

Figure 3. a) Histogram of density values from McMurray well logs, coloured by V_{clay} . The higher-clay points are centred at higher densities, making density a useful attribute for facies distinction. b) A crossplot of MuRho vs. density showing well points coloured by facies. The choice of crossplot axes provides a good separation of the different facies types.

between wells B and C, the properties on either side of this discontinuity are not, in fact, similar. Well C shows as having high density, while the discontinuity between the wells is comparatively low. It is now a valuable function of the interpreter to explain what these differences mean in a geological context.

Geological Classification

The critical link between geological properties and elastic properties is found through either well analysis or rock-physics modelling. In this example we will limit ourselves to well data, which matches elastic properties from the sonic, dipole sonic, and density logs with geological properties from other petrophysical curves and analyses. Each reservoir can have unique characteristics, and for the McMurray, density is a key property for distinguishing between the different facies with varying amounts of clay content.

Figure 3a shows a histogram of density values for all well-log points in the McMurray reservoir interval. The histogram points are coloured by V_{clay} and it is apparent that the points with high clay content tend to have higher densities. By identifying multiple attributes that distinguish geological properties, useful interpretive crossplots can be created. Figure 3b shows a crossplot of MuRho vs. density, where the points are coloured by facies. There is a good separation of the sands, IHS facies, and muds. These crossplots of well data provide a template for interpreting the equivalent data from seismic inversion.

The seismic inversion volumes are converted to include a range of elastic properties, including MuRho. Along with density, these points are crossplotted and compared with the well template (Figure 4a). In this case, interpretive cutoffs are applied to the data, corresponding to the log

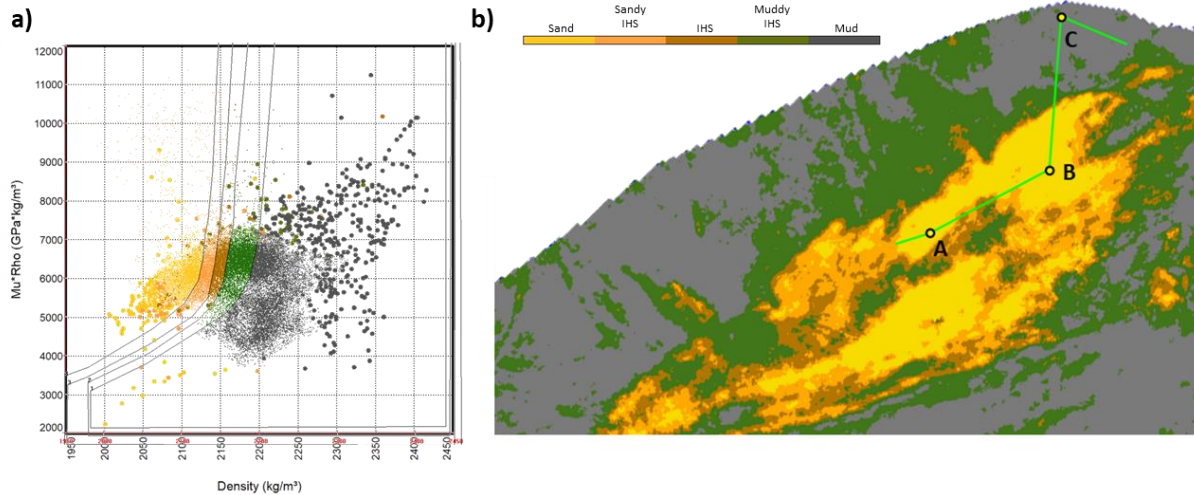


Figure 4. a) The same crossplot shown in Figure 3b with seismic points overlain. The seismic and well data correlate well, allowing for the well facies to be interpreted on the equivalent seismic points. b) A horizon slice extracted 20 ms above the base of the reservoir through the classified seismic volume. The facies interpretation shows a more clear picture of the geology than from amplitudes alone (Figure 1b).

facies. A time slice matching Figure 1b is shown through the classified inversion data in Figure 4b. Here it is much more apparent that the properties at wells B and C are more distinct.

Conclusions

Seismic inversion, specifically prestack AVO inversion, is a useful tool for extracting quantitative rock properties from the seismic amplitudes. By calculating properties such as P-impedance, S-impedance, and density through the inversion process, a number of useful elastic properties can be determined. While useful on their own, the elastic properties are more functional when interpreted into a geological context based on well or rock-physics templates.

Using an example from the McMurray oil sands, I demonstrate the steps needed to perform an AVO inversion and where special consideration to parameters is important. The results of the inversion are then compared to the conventional options for interpretation. While consistent with one another, the advantage of the interpreted inversion is that the geological context is more immediately apparent.

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