P- and S-wave reflectivity modeling of basement seismic reflections in Athabasca Basin

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Previous interpretations of seismic data in Athabasca uranium exploration projects were based on structural images of reflected P-waves, and the seismic profile displays significant loss of image quality at several sections along the unconformity underlying the sedimentary strata. P-wave imaging problems could be caused by either the strong interference of P-waves with ground roll due to small reflector depth, or attenuation of reflection by common mid-point stacking due to P-wave weakening and phase changes at far offsets. In contrast, S-waves with different amplitude versus incident angel (AVA) property have potential to image such target structure. Our study is focusing on demonstrating the availability of converted S-wave for enhancing reflected P-wave images of the basement reflector based on forward modeling of P-P and P-S reflectivity. P- and S-wave velocity and density can be compiled from existing multidisciplinary geophysical data including 3-component surface seismic survey, 3-component vertical seismic profiling survey and borehole geophysics logs. Calculation of AVA response using Zoeppritz equation indicates prominent phase reversal of P-wave reflectivity with increasing incident angle for a low P-wave velocity contrast model; on the other hand, converted S-wave reflectivity tends to show brightening amplitudes. However for a shallow reflector, Zoeppritz equation based on planar wavefront assumption is not sufficient to predict amplitudes of P- and S-waves correctly. 2D full elastic forward modeling will generate synthetic seismic record containing P-, S-wave and surface wave for evaluation of the imaging potential of converted S-waves. The study will assess lithological interpretation based on seismic amplitude of both horizontal and vertical components for regional mapping of the basement reflector in the Athabasca Basin.

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