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Seismic characterization of Montney shale formation using Passey's approach

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Seismic characterization of shale reservoir formations or source rocks is an important goal, considering the high level of activity in oil companies that are engaged in shale-resource exploitation across North America. Well logging carried out in these formations yields some of the measured parameters helping us understand their properties. Resistivity and velocity are two such parameters that are of interest, as they can indicate the presence of organic material or kerogen in these rocks. Higher values of resistivity and lower values of velocity seen on the well-log curves are indicative of the sweet spots in these formations. Passey et al. (1990) demonstrated that at any well location, ΔlogR is a useful measurement, in that when the resistivity and sonic transit-time curves are scaled and overlaid, they follow each other almost everywhere, except in the kerogen-rich zones where they crossover. However, our goal is to characterize the shale formations not vertically but laterally, so that sweet spots over different pockets could be detected and targeted for drilling. For doing this we turn our attention to seismic data. Any set of seismic attributes that incorporate both resistivity and velocity could be useful for the delineation of sweet spots.

In this study, we introduce a methodology for computing ΔlogR from seismic data. For doing this, the ΔlogR curve computed at well locations is correlated with different attribute curves that can be derived from seismic data. That attribute curve which shows the maximum correlation is selected and crossplotted against ΔlogR to determine the relationship between the two. This relationship is then used for extracting the ΔlogR volume from 3D seismic data.

Besides velocity and resistivity, porosity, gamma ray (GR) and brittleness are other parameters that are of interest for characterizing shale formations. We use extended elastic impedance for obtaining the GR and porosity volumes and simultaneous inversion for obtaining the brittleness volume. All these attribute volumes are determined for 3D seismic data over the Montney shale formation, one of the most active natural gas plays in Canada.