Radiations of DC Electric Field from Granite under Pressure prior to Earthquakes

*Minoru Tsutsui[1]

1. Frofessor Emeritus, Kyoto Sangyo University

Abnormal increases of total electrons contents (TEC) in the ionosphere appeared 1.5 hour ~ few tens of minute prior to large earthquakes were measured by GPS signal [1]. It is considered that the increase of TEC might be caused by deformation of electron density profile in the ionosphere due to DC electric field which would be generated in the earth’s crust under a high pressure and radiated up to the ionosphere at a stage prior to an earthquake. I here present results of a laboratory experiment on DC electric field radiations from granite under pressure.

So far, I have been studying the excitation mechanism and behaviors of co-seismic electromagnetic (EM) waves by detecting EM signals in a deep borehole and above the ground together with the measurement of seismic waves. From the analysis of these data, I found that co-seismic EM waves were basically excited by seismic P-waves due to piezo-electric effect [2], and the EM amplitude was enlarged at arrival of S-waves, via P-wave amplitude largely deformed by seismic S-wave. However, the excited EM wave was easily decayed in the earth’s crust due to its large electrical conductivity [3]. Therefore, it was concluded that co-seismic EM waves can be detected only when the S-wave arrived at the EM observation site. Furthermore, I found EM waves generated at earthquake hypocenters couldn’t be detected at far EM observation sites because the EM waves radiate almost vertically upward by an extremely small critical angle due to the large different dielectric constants between in the earth’s sedimentary layer and in the air. Therefore, EM waves couldn’t become a candidate of precursor of earthquakes [4].

However, from the series of the observational results, I noticed an important point that the piezo-electric effect is very sensitive in the earth’s crust. When we think of electric situation in the earth’s crust loaded by an extremely high pressure before the occurrence of earthquakes, a large electric charge polarization would be formed in the earth’s crust, and a DC electric field would appear above the ground.

I have also noticed an important fact in an experiment. I conducted the laboratory simulation experiment on EM wave excitation in a fragmentation layer in an active fault. The fact was an appearance of DC electric field just before the fracture of small stone in the fragmentation layer. This suggests that DC electric field is expected to be radiated out of the ground whenever extremely high pressure is loaded to the earth’s crust before earthquakes.

Then I conducted another laboratory experiment on high pressure loading to a granite pillar for confirming the radiation of DC electric field from it. A granite pillar (10 cm x 10 cm x 50 cm) and a hydraulic jack with a pressure gauge were straightly arrayed on a wooden bench. A crossed linear electric-dipole-antenna system was set near the side surface of the granite pillar. Figure shows a time-sequence of electric fields of east-west and north-south components when pressure of 3.5 ton were repeatedly loaded to the top of the granite pillar. Both electric field components increased when the pressures were loaded to the granite, and decreased when the pressures were withdrawn from the granite.

This experimental result has manifested that the DC electric field would appear before earthquakes. Therefore the observation of DC electric field above the ground is important for forecasting earthquakes.

[1] K. Heki and Y. Enomoto, “Mw Dependence of preseismic ionospheric electron enhancements,” *J. Geophys. Res. Space Phys.*, **120**, 7006-7020, 10.1002/2015JA02135, 2015

[2] M. Tsutsui, “Behaviors of electromagnetic waves directly excited by earthquakes,” *IEEE GRS Lett.*, **11**, 11 pp. 1961-1965, 2014.
[3] M. Tsutsui, “Derivation of electrical parameters of earth’s medium from electromagnetic waves excited by earthquakes (in Japanese),” *IEEJ Transactions on Fundamentals and Materials*, **136**, 5, pp. 221-226, 2016.
[4] M. Tsutsui, “Excitation Mechanism and Behaviors of Co-seismic Electromagnetic Waves,” in *Proc. 32nd URSI GASS*, submitted, 2017.

Keywords: Laboratory experiment, Granite under pressure, Radiations of DC electric field