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Dependence of seismoelectric amplitudes on water content - a field study

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In porous saturated media, seismic compressional waves can cause seismoelectric and seismoelectromagnetic signals through electrokinetic coupling. It has been observed that these measureable signals also occur in partially saturated media, but the theory is largely unknown for these circumstances. Seismoelectromagnetic tomography is expected to combine the sensitivity of electrical properties to water-content and permeability, to the high spatial resolution of seismic surveys. A better understanding of the physical processes and a reliable quantification of the conversion between seismic and electric energy are necessary and need to take into account the effect of water-content, especially for shallow subsurface investigations. In order to quantify seismoelectric signals with changing water content, we repeated seismoelectric and seismic measurements on the same profile in the Vosges Mountains during several months. The electrical resistivity was also monitored to take into account the water-content variations.

We show that an exponential relation can be established between the seismoelectric amplitudes normalized with the seismic amplitudes and the resistivity which in turn is related to the saturation: Increasing resistivity (decreasing water content) leads to decreasing normalized seismoelectric amplitudes. These results imply that the electrokinetic coefficient should increase with water-saturation, as measured in laboratory, but not predicted by theory.

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