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Seismic interpretation of subglacial till units: thin layer effects in amplitude-versus-angle (AVA) analysis.

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The physical properties of subglacial material can be estimated using seismic amplitude-versus-angle (AVA) methods, although the interpretation of an AVA response is complicated in the case of a thinly-layered substrate. If the thickness of a layer is less than one-quarter of the seismic wavelength, it is considered seismically 'thin' and its upper and lower interfaces are perceived as a single horizon. Since a lodged (non-deforming) subglacial till can be overlain by a thin (metre-scale) cap of dilatant (deforming) till, serious misinterpretations can result if thin layer considerations are not honoured.

We simulate seismic AVA responses for layered subglacial tills, in which dilatant layers of thickness 0.1-3.0 m (up to a quarter-wavelength of our synthetic seismic pulse) overlie a lodged half-space, and assign typical acoustic impedance and Poisson's ratios to each. Neglecting thin layer considerations, we show that the AVA response to ultra-thin (< 1.0 m) dilatant layers yields incompatible physical properties (acoustic impedance and Poisson's ratio that indicate, respectively, low- and high-porosity unit till). We present an interpretative strategy that identifies thin layer effects and accurately quantifies the modelled acoustic impedance of lodged till from the composite AVA response.

We present a thin layer interpretation for seismic data acquired on the Russell Glacier outlet of the West Greenland Ice Sheet. By invoking a thin layer argument, we show that the substrate comprises a stratified till with upper and lower layers of high- and low-porosity, interpreted respectively as dilatant and lodged material. Ignoring the effect of thin layers may lead to a serious misinterpretation of substrate physical properties, hence we recommend that their impact is considered in any AVA analysis.