Facies recognition using PP and PS stratigraphic inversion

Alejandro A. Valenciano, Rafael E. Banchs, and Reinaldo J. Michelena, PDVSA Intevep

Elastic parameters of the subsurface can be used as lithologic indicators. One way to obtain such elastic parameters from seismic data is stratigraphic inversion of poststack *PP* and *PS* data (Valenciano and Michelena, 2000). Using such elastic parameters and relations derived from well logs, a neural network based estimator can be trained to obtain the lithology distribution over the seismic section.

The data set we used to test the previous ideas was a 3D-3C survey recorded over the Zuata field in the Orinoco heavy oil belt, Eastern Venezuela, in August 1997. The reservoir zone consists of closely interbedded series of heavy oil sand bodies at very shallow depths with no contrast of acoustic impedance between sands and shales. Figure 1 shows a scatter 2D plot of Vs (from a dipole sonic log) and density. The color represents the value of the gamma ray log. We can see a clear cluster separation between the higher and lower values of the gamma ray. As we can see, density plays an important role in this cluster separation.

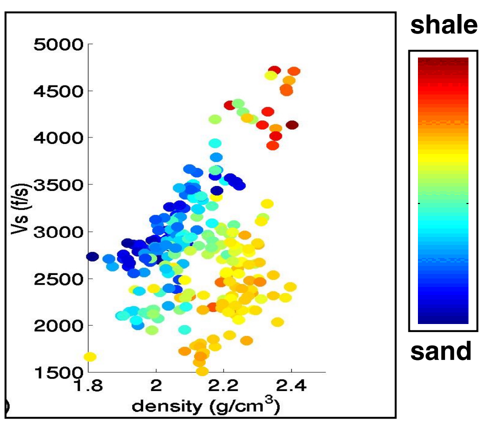

Figure 1 Scatter 2D plot of the elastic parameters measured at well.

This result suggested the possible use of a neural network based classification algorithm to extrapolate the along the seismic section the relations between elastic parameters and lithology found at the well. This transformation is valid only if the relation between the elastic parameters and the lithology remains constant along the seismic line; i.e. stationarity has to be assumed.

We estimated the elastic parameters from poststack *PP* and *PS* data by using stratigraphic inversion (Valenciano and Michelena, 2000). This method can be used to invert *PS* converted waves poststack data to obtain pseudo *S*-wave impedance, in the same way *PP* poststack data is used to estimate *P*-wave impedance. The pseudo *S*-wave impedance obtained is the product of a pseudo density (that depends on the Vp/Vs ratio) and *S*-wave velocity. We also estimated rock density values that depend on VpVs, Vp/Vs, *P*-wave impedance, and pseudo *S*-wave impedance; all these parameters are estimated from well data and stratigraphic inversion of near offset *PP* and *PS* data. The final result is a complete set of elastic parameters (Vp, Vs and density) along the seismic line.

Figure 2 shows the lithology distribution over an arbitrary line of the 3D-3C data set. Again, sands are presented in blue, shales in red, and the transition zones in yellow.

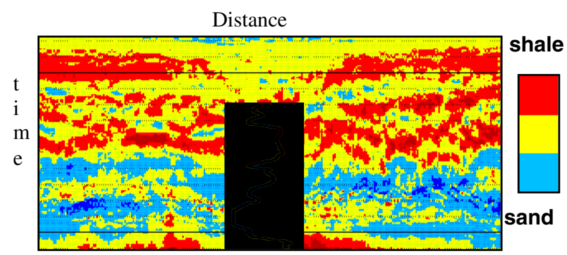

Figure 2 Neural network classified section using Vp, Vs and density estimated from seismic data. The well log in the middle of the line is the gamma ray used to classify the elastic parameters.

The neural network architecture used for this classification was a multilayer perceptron with one hidden layer, which was trained by using the backpropagation learning algorithm.

This result illustrates how elastic parameters estimated from *PP* and *PS* data can be used to identify different rock types. The use of a non-linear classification algorithm, such as neural networks, is of great importance due to the complexity of the cluster distribution in the Vp-Vs-density space.

REFERENCES

Valenciano, A. A.; and Michelena, R. J.; 2000, *Stratigraphic inversion of poststack PS converted waves data:* 70th Ann. Internat. Mtg., Soc. Expl. Geophys.