A Feature-Based Approach to the Classification of Anomalous Signals in Geomagnetic Data

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1. QuakeFinder

QuakeFinder and its international collaborators have installed and currently maintain an array of 165 three-axis induction magnetometer sites in California, Peru, Taiwan, Greece, Chile and Sumatra. Based on research by Bleier *et al.* (2009), Fraser-Smith *et al.* (1990), and Freund (2007), the electromagnetic data from these instruments are being analyzed for pre-earthquake signatures. This analysis consists of both private research by QuakeFinder and institutional collaborators.

QuakeFinder has developed an algorithm framework aimed at isolating anomalous signals (pulses) in the time series. We apply this framework to the magnetometer data and compute features of the isolated pulses. Based on these features, the pulses are then filtered and categorized using a variety of methods. Pulses of interest can then be analyzed with respect to their relationship with seismicity. We map daily pulse-counts to a time series representing the likelihood of a seismic event occurring at some future time. These “pseudo-probabilities” can in turn be represented as Molchan diagrams. The Molchan curve provides an effective cost function for optimization and allows for a rigorous statistical assessment of the validity of pre-earthquake signals in the electromagnetic data.

We explore different methods to isolate these pulses in the data, features to characterize them, and ways to determine their source. Specifically we emphasize the usage of clustering algorithms applied to principle components in feature space and algorithms that identify simultaneous pulses at more than one station where typical station distance is approximately 32km. By integrating these new techniques into our algorithm, we can compare the Molchan curves and fairly assess their performance.

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