Issues in uncertainty estimation for time-to-depth conversion

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Abstract

Generating a structure map from depth conversion of a time seismic horizon is a standard practice in seismic interpretation. For most methods, however, a depth uncertainty estimate is not provided. Geostatistical methods are the exception in this regard. Some commonly used approaches such as cokriging the depth markers from well control and kriging with external drift, provide uncertainty estimates through the kriging variance, where the time horizon is incorporated as soft information. A shortcoming of these methods is that no accommodation is made for including time-horizon uncertainty. We provide a simple approach to remedy this by using kriging to interpolate average velocity, which we then use to convert the time-horizon to depth. We obtain a depth uncertainty by combining the average velocity uncertainty (obtained from kriging variance) with the time-horizon uncertainty, using standard methods from the theory of propagation of errors. Another issue for all of the above methods is: how good an estimator of local error is the kriging variance? We address this with a data example, where we blind-test our results with some wells that were held out of the analysis. We also introduce an attribute that we call a gridding sensitivity indicator, which gives another uncertainty measure in addition to kriging variance. This attribute extends the concept of cross-validation to a map view by displaying the standard deviation of all of the maps generated by the leave-one-out method. We also discuss other alternatives for local error estimation such as conditional simulation.