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Interactive Comment

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

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Communicated on behalf of F. Freund.

Dear Dr. Masci,

Dahlgren et al.* [DJVN] recently reported on rock stressing experiments which they had conducted at the NASA Ames Research Center as part of a collaboration that I had initiated – upon NASA’s request – to resolve a longstanding disagreement between Malcolm Johnston and myself regarding the nature of the charge carriers that become activated when rocks are subjected to deviatoric stress. I was present at the start of the project, when Dr. Johnston insisted on preloading the rock samples, arguing that firm clamping was “common procedure in rock mechanics”. I pointed out that preloading is the worst thing to do, if the goal is to measure stress-activated electric currents in rocks. Unfortunately, for personal reasons, I was unable for some time to participate in the experimental work. During this time DJVN went ahead with their preloading procedure.

Why is preloading bad? Peroxy defects tend to be located along, even straddle grain boundaries. As soon as stresses are applied, grains will shift relative to each other, causing peroxy bonds to break and release highly mobile positive holes. These charges flow out of the stressed rock volume forming positive outflow currents. At the same time, the positive holes also recombine with half-lives ranging from milliseconds to hours, even days. As a result, the stress-activated outflow currents are inherently unstable, especially at the beginning of loading, when these currents vary non-linearly as a function of time and as a function of the rate at which stresses are applied.

The proper way to measure stress-activated electric currents is to start at 0 MPa, to make sure that the baseline currents are stable near 0 pA, and to end at 0 MPa. By clamping their rock samples, DJVN created conditions where the baseline currents varied wildly between –1000 pA and +450 pA for dry rock samples and tens of nA for water-saturated rocks. DJVN never made any attempt to validate their preloading procedure or to determine whether the stress-activated charge carriers are electrons or holes. Nonetheless they call currents that decrease “negative” currents. This is unphysical to say the least. A positive current that decreases is not a negative current.

DJVN’s statement that the “negative sign . . . is inconsistent with the physical model of positive hole generation” can therefore be assumed to be based on a fundamental misconception of electric charge. Likewise, DJVN’s statement that the alleged negative currents “raise questions about the applicability of the semiconductor p-hole theory proposed by Freund (2002) to explain the earlier results” is totally unfounded.

By the time I was able to rejoin, DJVN had completed their runs. NASA provided additional funds to finish the project and to repeat the experiments without preloading.

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However, DJVN never returned to complete the collaborative work. Instead they started to disseminate the results they had obtained – against my outspoken advice – with their preloading procedure and without any controls that would have uncovered the shortcomings of their approach. DJVN have taken this work, initiated as a collaboration, into a very one-sided, biased direction. They have not proven in any way what they allege to have shown. Referencing their paper would do science a disservice.

Sincerely,

Friedemann Freund

References:

* Dahlgren, P. R., M. J. S. Johnston, V. C. Vanderbilt, and R. N. Nakaba (2014), Comparison of the stress-stimulated current of dry and fluid saturated gabbro samples, *Bulletin of the Seismological Society of America*, 104, 2662-2672.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 7367, 2014.