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Seismoelectric exploration of the cryosphere

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Several hundred vertical seismoelectric soundings were conducted on Glacier de Tsanfleuron, Switzerland using a hammer-and-plate source. Recorded signals were repeatable and considerably stronger and less noisy than in other earth materials tested. Spring data were more consistent than summer data. The desired electrokinetic interface responses (EIRs) can be isolated from coseismic and direct-field noise using a simple gradient-based scheme because EIRs and noise have opposite phase relationships on opposite sides of the shot point. EIRs depend sensitively on azimuthal orientation of the dipole array, and occur within the snow pack and at the cold-warm ice and ice-bed interfaces. Active seismoelectric techniques promise to allow directionally-dependent detection and mapping even of thin water-bearing layers or inclusions within or beneath glaciers or frozen ground, as well as estimation of layer hydraulic and fluid properties. Passive seismoelectric techniques appear well-suited to monitoring ice fracturing or basal properties and processes at improved spatial resolution.