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Correlation of pre-earthquake electromagnetic s with laboratory and field rock experiments

T. Bleier[1], C. Dunson[1], C. Alvarez[1], F. Freund[2], and R. Dahlgren[3
[1]Quakefinder, Palo Alto, Ca, USA
[2]NASA Ames Research Center, Moffett Field, Ca, USA
[3]Dept. of Physics and Astronomy, San José State University, San José, C

Abstract. Analysis of the 2007 *M*5.4 Alum Rock earthquake near Sa California showed that magnetic pulsations were present in large ı and with significant amplitudes during the 2 week period leading u event. These pulsations were 1–30 s in duration, had unusual pola (many with only positive or only negative polarities versus both po and were different than other pulsations observed over 2 years of that the pulse sequence was sustained over a 2 week period prior quake, and then disappeared shortly after the quake. A search for underlying physics process that might explain these pulses was w undertaken, and one theory (Freund, 2002) demonstrated that ch carriers were released when various types of rocks were stressed laboratory environment. It was also significant that the observed c carrier generation was transient, and resulted in pulsating current patterns. In an attempt to determine if this phenomenon occurred of the laboratory environment, the authors scaled up the physics experiment from a relatively small rock sample in a dry laboratory s to a large 7 metric tonne boulder comprised of Yosemite granite. T boulder was located in a natural, humid (above ground) setting at Lake, Ca. The boulder was instrumented with two Zonge Engineer Model ANT4 induction type magnetometers, two Trifield Air Ion Cou surface charge detector, a geophone, a Bruker Model EM27 Fourie Transform Infra Red (FTIR) spectrometer with Sterling cycle cooler, various temperature sensors. The boulder was stressed over abou using expanding concrete (Bustar^{tm}), until it fractured into three m pieces. The recorded data showed surface charge build up, magne pulsations, impulsive air conductivity changes, and acoustical cues about 5 h before the boulder actually broke. These magnetic and a conductivity pulse signatures resembled both the laboratory rock s results and the 30 October 2007 *M*5.4 Alum Rock earthquake field

The second part of this paper examined other California earthquak to the Alum Rock earthquake, to see if magnetic pulsations were a present prior to those events. A search for field examples of mediu earthquakes was performed to identify earthquakes where functio magnetometers were present within 20 km, the expected detectio of the magnetometers. Two earthquakes identified in the search ir the 12 August 1998 *M*5.1 San Juan Bautista (Hollister Ca.) earthqu

the 28 September 2004 *M*6.0 Parkfield Ca. earthquake. Both of th
sets were recorded using EMI Corp. Model BF4 induction magneto
installed in equipment owned and operated by UC Berkeley. Unfor
no air conductivity or IR data were available for these earthquake
examples. This new analysis of old data used the raw time series
samples per s), and examined the data for short duration pulsatio
exceeded the normal background noise levels at each site, similar
technique used at Alum Rock. Analysis of Hollister magnetometer,
positioned 2 km from the epicenter, showed a significant increase
magnetic pulsations above quiescient threshold levels several wee
and especially 2 days prior to the quake. The pattern of positive a
negative pulsations observed at Hollister, were similar, but not ide
Alum Rock in that the pattern of pulsations were interspersed with
pulsation trains, and did not start 2 weeks prior to the quake, but
days prior. The Parkfield data (magnetometer positioned 19 km fr
epicenter) showed much smaller pre-earthquake pulsations, but th
had significantly higher conductivity (which attenuates the signals)
interesting was the fact that significant pulsations occurred betwe
aftershock sequences of quakes as the crustal stress patterns we
migrating.

Comparing laboratory, field experiments with a boulder, and earth
events, striking similarities were noted in magnetic pulsations and
conductivity changes, as well as IR signals (where instrumented).
earthquake samples, taken with the appropriate detectors and wi
15 km proximity to large (>*M*5) earthquakes, are still needed to pr
more evidence to understand the variability between earthquakes
various electromagnetic signals detected prior to large earthquake

Full Article (PDF, 2585 KB)