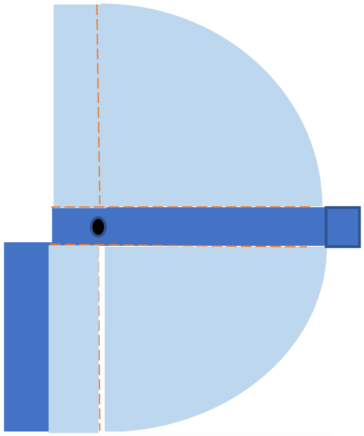
For example, the charge distribution shows such that a negative appears directly above the fluid and a positive appears around it (just above the bedrock), but in this case, the positive charge neutralizes the negative charge on the crustal surface.[10]

Since there is an infinite number of positively and negatively charged water vapor in the air, the large negative charge from the ground exerts the Coulomb force, and a lot of water vapor condenses close to the path with minimum mechanical energy that is less susceptible to disturbances. As a result, two type (horizontal and vertical) seismic clouds are formed here.

4. Earthquake source prediction by electric field (or micro-potential) measurement

Prediction of the epicenter by condensation clouds of moisture in the air is considered to be insufficient because it is limited by weather conditions such as wind speed and humidity. On the other hand, the intersection of the maximum electrostatic field orientation from two observation points by a simple electrostatic field (or micro-potential) compass can be inferred to be a very rough epicenter.。 The charge on the contact surface is generated continuously for time and it rises in the conductor and reaches the ground surface and sea surface while decreasing.





Metal Shell Ball and Kit Box (Osaka Univ. developed).

Field Orientation Box and Expanded View (Right)

Fig. 5 Conceptual diagram of installation of electrostatic field azimuth

In the electrostatic field (or micro-potential) orientation method, precise zero-point adjustment or sensitivity adjustment of the measuring instrument is not required, but only the orientation is the problem.

As shown in the concept of an electrostatic field (or micro-potential) compass (Fig. 5), the electric field (or micro-potential) compass box is surrounded by a fan-shaped metal plate that opens only in one direction, and the metal shell sphere receives the electric field from one direction, and the metal plate shields the electric field from the other direction. The measurement principle is the same for both electrostatic field measurement and micro-potential measurement.

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