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Seismoelectric Interferometry

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The seismoelectric effect is a very interesting and complex physical phenomenon, dealing with the subsurface coupling between mechanical poroelastic wavefields and electromagnetic diffusive fields. Therefore, the seismoelectric method can provide us with both seismic resolution and electromagnetic sensitivity at the same time. In addition, several studies have shown that the seismoelectric method can provide supplemental information about porosity and permeability, or on pore–fluid properties such as viscosity. These features do not only make seismoelectrics a worthwhile phenomenon to study for exploration purposes, but also for e.g. the field of earthquake mechanisms and risk analysis. Two types of seismoelectric coupling can be distinguished:

1) localized coupling generating an electromagnetic field that is present inside the seismic wave and travels with seismic velocity, the so-called coseismic field.

2) An independently diffusing electromagnetic field with electromagnetic velocity, providing us with information at depth. This is referred to as the seismoelectric conversion (or interface response).

At present, the key challenge for seismoelectrics is its measurability in the field. Due to the very weak signal to noise ratio of especially the second-order seismoelectric conversion, the events are often not detectable. In order to make seismoelectrics applicable in the field, we need to find ways to improve the signal to noise ratio of this second order effect. From seismic interferometry, we know that by cross–correlating recorded fields, virtual source responses can be simulated. In this process, stacking inherently takes place thereby possibly enhancing the signal-to-noise ratio of the records. We here present initial results of applying interferometric principles to seismoelectric phenomena. Can we indeed retrieve the desired seismoelectric virtual source responses that we are after, by cross-correlating selected responses due to boundary sources of a certain type (mechanical or electrical)? We explore the area of seismoelectric interferometry using our analytically based, numerical modeling code ESSEMOD (ElectroSeismic and Seismoelectric Modeling). Acknowledgements: Shell–FOM project, 'Innovative physics for oil and gas'.

Keywords: Seismoelectric, Electroseismic, Interferometry, cross-correlation