Long-term magnetic anomalies and their possible relationship to the latest greater Chilean earthquakes in the context of the seismo-electromagnetic theory

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Abstract
Several magnetic measurements and theoretical developments from different research groups have shown certain relationships with worldwide geological processes. Secular variation in geomagnetic cutoff rigidity, magnetic frequencies, or magnetic anomalies have been linked with spatial properties of active convergent tectonic margins or earthquake occurrences during recent years. These include the rise in similar fundamental frequencies in the range of microhertz before the Maule 2010, TÅ hoku 2011, and Sumatra-Andaman 2004 earthquakes and the dramatic rise in the cumulative number of magnetic anomalous peaks before several earthquakes such as Nepal 2015 and Mexico (Puebla) 2017. Currently, all of these measurements have been physically explained by the microcrack generation due to uniaxial stress change in rock experiments. The basic physics of these experiments have been used to describe the lithospheric behavior in the context of the seismo-electromagnetic theory. Due to the dramatic increase in experimental evidence, physical mechanisms, and the theoretical framework, this paper analyzes vertical magnetic behavior close to the three latest main earthquakes in Chile: Maule 2010 (Mw 8.8), Iquique 2014 (Mw 8.2), and Illapel 2015 (Mw 8.3). The fast Fourier transform (FFT), wavelet transform, and daily cumulative number of anomalies methods were used during quiet space weather time during 1 year before and after each earthquake in order to filter space influence. The FFT method confirms the rise in the power spectral density in the millihertz range 1 month before each earthquake, which decreases to lower values some months after earthquake occurrence. The cumulative anomaly method exhibited an increase prior to each Chilean earthquake (50-90 d prior to earthquakes) similar to those found for Nepal 2015 and Mexico 2017. The wavelet analyses also show similar properties to FFT analysis. However, the lack of physics-based constraints in the wavelet analysis does not allow conclusions that are as strong as those made by FFT and cumulative methods. By using these results and previous research, it could be stated that these magnetic features could give seismic information about impending events. Additionally, these results could be related to the lithosphere-atmosphere-ionosphere coupling (LAIC effect) and the growth of microcracks and electrification in rocks described by the seismo-electromagnetic theory.