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Solid Earth
Discussions

Interactive comment on "The model of own seismoelectromagnetic oscillations of LAI system" *by* M. K. Kachakhidze et al.

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The authors of this paper have embarked on an ambitious project: develop a model concept that could explain some or many of the reported pre-earthquake (pre-EQ) phenomena. They correctly identify electrical processes to be at the root of the most commonly discussed pre-EQ phenomena, the emission of electromagnetic (EM) signals over a wide frequency range.

This should lead them immediately the most fundamental question: How can EM signals be generated in the natural environment?

The only possible avenue toward solving this question is to discuss changes in the electrical characteristics of the rocks themselves in the Earth's crust or across the

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ground-to-air interface. These changes cannot be passive - meaning just an increase in the electrical conductivity of the rocks - but they have to be active - meaning that electric charges of some kind have to be generated and moved around or separated in such a way that dipoles form which change with time. Such changing dipoles can then act as “antenna” to produce EM emission.

They indeed write along these lines postulating a “sharp change of electric conduction of lithospheric medium before earthquake and its subsequent atmospheric effect caused by emanation of charged particles or ionization of medium.”

The literature dedicated to pre-EQ phenomena is full of papers that address the very same issues, namely what are the processes that can take place in rocks during increasing tectonic stress and that could lead (or would lead) to the movement of electric charges and ultimately to dipoles. Several mechanisms have been proposed, prominent among them microfracturing, streaming potentials and the piezo-electric effect.

Microfracturing is a concept that has developed over the years by those who conduct rock fracture experiments in the preferred laboratory way: by loading rock cylinders in a press until they fail. Of course, given an unconstrained rock cylinder loaded over its entire cross section, the Poisson ratio comes into effect full force: the cylinder will increase its volume and bulge outward, allowing microfractures to form in the inside and tensile forces to act on the surface of the rock cylinder. These tensile forces initiate the failure.

Though an wildly popular concept in seismology circles, microfracturing is inconceivable deep inside the Earth’s crust, where fault ruptures are initiated. The lithostatic pressure due to an overload of 10-35 km rocks will counteract any volume expansion, which is a condition sine qua non microfractures cannot even begin to form. The fact that rock fracture experiments have been conducted inside pressure vessels under “simulated” high pressure conditions and have produced certain results is pretty irrelevant. Those “simulated” experiments use gas pressure to imitate the load. This is a

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fundamentally wrong approach since gases are easily compressible at any pressure range and rock cylinders loaded under such “simulated” high pressure condition will bulge outward just as much as they do in open lab experiment. What would be needed to establish truly simulated crustal conditions is to surround the rocks under deformation with a medium that will resist any ever so slight outward bulging delta-x with a counterforce that increases exponentially with x.

The authors do not discuss microfracturing but mention it just once, in the Introduction.

Streaming potentials, where water is the carrier, can only occur in the most shallow crust, in the range where rocks have interconnected “open” pores through which water can be pushed. This causes cations in the water to be preferentially retained on the walls of the pores, while anions tend to be carried along with the fluid stream. The result are slight electrical potentials, on the order of millivolts for saline water as expected to exist in these environments.

Without discussing streaming potentials, the authors go straight to the next process in line, also widely discussed in the literature: “It is known that in the period of earthquake preparation piezo-electric effect, caused by mechanical stresses, is observed in rocks”.

Nothing is “known” that the piezo-electric effect is anything more than a suspicion, poorly supported, even contradicted by evidence. For instance there is this fact that the same type of electric signals that have been reported for quartz-bearing rocks [Tuck, B. T., et al. 1977, A search for the piezoelectric effect in quartz-bearing rock, Tectonophys., 39, 7-11; Bishop, J. R. 1981, Piezoelectric effects in quartz-rich rocks, Tectonophys., 77, 297-321; Huang, Q. 2002, One possible generation mechanism of co-seismic electric signals, Proc. Japan Academy. Ser. B: Physical and Biological Sciences, 78, 173-178] can be also observed with gabbro and other rocks not containing a single crystal of quartz [e.g. Cress, G. O., et al. 1987, Sources of electromagnetic radiation from fracture of rock samples in the laboratory, Geophys. Res. Lett., 14, 331-334].

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In physics, if there is ONE observation which proves beyond reasonable doubt that a given effect does not apply and cannot explain the observation, that effect has go out of the window. Repeating the old stuff does not provide enough of an argument to "save" a disproven effect.

This is why, I think, the authors of this paper start off on a weak, even wrong basis. This is apparent right at the beginning. It is also why, in the subsequent text, they get lost with lots of arm-waiving arguments. They truthfully confess to the uncertain nature of their arguments by often using words like "may", "possibly" and "hypothesis". This, however, does not make for a strong and convincing paper. For instance, at the end of the Abstract they write: "As physical basis of working hypothesis is atmospheric effect of polarization charges occurred in surface layer of the Earth, it is possible to test the below constructed model in medium, where reasons of polarization charge generation may be different from piezoelectric mechanism, for example, due to electrolytic hydration." This sentence makes no sense and, by the way, what does "electrolytic hydration" really mean? It is not explained anywhere in the paper.

Then there is the idea of "polarization charges", the physical reality or nature of which is also not explained except to indicate that these are meant to be electrostatic charges assumed to be generated by some stress-related process. The nature of these charges is left in the dark (unless they are assumed to be piezo-electric).

The only saving grace of this paper may be found in the theoretical description that comes out of this chain of ac hoc but unsubstantiated assumptions. The mathematical description is, of course, value-free. It might be useful to calculate what has been observed even though WHY something is observed may not be understood.

Interactive comment on Solid Earth Discuss., 2, 233, 2010.