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SCALING LAWS FOR ULF ELECTROMAGNETIC PRECURSORS: INDICATION OF A SOC PROCESS.

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Observations of ULF electromagnetic emissions possibly associated with large earthquakes have been presented and discussed in a number of recent publications, (e.g. Hayakawa et al., Geophys. Res. Lett., 27/10, 2000 ; Hayakawa et al., Geophys. Res. Lett., 26/18, 1999). These investigations concluded that prior to the earthquakes analysed therein, (a) there has been a significant increase of the intensity of the vertical magnetic field component, and, (b) there has been an evolutionary behaviour of the ULF power spectra assuming the form of an inverse power-law with the exponent i decreasing towards unity. Herein, we attempt an explanation of these observations by assuming that the ULF emissions are due to some precursory, time dependent polarisation, appearing in an ensemble of spherical volumes embedded in a conductive half-space and distributed according to a fractal power law. We calculate the resulting transient magnetic field, which turns out to be mainly vertical and observable only if the seismogenic process generates a source with polarisation rate perpendicular to the vertical plane through the source and the receiver. In order to explain the 1/f behaviour, we assume that the evolution of the precursory polarisation process is not coherent throughout the excited ensemble, (i.e. there's no unique relaxation time), but rather that the sources emit quasi-incoherently, exhibiting a spectrum of relaxation times having energy dependence expressed by an Arrhenius law with distributed energies. We show that the macroscopic ULF field resulting from the superposition of such an ensemble of sources has power spectrum distributed according to an inverse power-law and we discuss the conditions under which, such a power spectrum evolves towards an 1/f behaviour.