

DENSITY ESTIMATION FROM SEISMIC DATA USING A TRANS-DIMENSIONAL APPROACH: A FIELD DATASET EXAMPLE

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ABSTRACT

Discrimination between Commercial and low gas saturation (also called paleo-residual gas or PRG) is an outstanding problem in exploration and production Geophysics. Well log data and rock physics models have demonstrated that gas saturation affects the overall density of sandstone. Such density variations affect seismic wave amplitude at large offsets. However, reliable amplitude information is needed in seismic data to be able to derive density estimates by seismic inversion. Estimation of density from seismic data together with uncertainty is essential to reduce exploration risk. This problem is fairly common in the Columbus basin, Trinidad. Fortunately well processed (amplitude preserved) seismic data and well logs are available from this area. In this chapter, I demonstrate an application of the reversible jump Hamiltonian Monte-Carlo (RJHMC) sampling technique using a 3D seismic dataset. Prior probabilities of compressional and shear wave velocities, and densities are derived from the available well logs. The RJHMC samples V_p , V_s , and density models from the posterior pdf such that the number of layers is also treated as a variable. Our results demonstrate that in addition to V_p , and V_s , the mean and median models of density derived by RJHMC are in good agreement with those in the well logs at locations where they are available. I produce maps of 3D distribution of V_p , V_s , and density together with their uncertainties, which can be used for production planning.

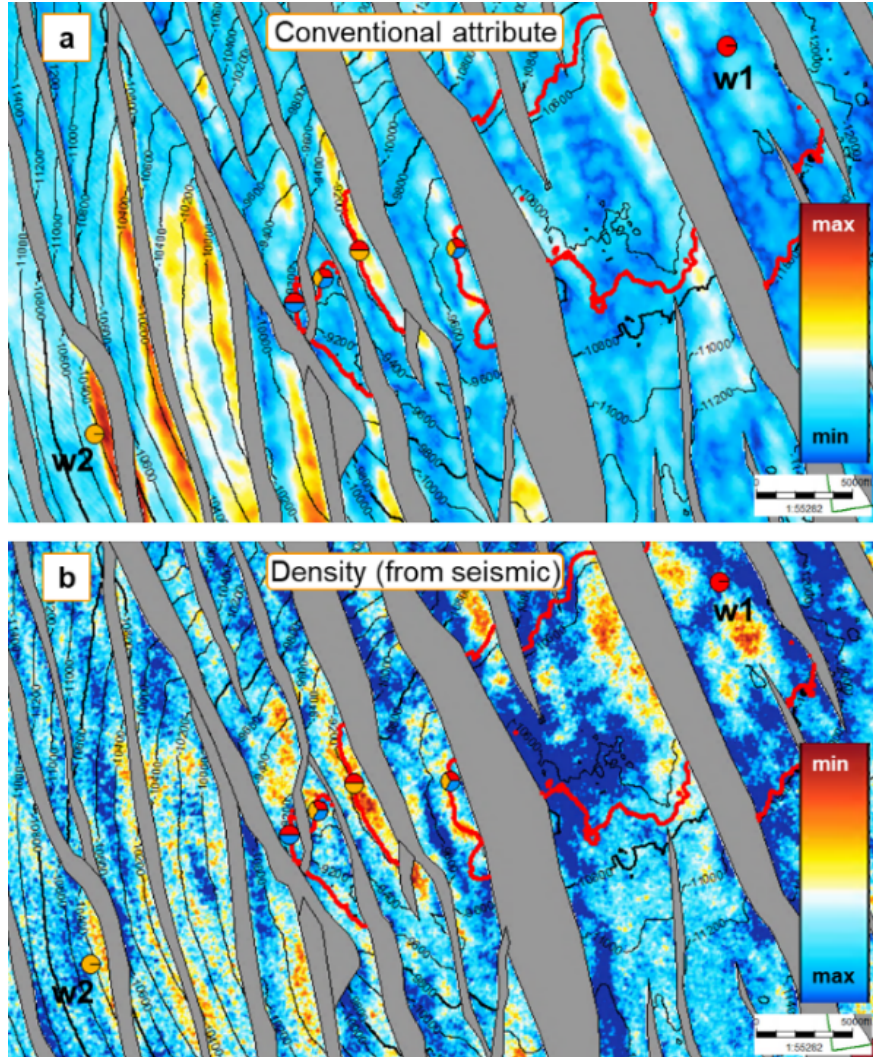


Figure 1. Comparing conventional seismic attribute (a) with seismic inverted density (mean value) model (b) at a reservoir level at about 1560ms. Red color (maximum amplitude) in conventional attribute is supposed to highlight the pay sands, and red color (minimum density) in density map is expected to highlight the pay sands. Few wells are marked with red showing commercial gas, orange showing PRG and blue showing brine sandstone reservoir. Well w2 (blind well) is better predicted in density map as PRG, while conventional attribute shows false positive as pay sand. We think both maps are complimentary, and they should be used along with other geological knowledge in decision making. Notice, significant subsurface faulting on maps and is marked by grey area with no amplitude.