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Interactive comment on "Pre-earthquake magnetic pulses" *by* J. Scoville et al.

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Dear Dr. Masci,

I would like to add a few comments to those already sent to you by my colleagues and co-authors.

I agree with your remarks in the Interactive Comment referenced above when you say "that the experiment of Dahlgren et al. (2014) does not fully match the physic-chemical condition of the Earth's crust, but also a merely dry crust does not *match reality*".

I think the last words are vital to the contribution of our paper. Let me bring to this discussion, another look at the context in which our paper came up. As we all know, any theory has to describe the phenomenon, make predictions, but essentially it should conform to, or as you put it "match", reality. In the research work I have been doing in Peru for the last seven years, I have encountered several good examples of the generation, propagation and detection of electromagnetic phenomena, with extreme care not to fall into false expectations, which conform to the theory of the generation of positive-holes in rocks pioneered by Dr. Freund. I met him as a consequence of one of my publications having to do with co-seismic light emission in the area of Lima, Peru highly time-correlated with the ground acceleration produced by the S-wave during the 2007 Ml 8.2 earthquake and I hypothesized that the electric charges that produced the light emissions were released locally, with the epicenter located about 160 km away. We coincided in appreciating the reality matching observations and in the conclusions connected with his research.

Besides studying light emissions, time was dedicated to develop a technique to reliably compute the azimuth for the arrival of the EM ULF pulses we observed after an earthquake in southern Peru, the second validation for similar phenomena observed by Quakefinder during the Alum Rock earthquake in California. The pulses, from about 0.01 to 1 Hz, had been conjectured, were produced in the Earth's crust and detected by our very sensitive 3-axis magnetometer network in Peru, consisting of 10 sites. A technique was thence developed to jointly process information from two of them, strategically deployed in the northern part of the bay of Lima, to triangulate the origin of the EM pulses and determine the geographic position of the stress area and try to predict the future epicenter. This was done successfully and the distance from our "predicted" future epicenters to the actual epicenter of the earthquake, has ranged from 0 to about 12 km in about a dozen observations. In about a year and a half, we have about a dozen hits in two areas of the country, about 1000 km from each other with no false negatives and in the few false positives we have, an earthquake has occurred, on the predicted day but in a nearby area in the south which looks seismically connected with the northern area. This alerts us that the possible two hundred km rupture between these areas, would mean a very high magnitude earthquake. Part of the above has been covered in the presentation cited in our paper, at AGU.

Although what I described is not the precise theme of this paper under discussion, it provides the experimental perspective for the model therein, since the pulses we are using, "to match reality", come from the precise magnetometer sites described above. It constitutes a reality then, that EM ULF pulses are being produced about 10 - 50 km from the coast, at depths of 25 to 60 km, prior to an earthquake. It is a reality that they can propagate through rock and sea water, for at least 75 km and perhaps 95 km, from observations in other magnetometer sites we operate in Peru. It is a reality that the computational results described in our paper under discussion, match outstandingly well the observed mono-polar pulses that nature produces, particularly in those cases where we can observe that an earthquake has occurred just a few kilometers away from the source detected, ahead of time, of ULF pulses with our magnetometers in Peru. EM pulses do occur, they are currently being used by my group in Peru to predict earthquakes and our paper, I think, models quite well their generation process.

The propagation of ULF signals in the lithosphere beneath the ocean bed, as well as on the sea water has been studied for some years now for practical purposes, especially for submarine communications and underwater detection. Even though useful bandwidths are very small, in some cases not more than a few Hz, it is enough to convey simple but potentially vital information on geophysical phenomena that can be used advantageously. Chave, Flosadottir and Cox[1] consider a model for the electrical conductivity beneath the deep seafloor using, precisely, geophysical evidence. Their model consists of relatively conductive sediment and crustal layers of 6.5 km on a sub-crustal channel of 30 km thickness. They found that significant enhancement of the field amplitude can occur at long ranges (> 100km) and low frequencies (<1 Hz) in sea water due to rather small attenuation of EM signals, with range decreasing by 1/e every 270m at 1Hz and also as the square root of the frequency. This is in close

agreement with our experimental scenario for the source of "reality matching" pulses to test the computational proposal. The authors even explored the practicality of lithospheric communication, obtaining sufficient signal/noise ratios but at 100 km ranges and 1 Hz bandwidths. Again, even through the under seabed crust, lower than 1 Hz waves can convey information at distances up to 100 km. It is obvious that before we talk about the feasibility of sea water propagation, lithospheric propagation has to occur, especially for the scenario used in the typical 20-60 km depth hypocenters in the subduction zone along the Peruvian coast. For magnetometer coils buried at the sites, several kilometers from the sea shore, the all-lithospheric propagation of the ULF pulses is a very plausible scenario. As you can see, we in Peru, are using Dr. Freund's positive holes theory to understand the underlying phenomena of charged particles and electromagnetic pulse generation as related to premonitory seismic activity. Even more, we are using it to predict the occurrence of earthquakes and their possible epicenters and complying in every case with reality. In summary, I believe that the model described in our paper explains very well the production of ULF pulses, embedded in reality as evidenced by the "predicted" earthquakes in central and southern Peru.

References:

1. Alan Chave, Agusta H. Flosadottir, and Charles S. Cox, Some Comments on seabed propagation of ULF/ELF electromagnetic fields, ATT Bell Laboratories, Murray Hill, New Jersey and Scripps Institution of Oceanography, La Jolla, California, *Radio Science.* Vol. 25, No. 5, p. 825-836, September-October 1990.

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