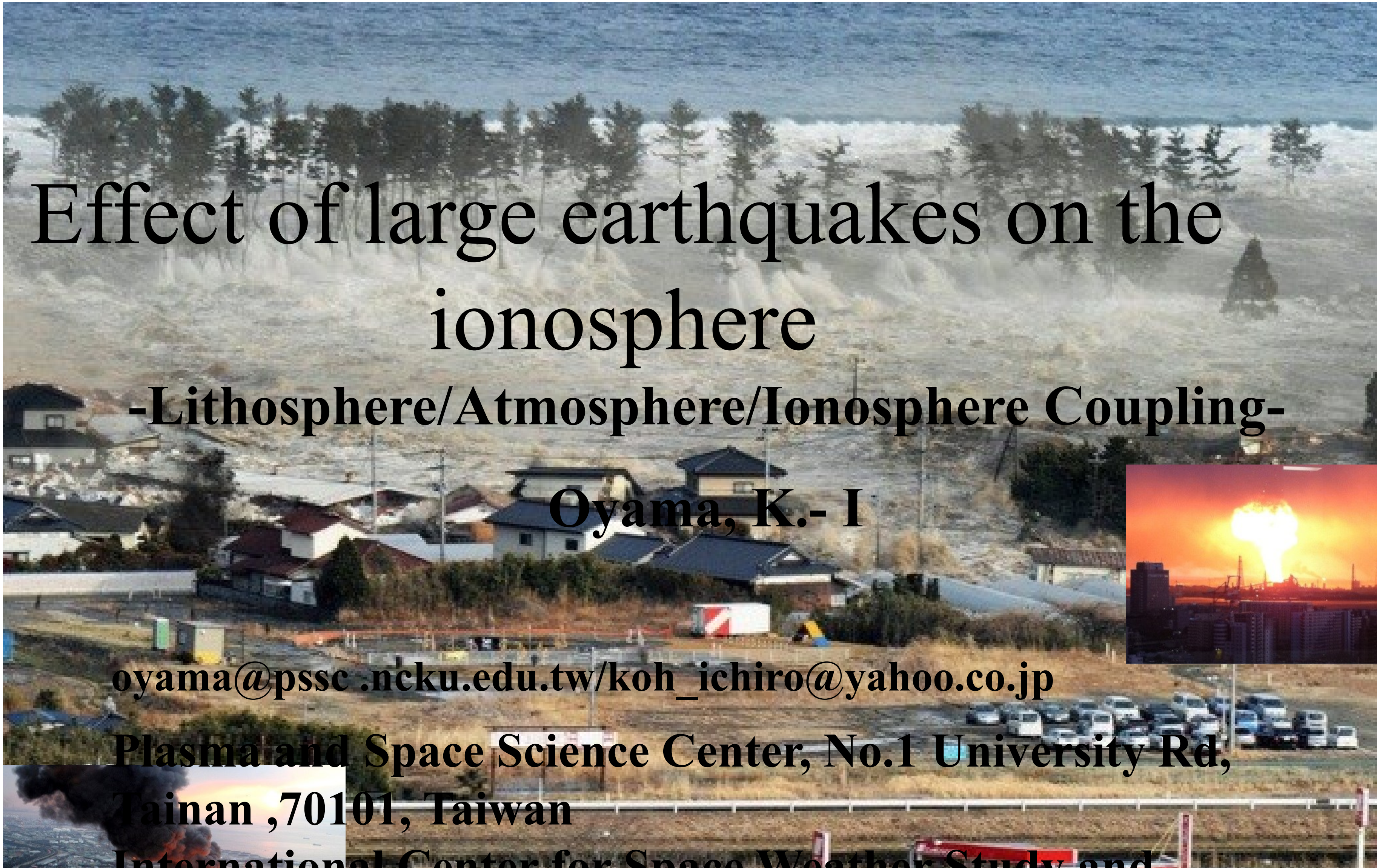
JPGU 2014 SApril28-May 2, 2014 MTI 13:00- 14:00 May 1 Room312



Effect of large earthquakes on the ionosphere

-Lithosphere/Atmosphere/Ionosphere Coupling-

Oyama, K.- I

oyama@pssc .ncku.edu.tw/koh_ichiro@yahoo.co.jp

Plasma and Space Science Center, No.1 University Rd, Tainan ,70101, Taiwan

International Center for Space Weather Study and Education, Kyushu University, Japan

Recent Reports on Precursor Phenomena of ionosphere/atmosphere of Large earthquakes

Ground Observations

foF2 :Liu et al., 2006, Maekawa et al., 2006; Hobara and Parrot , 2005;Zhao et al., 2008, Liu et al., 2009, Sharma et al, 2008

VLF propagation: Hayakawa et al., 2006, Rozhnoi et al., 2007

TEC: Zakharenkova et al., 2007

Atmospheric glow, Mikhalev et al., 2001

………………………………………………………………

Satellite Observations

Ne Pulinets, Te Sharma et al.,JATP 2006

VLF wave; DEMETER, MidInfrared (11-12 μm) Emission: Ouzounov et al, 2006

O^+, He^+ ion composition:Bankov et al., 2009, Smatra

Particle precipitation: Rothkaehl et al., 2006, Aleksandrin et al.,Ann.Geophys, 2003

Ground / Satellite combination

Oyama et al., 2008 Te/ foF2 , Akhoondzadeh et al., 2010 Ne / satellite GPSTEC, Samoa Island (29.Sep, 2009 and 3 others) , Pulinets et al.,

Computer simulation : Klimenko et al., Proc.XXXII Annual Seminar,2009
Namgaladze et al., Geoman.Aernom., 49, 252-262, 2009
, gravity wave . Kuo etal., 116,A10317, 2011,JGR,Kuo and Lee 2014,will be published

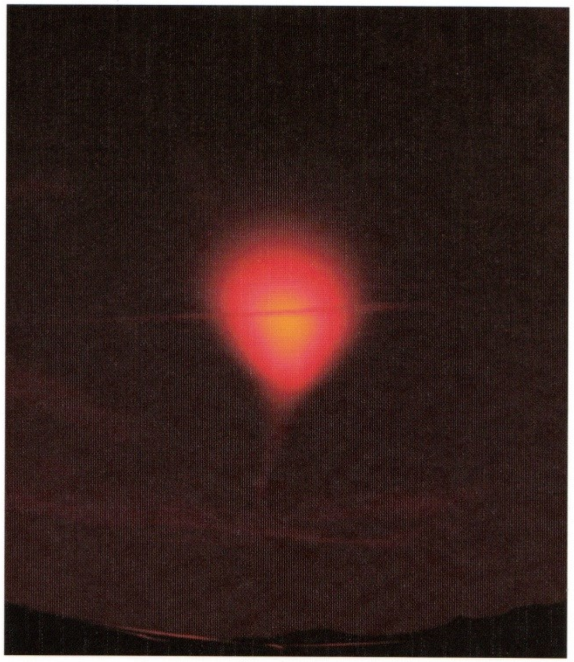
Most of these works were conducted by the scientists whose long time research carrier is not related to ionosphere.

<u>MTI group who have excellent ionosphere/ thermosphere scientists are encouraged to spend some time for the precursor features of large earthquake….. Satellite constelaltion</u>

An Introduction to
Space Instrumentation

Edited by

K. Oyama and C. Z. Cheng



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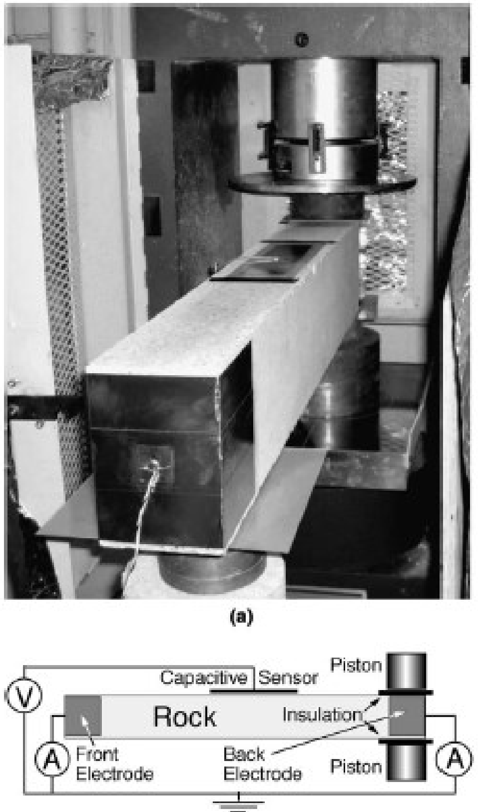


Fig. 1. (a) Granite slab placed in the press, ready for the uniaxial compression tests. The granite slab (1.2 m long, $10 \times 15\,\text{cm}^2$ cross section) is fitted with two Cu electrodes (each $30 \times 15\,\text{cm}^2$), one at the back end and one at the front end, plus a non-contact capacitative sensor for measuring the surface potential. The rock is insulated from the pistons and the press by 0.8 mm thick polyethylene sheets ($>10^{14}\,\Omega\,\text{cm}$). (b) Block diagram of the electric circuit for allowing the self-generated currents to flow out of the stressed rock volume.

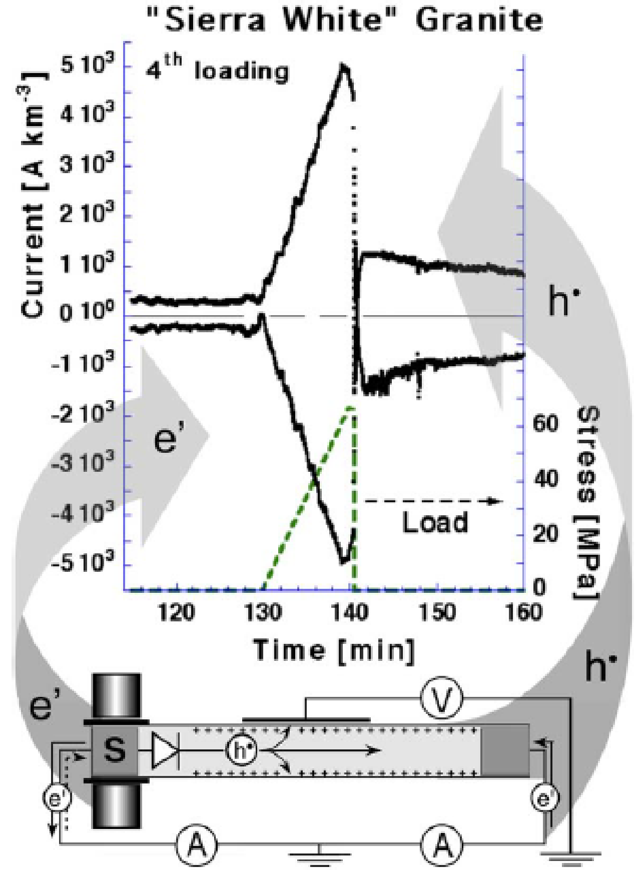


Fig. 2. Two currents flowing out of the stressed rock volume, the "source" S, and a schematic representation of the current flow through the external circuit and inside the rock passing through the interface between stressed/unstressed rock which acts as a barrier for electrons.

Physics and Chemistry of the Earth 31 (2006) 389–396

Electric currents streaming out of stressed igneous rocks
A step towards understanding pre-earthquake
low frequency EM emissions

Friedemann T. Freund [a,b,*], Akihiro Takeuchi [b,c], Bobby W.S. Lau [b]

Final goal
To establish morphology on earthquake effects , methodology to predict earthquake occurrence
;
Ground based observations ;need model which can reflect geomagnetic disturbance , as a first step—
1.Is accuracy enough , Maximum deviation from average is about 20%).
2. Observation side is nopt suffficient.
3. Only Japan has long term systematic observation(SPIDER).

Coordination of satellites !!!

Fundamental Solid State Defect

**Oxygen anions in minerals
in igneous and high-grade metamorphic rocks
exist in the valence 1–
(instead of the usual 2–)**

instead of $O_3Si\text{-}O\text{-}SiO_3$

there is $O_3Si\text{-}OO\text{-}SiO_3$

Quartz,
feldspars,
pyroxenes,
etc.

Peroxy

**Peroxy is a diamagnetic point defect
about 100-1000 ppm**

When stresses are applied, dislocations move

$$O_3Si/^{OO}\backslash SiO_3 + [SiO_4]^{4-} \rightarrow \{O_3Si/^{O\bullet}{}_{\bullet O}/SiO_3\} \rightarrow O_3Si/^{O\bullet}{}_{O}/SiO_3 + [SiO_4]^{3-}$$

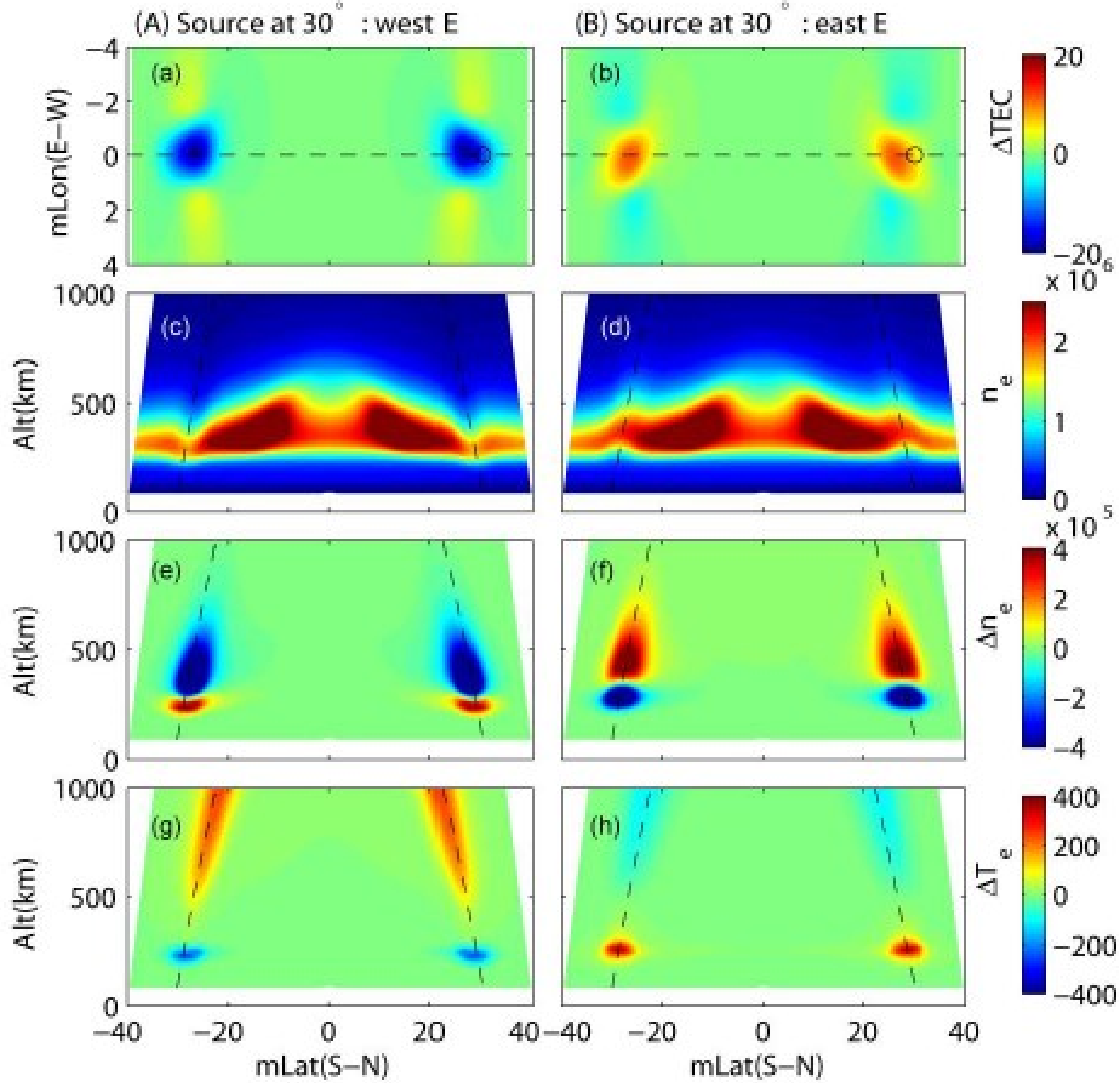
peroxy link + O^{2-} matrix → broken peroxy link → broken peroxy link + $h^{\bullet}$

e^-

Dislocations cut through grains

Dislocations break peroxy links

Electron transferred from neighboring O^{2-} generates an O^-



Kuo-et al, 2014 JGR

The space projects where the ionosphere observation and the earthquake precursors were studied

- **Alouette - 1964**
- **Cosmos-274 -1969**
- **OGO-6 - 1969**
- **OVI-17 - 1969**
- **ISIS-2 – 1971**
- **AE-C -1973**
- **GEOS-1 and 2 - 1978**
- **Intercosmos-19 – 1979**
  Aureol-3 –1981

- **Intercosmos-Bulgaria 1300 – 1982**
- **Salyut-7 - 1985**
- **Meteor-3 - 1986**
- **Cosmos 1809 -1987**
- **ISIS-2 – 1971**
- **Activny -(Intercosmos-24) -1989**
- **TOPEX/Poseidon - 1996**
- **GEOS-1 and 2 - 1978**
- **MIR Space Station**
- **DE-2**
- **Quakesat**
- **DEMETER**

Abnormal behavior of Ne,atmospheric glow,TEC,VLF,ion composition and particle precipitation have been reported ,which might have been associated with earthquake. **We report at the beginning the ionosphere result from Hinotorori satellite**