Study of Geomagnetic Anomalies Related to Earthquakes: Pisco Eq (M=8) 2007, Peru and Taiwan Eq (M=6.4) 2009

K. Yumoto\textsuperscript{1, 2}, E. M. Takla\textsuperscript{2}, J. Ishitsuka\textsuperscript{3}; D. Rosales\textsuperscript{4}; S. Dutra\textsuperscript{5}; Jann-Yenq Liu\textsuperscript{6}; Y. Kakinami\textsuperscript{6}; T. Uozumi\textsuperscript{1}, S. Abe\textsuperscript{1}, and A. Ikeda\textsuperscript{1}

[3] Instituto Geofisico del Peru, Ancon Observatory
[5] National Space Research Institute, Brazil.
[6] Institute of Space Science, National Central Uuiv., Taiwan.

Content

1. MAGDAS Stations near the EQs.
2. Geomagnetic anomalies related to Peru EQ 2007
3. Geomagnetic anomalies related to Taiwan EQ 2009
4. Summary of geomagnetic anomalies
Comparison of geomagnetic variations near the epicenter station with those at the remote reference station.
1.2 MAGDAS Magnetometer (2005)

- Fluxgate-type with 3-axial ring-core sensor (amorphous metallic alloys) (H, D, Z, F)-components
- Observation ranges:
  - ±300nT
  - ±1000nT
  - ±2000nT
  - (±65000nT)
- 16bit A/D converter:
  - 0.0091nT/dig, 0.031nT/dig, 0.061nT/dig
- Sampling rate:
  - 16Hz, 1-sec, 1-min
- Estimated noise level:
  - 0.02nTp-p
- Total weight = 14.5 kg
- GPS antenna

Tiltmeter of sensor:
- Range: ±1°
- Resolution: 0.2 arc-sec

Thermometer of sensor:
- Range: ±60°C
- Resolution: 0.002°C

The data can be transferred to SERC/Kyushu Univ. by using three lines:
(1) INTERNET, (2) Telephone and (3) Satellite mobile phone.
2.1 Details of Pisco EQ near ANC Station

EQ Details
Magnitude: 8.0
Date-Time: at 23:40:57 UT on Aug. 15 (Wed), 2007
= at 06:40:57 PM at the epicenter
Location of EC: (13.354° S, 76.509° W)
Depth of EC: 39 Km
Distance from ANC to EC: ~ 180 km;
Ancon station (ANC): (11.77 S°, 77.15° W)
The daily average values of H, D and Z components recorded at ANC station from 2003 to 2010. The red line can be used as a reference to examine the wavy-shape variations and also the change in the decreasing rate of the Z component after and before the Pisco earthquake.

Takla et al. (2011)
2.3 Comparison of Daily Variations at ANC and EUS (MAGDAS) during 14-16 Aug. 2007
2.4 Comparison of Daily Variations at ANC and EUS (MAGDAS) during 14-16 Aug. 2007

Takla et al. (2011)

Disappearance of Z-component Sq Variation
2.4.2 Comparison of Daily Magnetic Variations recorded at ANC (Red) and HUA (Blue) stations during 14-16 August 2007

![Graph showing magnetic variations](image-url)
The polarization ratio (Z/H) of Pc 3 [10-45 s] amplitude observed at ANC station during 2007-2010. The red line represents the 10 days running average.
The distance between the Epicenter and the HLN station is about 20 km.

Cross section of the subduction plate boundaries at Taiwan Island.

Hualien station

Depth 49 km

The distance between the Epicenter and the HLN station is about 20 km.
3.2 Co-seismic Magnetic Variation (about 5 nT)

E. Takla et al. (2011)

Comparison of the total geomagnetic field intensity (nT) recorded at HLN and AMA.

The total field intensity (F) at HLN (Red) and AMA (Blue) station [nT ]

<table>
<thead>
<tr>
<th>Time</th>
<th>Station 1</th>
<th>Station 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00 UT</td>
<td>DCE 9, 2009</td>
<td></td>
</tr>
<tr>
<td>13:00 UT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16:00 UT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HLN near the epicenter (~20Km)

AMA (remote reference station ~900 km)

Comparison of the total geomagnetic field intensity (nT) recorded at HLN and AMA.
3.3-1 Geomagnetic Data (HDZ) at **HLN (~20km)** and **AMA (~900km)** Stations during **Sept. 2009**

E. Takla et al.(2011)

Geomagnetic data (HDZ components) nT recorded at HLN(Red) and AMA(Blue) stations

**H**

**AMA (remote reference station ~900 km)**

**HLN near the epicenter (~20Km)**

**D**

**AMA**

**HLN**

**Z**

**AMA**

**HLN**

Days of September 2009
3.3-2 Geomagnetic Data (HDZ) at HLN (~22km) and AMA (~900km) Stations during Dec. 2009

E. Takla et al. (2011)

Geomagnetic data (HDZ components) nT recorded at HLN (Red) and AMA (Blue) stations.

HLN near the epicenter (~20Km)

AMA (remote reference station ~900 km)
3.3-3 Correlation plots at HLN and AMA for the night-time (7 PM to 5 AM LT) during September and December 2009

E. Takla et al. (2011): Comparison between near epicenter and remote reference
3.4 Difference of the HDZ components recorded at HLN near the epicenter to AMA reference station (August - December 2009) night-time data (7 PM to 5 AM local time)

E. Takla et al.(2011)

EQ 19 Dec. 2009, M=6.4
3.5 Six hours average values of Pc 3 amplitude (10-40 s) at HLN and the Polarization ratio (Z/H) Aug. 2009-Jan. 2010

E. Takla et al. (2011)
4. Summary of Geomagnetic Anomalies

(1) Pisco Peru EQ 2007 (M=8.0);
   a) Long-term, anomalous geomagnetic Z-component variations at ANC station (~180km) with several month period.
   b) Disappearance of Z-component Sq magnetic variation at ANC on the day of great earthquake, by comparing with the remote reference.
   c) Decreases of Pc 3 (10-45 sec) Z/H ratio at ANC in relation to the onset of EQs.

(2) Taiwan EQ 2009 (M=6.4); By comparing with the reference station,
   a) A co-seismic geomagnetic variation of about 5 nT decrease in the total magnetic field intensity at HLN station (~20km).
   b) Anomalous geomagnetic variations about 15 nT started about 7 days before the onset of EQ, and lasted for about 10 days at HLN.
   c) A small decrease of Pc 3 polarization (Z/H) at HLN started a few days before the onset of EQ.

These results indicate the anomalous increase of lithospheric conductivity before the EQs.

Thank you very much  http://www.serc.kyushu-u.ac.jp/