

Investigation of "positive hole excitation" for stressed igneous rocks with a control of water content

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Piezo electric effects, positive hole excitation for stressed igneous rocks and streaming potential have been considered possible mechanisms that explain pre-seismic electric signals. Especially, positive hole excitation, (Freund et al. 2006), explains long-term anomalous electromagnetic signals and telluric current signals observed for a long distance, therefore attracts a lot of attention.

To clarify the mechanism of pre-seismic electric signals, we performed following experiments for stressed igneous rocks with saturated by water. Samples of granite and gabbro sized $3 \times 3 \times 10$ cm. Then, the samples were loaded from 1.08MPa to 5.45MPa, with recording of water content. Current-flows from -40pA to -20pA and around -1.5nA were observed for granite and gabbro samples respectively, while any current changes were not observed from bone-dry rocks. These results indicate that pore water is closely tied to current changes. Samples with different size were also tested. The values of current-flow agree well with results of observation of pre-seismic anomalous telluric current signals in Kozu-shima Island (Orihara et al. 2012), assuming the resistivity 10-1000 Ω m.

Reference

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- 2) Y.Orihara, M.Kamogawa, T.Nagao, S.Uyeda, 'Preseismic anomalous telluric current signals observed in Kozu-shima Island, Japan', *Proceedings of the National Academy of Sciences* Vol.109 No.47 pp.19125-19128. (2012)

Keywords: Seismic electric signals, Streaming potential, Positive hole excitation, Igneous rocks

Analysis of geomagnetic diurnal variations at Esashi station from 1997~2012

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There have been many reports on ultra-low-frequency (ULF) electromagnetic phenomena associated with earthquakes in a very wide frequency range. In this study, unusual behaviors of geomagnetic diurnal variations prior to the 2011 off the Pacific coast of Tohoku earthquake (Mw9.0) have been reported. Ratios of diurnal variation range between the target station Esashi (ESA) which is about 135 km from the epicenter and the remote reference station Kakioka (KAK) have been computed. The results showed that there had been clear anomalies exceeding the statistical threshold in the vertical component about 2 months before the mega event. These anomalies are unique over a 16 years background. The original records of geomagnetic fields of the ESA station also exhibited continuous anomalous behaviors for about 10 days in the vertical component from Jan.3, 2011-Jan.13, 2011, about two months prior to the Mw 9.0 earthquake. During the same period, other independent geophysical parameters such as seismicity and crustal deformation also show clear unusual changes, which suggests these anomalies might be related with the mega event.

Keywords: ULF seismo-magnetic phenomena, earthquake, geomagnetic diurnal variations

Identification of seismo - ionospheric signatures by using amplitude and phase information of VLF/LF transmitter waves

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In this paper, we analyse the VLF/LF transmitter signals in association with major seismic activities over Japan. Particular attention is paid to phase in addition to amplitude information of the VLF/LF signals. As a result, significant change both in the phase and amplitude are identified as an anomaly of seismo - ionospheric signatures. Moreover, the results of numerical analysis of VLF/LF transmitter waves in the earth - ionosphere waveguide by using FDTD method are in good agreement with the experimental results. We conclude that simultaneous use of amplitude and phase information of VLF/LF signal will be useful to identify the special scale of seismo - ionospheric anomalies.

Keywords: seismo - ionospheric perturbation, FDTD method, VLF/LF transmitter, earthquake

Ionospheric Anomaly as an Earthquake Precursor : Statistical Study during 1998-2012 around Japan

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Many anomalous electromagnetic phenomena possibly associated with large earthquakes have been reported. TEC (Total Electron Contents) anomaly is one of the most promising phenomena preceding large earthquakes. We investigated statistically TEC anomalies before large earthquakes around Japan region during 1998-2012. In this study, superposed epoch analysis (SEA) and Molchan's error diagram (MED) analysis have been taken to investigate correlation and predictability in the statistical manner. The results of SEA show that positive anomaly 1-5 days before the large earthquake ($M \geq 6.0$ and depth ≤ 40 km) is significant. The results of MED analysis indicate the some gain against the random estimation (Poisson model). That is, the prediction using TEC anomaly around Japan is not random and has an information. The details will be given in the presentation.

Detection of thermal anomaly associated with Earthquake from MODIS data

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It is a critical issue to mitigate of disasters including earthquake. And it is required to develop of technique to monitor and predict major earthquakes. Therefore, the purpose of this study is to develop an adequate algorithm to detect LST (Land Surface Temperature) anomalies related to earthquakes using MODIS (Moderate Resolution Imaging Spectroradiometer) infrared sensor onboard Terra/Arqua satellite.

We investigate spatial-time changes in LST in the statistical way. In order to detect only hotspots related to earthquakes without faints, the developed algorithm investigates the difference temperature behavior between a target point and spatial average, and we get spatial difference of brightness temperature(ΔT). In order to evaluate the temporal singularity of ΔT , we calculate the following equation.

$$R = (\Delta T(x,y,t) - \text{ave}(x,y)) / \sigma(x,y)$$

where $\text{ave}(x,y)$ is multi year plus minus 15 days moving average. And $\sigma(x,y)$ is multi year plus minus 15 days moving standard deviation.

We detect LST anomaly 8 days before L'Aquila earthquake. And it continued for several hours. This result represents that it has potential for monitoring/predicting major earthquakes to develop algorithms to detect thermal anomalies using MODIS data.

Keywords: MODIS, Earthquake, L'Aquila, thermal anomaly