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Solid Earth Discussions

Interactive comment on "A critical discussion of the electromagnetic radiation (EMR) method to determine stress orientations within the crust" *by* M. Krumbholz et al.

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General Comments:

This paper clearly demonstrates that geoelectromagnetic field measurements made in the VLF frequency band are dominated, not surprisingly, by the hefty signals arising from VLF radio transmitters. These radios are designed to communicate with submarines across vast intercontinental distances. The powerful radio signals have long been exploited by practitioners of the well-established VLF prospecting method to probe crustal geology. On the other hand, abundant and reliable laboratory data have indicated that bursty VLF electromagnetic fields are also generated as rock samples

fracture in response to an applied stress. Previous researchers have seized upon the laboratory results and have attempted to map regional-scale VLF bursts using specially designed antennas and then have tried to associate the mapped electromagnetic measurements to regional-scale horizontal stress distributions, keeping in mind that micro-cracks align themselves with horizontal stress directions. While some apparent successes have been reported, none of the previous researchers have been able to link the electromagnetic measurements directly to observed subsurface micro-crack systems, such that the latter have remained purely hypothetical. The main contribution of this paper is that it demontrates that the previous researchers also do not properly take into account the important role of the VLF radio transmitter signals, and furthermore the paper points out some important concerns about the design, performance and use of the specially designed antennas that make the regional-scale measurements. The conclusion of the paper is that previous interpretations of geophysically-mapped, apparent bursty VLF signals in terms of a regional-scale horizontal stress distribution are severely compromised.

Specific Comments:

The strength of this paper is that it does an excellent job in convincing the reader that regional-scale VLF-band electromagnetic measurements made in Europe respond dominantly to VLF radio transmitter signals. A number of lines of evidence are cited, including: the circular pattern of electromagnetic field polarization centered on a known VLF radio transmitter; the fall-off in electromagnetic field intensity with range from the radio transmitter; the number of apparent VLF bursts in a given period of time corresponding precisely to the VLF radio transmission frequency; the dimunition of electromagnetic field intensity during the OFF time of the VLF radio transmitter and its increase when the radio transmitter is switched ON.

The authors also correctly point out that the traditional VLF geophysical prospecting method is particularly well-suited to detection of electrically conductive fault zones, by sensing the enhanced subsurface electrical conductivity caused typically by the pres-

ence of water or clay within the fault zone. The traditional VLF prospecting method does not detect bursty VLF signals from micro-cracking but instead the secondary magnetic field due to electric currents induced in the conductive fault zone by the primary VLF signal arising from the radio transmitter. Previous interpretations of apparent bursty VLF signals emanating from micro-cracking within fault zones do not clearly rule out the traditional VLF-prospecting interpretation.

A first weakness of this paper is that it does an inadequate job of criticizing the performance and operating characteristics of the specially designed antenna. In particular, the authors claim that the pass filters are not effective while the notch filters perform well. This assertion is not documented quantitatively, especially when it is considered that VLF towers do not broadcast a purely monochromatic signal. The power spectrum of the transmitted signal might reveal spectral leakage. In my opinion, any discussion about the effectiveness of the filters is not necessary to support the central thesis of this paper and can be removed from the text.

A second weakness of the paper is that, during the OFF time of the closest VLF transmitter the authors claim that the received signals are due to other, more distant VLF transmitters. While plausible, I didn't think that the authors make a particularly strong case for this supposition. In my opinion, exploration of this topic would contribute hugely to the main thesis and authors are advised that its better development would further strengthen the paper.

Interactive comment on Solid Earth Discuss., 4, 993, 2012.