Source mechanism for pre-seismic EM phenomena imminent before the 2011 M9.0 Tohoku-Oki earthquake

*Yuji Enomoto[1], Kosuke Heki[2], Shigeki Sugiura[3], Hitoshi Kondo[3]

1. Shinshu Univeristy, Ueda Campus Fii, 2. Hokkaido University, Faculty of Science, 3. Genesis Research Institute, INC.

Various types of precursor anomalies preceding the 2011 Tohoku-Oki earthquake have been reported in terms of seismic, geodetic, geochemical and geo-electromagnetic activities; i.e. decrease in *b*-value, tidal triggering, and foreshocks of earthquakes, short and long term slow slip and crust deformation, of which anomalies grew with time since about 10 year leading up to the M9.0 main shock. The ionospheric electron enhancement and the geomagnetic declination change starting about 40 minutes prior to the main shock have attracted an attention as possible imminent prediction of earthquake occurrence.

Geo-physicochemical evidences strongly suggests that deep Earth fluids along fault plane have an important role in generating the above mentioned seismic and geodetic anomalies leading up to the M9.0 main shock (Fujise et al., 2000:Kawagucchi et al. 2012;Sano et al., 2013).

Taking into account the coupled interaction of rock ruptures with the gas flowing-in as a working hypothesis for earthquake preparation (quasi-static rupture) stage (Enomoto,GJI,2012), we conducted laboratory experiments of uniaxial rock rupture of gabbro or basalt with high-pressure hot gas flow of CO2,N2, CH4 or H2O vapor at the temperature of about 160 degree C. The electric currents as high as 0.1-0.3 microampere, depending on the gas-fracture interacting area *S*, were successfully measured without electrode bias (0 volt). The peak electric current per unit the ga-fracture interaction area was 1 mA/m^2. The maximum current at the final stage of quasi-static fracture of the earthquake nuclei is, then, estimated as 208kA, which might induce geomagnetic change of 1.86 nT and geomagnetic deflection of 6.42×10^(-5) rad at Esashi geomagnetic observatory of 182km distant from the epicenter of the M.9.0 main shock, which agree well with the observed results.

Furthermore, observed precursor period of 40 min. could be explained as the effective time for which the deep Earth gases passed through the whole nucleation zone with crack gap of 0.9mm and the gas viscosity of 9.76×10^(-4) Pa・sec
In conclusion, the present model provides well-reasoned explanation for geomagnetic anomalies as observed in the 2011 Tohoku-Oki earthquake.

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