Using Bayesian Inference to Compute Facies-Fluid Probabilities

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Abstract

The ideas of Bayesian inference can be used to infer the probabilities of occurrence of geologic facies from seismic reflection data and, in particular, from full-stack and AVO inversions. The models come from observations from well logs of the distributions of values for reservoir properties of interest. The reservoir properties can be defined by facies, lithologies, fluids or any combination of these. It is simply required that the disparate models be somewhat separable with respect to the properties derived from the inversions. The models are manifest as histograms which are subsequently modelled as probability density functions (pdfs). We commonly take the priors on the models to be equal, although this may be undesireable in some situations and can be altered appropriately. Using an estimate of the uncertainty in the reservoir parameters from inversion, likelihoods are computed from the pdfs for each facies and at each voxel. From these, Bayesian estimates for the posterior probability of each facies/fluid are computed. In this way, facies-fluid probability (FFP) volumes for each facies can be formed and a most-probable facies volume constructed.

QC's of interest include the winning probability and penultimate probability at each voxel. The inputs to the process need not come from a single source. In addition to inversions, inputs could come simultaneously from seismic attributes or e/m experiments, for example. We will review the theory of the method and present some examples.