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Study of Thermal Anomalies before Earthquake

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Abstract- Seismic waves have been widely studied in relation with earthquake. However, we can also get information from non-seismic phenomena occurring before large earthquakes. Some of these pre-earthquakes for some, in homogeneity in temperature by several degrees in a wide range which can be seen through satellite imagery. In this research, experimental works for observation of pre-earthquake phenomena are reviewed and those works with results related to studies of bullets hitting the rocks which are the simulated pressure in the rock layer. With calculation of types of transformed energies, energy losses and surface charge and the energy stored in surface are calculated. These studies can be used for future research studies on earthquake precursors.

Keywords- *Earthquakes, seismic phenomena, earthquakes, positive holes, magnetic anomalies, thermal anomalies, ionosphere*

I. Introduction

Any parameter which has changes before earthquake occurrence in such a way that earthquake can be predicated by accurate investigation of these changes is called precursor. More than 30 precursors for earthquake have been identified up to now. Although relationship between most of these precursors and earthquake has been specified, techniques for using them are still in early research steps, and it is not possible to express opinions certainly about probability of earthquake occurrence relying on occurrence or non-occurrence of precursors in a specific region. Some main earthquake precursors include: Hydrological precursors, (radon gas changes in groundwater and changes in temperature and groundwater levels, etc.), earthquake cloud, changes in temperature, pressure and wind speed and relative humidity and etc.

II. Purpose of Implementation Collision Experiments

Purpose of explaining collision experiments here is not simulating a specific natural situation rather the purpose is achieving two goals. First, showing that generating charge carriers of electron type from precursor of the positive electron pairs was previously present, and second, understanding relatively strange properties of these charge carriers which yet diffuse along the rocks. This idea results from experiments of breaking previous crystals using MGO as oxide materials and regular structure. These experiments indicated the sound waves produced by fracture were enough to cause dissociation of PHP.

If weak sound waves produced by fracture can activate positive electron holes, this question is raised: Can micro-fractures in the rocks before the earthquake activate positive electron holes at least in a small amount around the micro-fractures? In addition, if imposed pressures cause plastic deformation of rocks resulting in movement disorders, electron holes probably would be activated. Assume micro-fractures and plastic deformation are pervasive in critical tectonic pressures; in this case activation of electron holes and their exit from compressed volumes represent charge generation mechanisms which is responsible for tectonic electricity and electromagnetic signals which are reported before earthquake activity. Low velocity experiments were performed using stainless steel with a thickness of 6.3 – 3.1 – 1.8 to 1.4 inch with the launch of 100 m/s and transfer 0.43 – 0.06 joules of kinetic energy to the cylindrical core of rock with 3.4 inch (20 mm) in diameter and a height of 4 inches (100 mm). Projectiles impressed small white marks on font surface of rock cores, and caused corrosion and splitting the rock. Sensors included: 1) magnetic loops which are fixed diagonally (with 2 cm width, 3000 round, 30 magnetic wire sheets), 2) Photodiodes were placed either at the surface front or at the bottom of the tubes so that the edge or surface is visible, 3) An annular capacitor near the front, 4) Plate capacitor on the back and 5) Annular electrodes attached directly to the rock surface, but without any strain gauges. Current flows from the electrode to the rocks were measured by voltage drop with 240 mΩ resistance. Basis point was approximately 2.3 lower than the length of the cores. To obtain data, Oscillograph Tektronix 200 mhz was used.

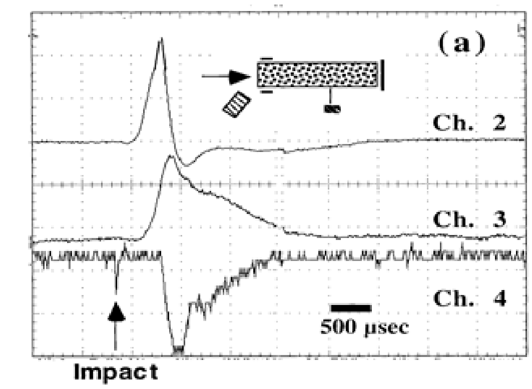

Figure 1. Collision of Gabbro core (a-m/s), steel bullet in 1.8 inch. Channel 2: ring capacitor 200 mv. Channel 3: plate capacitor at the back, 20 mv. Channel 4: Light emission from the front end, 200 mv. b. Gabbro core 3.16 inch. Channel 1: ring collector with voltage 400 mv. Channel 2: magnetic field diffusion, 10 mv. Channel 3: back capacitor voltage, 20 mv. Channel 4: light emission from the front end, 500 mv

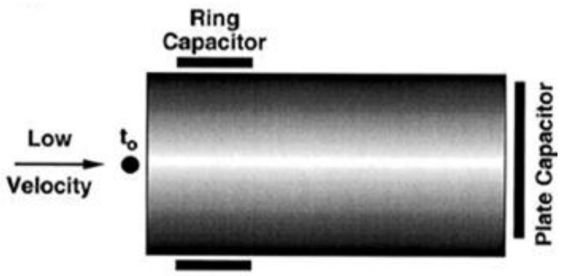

Figure 2. Experiments of impact of low velocity which indicates a small light signal is effective in a channel. It is due to triboluminescence. In channel 2, positive charge entry in front end of capacitive sensor loop, in channel 3, the current reached to the charge with delay, and at the back end of capacitive sensor, and in channel 4, a delayed flash light is observed.

III. COLLISION EXPERIMENTS IN AVERAGE VELOCITY

These experiments were performed in nasa ames vertical gun range in vacuum chamber with a width of 3 m and 5.2 m in height. As mentioned, about 4 m around the chamber was evacuated. Vacuum chamber protected specimen against earth magnetic field. Specimens were of rocks in dimensions of 25× 25 × 20 cm from Granite Bar. Thickness of projectiles was 1.4 inch (3.6 mm). In order to eliminate undue electrostatic charges which may be accumulated by projectiles within finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading acceleration or exit from barrel, Al sphere was passed through a thin A1 foil connected to the ground.

If the rock is equipped with three types of sensors: 1)Three built-up magnetic loops were placed on wooden frames with dimensions of 26 × 26 cm^2 with 300 coils of 30 magnetic sheets. One of the sheets is placed 10 cm above the level so that the plasma plume diffusion is recorded (Crawford, Schultz, 1997).2)Two other loops are placed lower than half of the height and close to the end of rock, respectively. Although, space between loops was smaller than their thickness, self-induction had little significance. 3) Three capacitors consisted of 3 electrical insulation pieces in thickness of 0.05 mm, length of 22 cm, and width of 20 mm. slabs of cu with height of 20 cm and width of 12 mm are attached on them. Place of capacitive sensors will be shown in the following figure.4)Two electrodes which are composed of adhesive tape and conductor cu with height of 20 cm and width of mm. they are directly connected to the rock so that direct contact is achieved. Electrodes are connected to the ground with resistance 2.4 m, by which voltage drop is measured. Place of the electrodes is shown in the following figure. Two digital oscilloscopes with four networks in parallel were used to obtain data.

As observed, due to collision of steel bullet to the white gabbroic rocks, that includes more than 80% plagioclase Collage, some energy from diode and some energy from the ring capacitor, and some energy as thermal energy are transferred into the rock and some energy is transferred to capacitor and some energy is lost in various forms.

Thus, if total released energy due to collision provide these energies, then: $\mathbf{Q = E = \alpha E_D + \beta E_L + \delta E_C + \gamma E_T + \theta E_f}$, In this relation: E_D denotes the energy transferred to photodiode, $(\boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\delta}, \boldsymbol{\gamma}, \boldsymbol{\theta}) < \mathbf{1}$, $(\boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\delta}, \boldsymbol{\gamma}, \boldsymbol{\theta}) \boldsymbol{\in} \mathbf{R}$, E_L = energy transferred to the ring capacitor, E_C = energy transferred to the plate capacitor, E_T = thermal energy , E_f = non-calculated energy . Calculation of Rock and Bullet Mass: $\mathbf{m_2 = PV = 2660 \times 384 \times 10^{-5} = /083524kg}$. Calculation of Bullet Mass: $\mathbf{K_1 = /06j\ to\ 0/43j}$, $\mathbf{M_1 = \frac{2k}{V^2} = \frac{2\times 0/43}{10^4} = 0/86 \times 10^{-4}kg}$.

Abbreviations and Acronyms

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

A. Numerical Calculation of Energy Generated from Collision

If the bullet dived into the rock after collision, then:

$$Q = \frac{P_{1I}^2}{2m_1} - \frac{1}{2}(m_1 + m_2)V_f^2 \rightarrow Q = \frac{P_{1I}^2}{2m_1} \times \left(\frac{m_2}{m_1 + m_2}\right), \quad \rightarrow Q = E = K\left(\frac{m_2}{m_1 + m_2}\right) \quad Q = \frac{0}{43}\left(\frac{\overline{083524}}{\overline{083524} + \overline{000086}}\right) = 4295731 \times 10^{-7} j,$$

Calculation of the number of released bonds o – o due to collision: bond energy : o − o : 118138 $cal/mole$, $n = 8235/396 \times 10^{-23} j$

$$\text{broken bonds number} = \frac{4295731 \times 10^{-7}}{82315/396 \times 10^{-23}} = \frac{52}{18} \times 10^{16} \text{electron}$$

B. Photodiode

Photodiode current is represented by ID and it is obtained from following formula: $I_D = I_S\left(e^{\frac{VD}{\eta V_T}} - 1\right)$, In this formula: I_s = Reverse saturation current, η: It depends on material of diode Semiconductor $\eta_{Ge} = 1$, $\eta_{si} = 1/4$, V_T = it is thermal voltage of diode and for room temperature, i.e. in 24 or 25°C, thermal voltage is about 26 mV.

$V_T = \frac{KT}{q}$, the charge transferred to the photodiode is calculated:

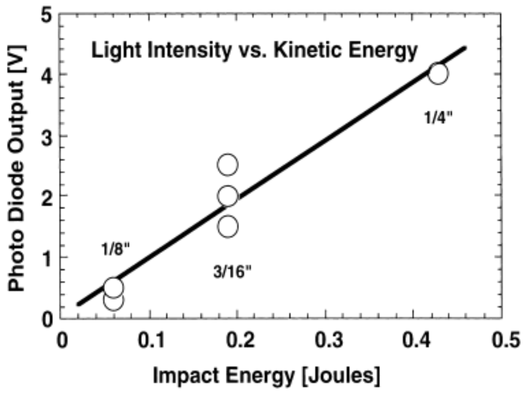

Figure 3. Potential disruption in terms of photodiode energy

$$\Delta V = \frac{\Delta U}{q} \rightarrow \begin{cases} \Delta U = q\Delta V = 0/1 \times 0/2 = 0/02j \\ \Delta V = \frac{1}{q}\,\Delta U \end{cases}$$

$$q = \frac{0.02}{0.2} = \frac{1}{10}c \rightarrow q = ne \;\rightarrow n = \frac{0.1}{1.6} \times 10^{+19} = 6.25 \times 10^{17} electron.$$

C. Energy Stored on Plate Capacitor and Ring Capacitor

$$q = ne \;\rightarrow n = \frac{311.52\times 10^{-13}}{1.6\times 10^{-19}} = 194.7 \times 10^{+6}\text{electron},$$

$$\Delta U = \frac{1}{2}q\Delta V = \frac{1}{2} \times 311.52 \times 10^{-13} \times 40 \times 10^{-3} = 623.04 \times 10^{-15}\text{j}$$

D. Energy Stored on Plate Capacitor and Ring Capacitor

Retarded magnetic vector potential resulting from N loop,

$$A\Phi = \frac{+\mu.I.a^2Lw}{4c} sin\Theta \frac{\text{SIN}\, w\left(t - \frac{r}{c}\right)}{r} - \frac{\mu.I.aL^2w}{8rc} sin\Theta \frac{\text{SIN}\, w\left(t - \frac{r}{c}\right)}{r}$$

For calculation of retarded electric field

$$E_\varphi = \frac{-\mu.I.a^2Lw^2 \text{SIN}\Theta\text{SINW}\left(t - \frac{r}{c}\right)}{4c^2} + \frac{\mu.I.aL^2w^2}{8c^2} \times \text{SIN}\Theta\text{SINW}\left(t - \frac{r}{c}\right) ,$$

Thus, expectation value of Poynting vector at surface unit is:

$$\frac{<s>}{\pi a^2} = \frac{\left(\frac{3}{4}\right)^{\frac{7}{6}}\mu.I.^2rl^2w^3}{32\mu c^4}\left(a^2 + \frac{l^2}{4} - al\right), \frac{<s>}{\pi a^2} = \left(\frac{3}{4}\right)^{\frac{7}{6}} \times 0.16490343 \times 10^{-20}\,\frac{w}{m^2},$$

E. Calculation of Thermal Heat in Gabbroic Rocks (Granite)

Thus, considering volume size of these specimens are identical to the respective volume size, and considering specific heat capacity of granite as a kind of gabbro rock, then thermal heath can be calculated as follows:

$$Q = mc\Delta T = 0.083524 \times 750 \times 0.5 = 31.321j$$

Considering above calculations it is observed that considerable thermal energy is provided due to occurrence of earthquake in case similar to the collision state.

IV. Calculation of Lost Energies in Volume Unit

$Q = E = E_D + E_L + E_C + \theta E_f$, , $\frac{E_f}{V} = \frac{0.4}{3.14\times 100\times 100\times 10^{-9}} = \frac{4}{31.4} \times 10^{+5}$,

considering the fact that in experimental experiments, temperature of two sides of the specimen is not provided, calculation of thermal heath in this part is overlooked due to lack of experimental facilities for practical tests and measurement of temperature by advanced imaging cameras and calculation of temperature using relations of blackbody temperature, and its amount is included in the lost heat.

V. Conclusion

In this research, using simulation experiment in the form of collision of a bullet to the rock released and deformed energies including energy transferred to the ring capacitor, energy transferred to the plate capacitor, thermal energy, and photodiode energy and lost energies were calculated, and energy losses were obtained analytically. These results can help in studies on earthquake precursors, and changes in fault layers can be obtained from changes in estimated energy and changes of surface charge. Since these changes are transferred in higher velocity, they can be used as precursors.

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