Seismo-Electromagnetic Research in Indonesia: Recent Progress and Some Results

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Indonesia is recognized as one of the most tectonically active regions in the world. This is evident in the number of earthquakes experienced by the country annually. Every year, Indonesia suffers extensive damage and loss of human life from earthquakes. To mitigate death and destruction on the islands of Indonesia, it is necessary that a way of making a "forecast" for earthquakes be developed. Recently, seismo-electromagnetic phenomena have been considered a promising tool for monitoring seismic activity. The presence of such precursory signature related to strong earthquakes has been identified in the ionospheric perturbations and anomalous ULF geomagnetic field change. There has been a good deal of accumulated and convincing evidence of ionospheric perturbations and ULF magnetic signatures before strong earthquakes as reported in the previous studies. Studies related with ionospheric precursors of the earthquakes in Indonesia using the TEC (Total Electron Content) data and the pre-earthquake ULF geomagnetic anomalies are carried out at LAPAN in collaboration with Chiba University, The University of Electro-Communications, Nagoya University, Kyushu University, NCU Taiwan, LIPI, BMKG, and Bakosurtanal. Case studies are carried out in this work to investigate the ionospheric precursors of the earthquakes and the pre-earthquake ULF geomagnetic anomalies during the Aceh earthquake on December 26, 2004 (magnitude Mw= 9.0 and depth = 30 km from USGS catalog), and Nias earthquake of March 28, 2005 (Mw= 8.7 and depth = 30 km). It has been found that the ionospheric anomalies appear a few days prior to earthquakes and seismic activity is possible source of the ionospheric anomalies. To investigate the pre-earthquake ULF geomagnetic anomalies, we have adopted the spectral density ratio analysis and transfer functions analysis based on wavelet transform method. Results of the spectral density analysis indicate similar variations to those of amplitude for the induction arrow in transfer function analysis. Both of these variations at Kototabang exhibit strange or anomalous changes from a few weeks before the Sumatra-Andaman earthquake to March 2005, while there are no apparent changes at remote station of Biak. To make these results more convincing, the fractal analysis based on Higuchi method has been applied to the same observed data, which also show a significant change in mono-fractal dimension a few weeks before the

earthquakes. This result would lend a further support to those by the polarization and transfer function analyses. So, we can conclude that the anomalous change as observed simultaneously by the these methods, might be a possible signature related with the earthquake preparation phase of Sumatra earthquakes.