Z-To-Depth or Resizing an Image

Velocity model improvement can eliminate well mis-ties.

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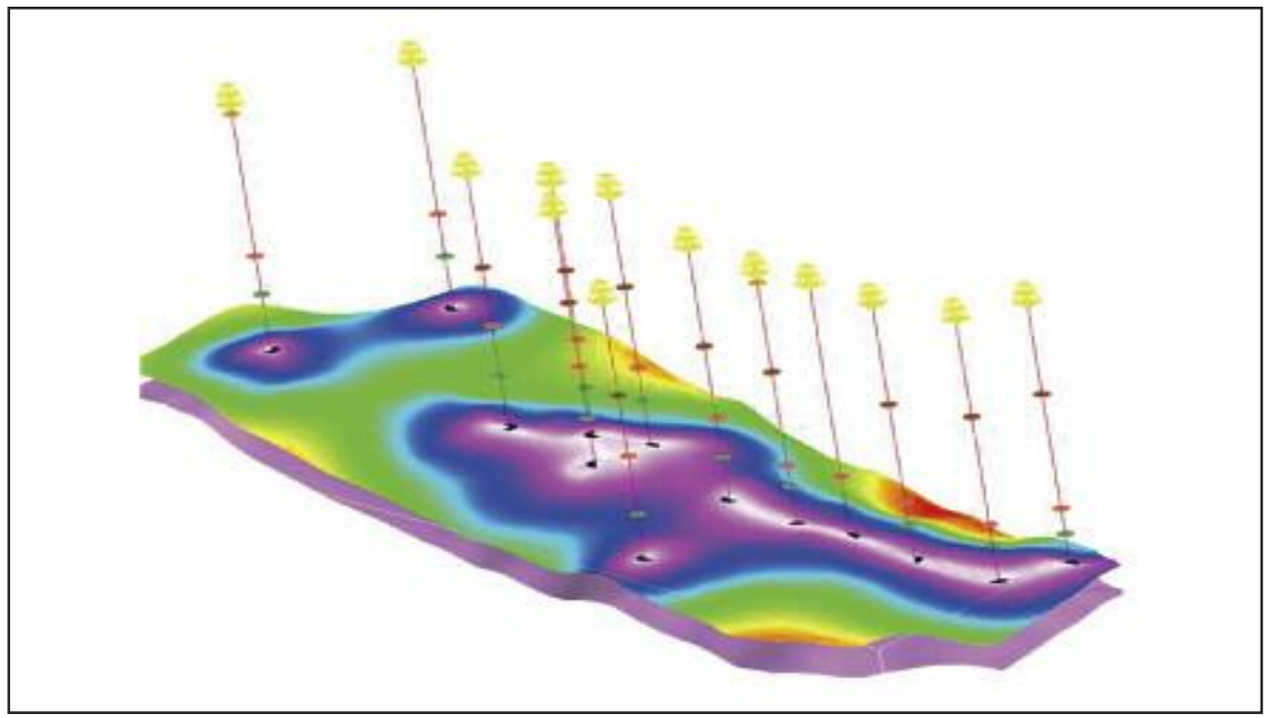
One of the major problems facing explorationists today is trying to get their exploration well prognosis based on the seismic data to be as close as possible in depth and be close in depth when drilled. In rank wildcat areas, this may not be possible unless the interpreter can guess the seismic characteristics and/or properties of the overburden and reservoir rocks before the first well is drilled. But why is this problem in the first place?

The explorationist has spent millions on acquiring 3-D seismic data, available well data, and sophisticated technical software. So what happened? This answer is well known and understood by the explorationists but often missed by those making project budgetary decisions because what they see is a mis-tied well marker and a seismic horizon. While seismic data can and does image the earth very well, its ability to both image and provide precise depths at the same time is not always achievable. The simple reason is that velocity models that are good for imaging are not necessarily constrained by well data and the geology. This is understood in wildcat areas where there are no wells, but in areas where there are wells, the seismic image derived from imaging velocities needs to tie those wells.

There are many reasons for depth mis-ties between the local geology, wells, and the seismic data. Some of these are: These include acquisition recording errors, the fundamental difficulty of estimating velocities in the subsurface using data recorded on the surface, reflector dip, lithologic heterogeneities, poorly selected processing parameters, and seismic anisotropy, just to name some of the key causes. Several pitfalls in the depth imaging process can occur as well. These include inaccuracies introduced by the Dix formula, insufficient effort taken in building a geologically consistent velocity model, a foregone assumption that the time image and interpretation is correct, and simply poor quality control. All of these reasons for mis-ties can be adjusted and/or corrected to a varying degree, as long as high-quality data is available in sufficient coverage (quantity) and sample rate, and the seismic interpreter has the technical software to do it.

Paradigm has several software suites capable of adjusting mis-ties in various workflows, which depend on the available data types and time available to resize the seismic image. The prime software packages for these resizing efforts are Paradigm GeoDepth, Explorer, and Anisotropic prestack depth migration (pre-SDM).



Result to Z-to-Depth conversion. The surface, calibrated to the wells, has ± 27 meters maximum uncertainty on the structure far from wells, based on the kriging error of calibration. The two structures are properly imaged in depth whereas in time the two reservoirs coalesce. ***(Image courtesy of Paradigm)***

Paradigm believes the key to alleviating these mis-ties in depth is best handled by velocity model improvement. Using an integrated pre-SDM workflow that utilizes model-based velocity estimations and refinements is one method. Paradigm software advances and the increase in computer throughput make this an excellent workflow to solve the resizing problem. Using Paradigm Explorer software, an interpreter can utilize borehole and seismic velocities to build a layer-on-top-of-layer calibrated velocity model (layer stripping) where each layer-by-layer model is fitted to the well markers in depth. This provides a calibrated interval velocity model that ties horizons to the well markers in depth. By doing this, we resize Z-to-Depth is resized, and the seismic data, pre-or post-stack, have seismic horizons (Z) tied to the wells (depth).

An example taken from work done in the Australian Bass Straits is shown in Figure 1. The target horizon has been successfully converted to depth using GeoDepth and Explorer workflows. In time and in depth (using an uncalibrated velocity model), the two closures shown coalesce into one, thereby providing erroneous field size and volumetrics. The reservoir top resulting from the calibrated velocity model is within the desired window, and it is properly shaped.

Paradigm offers several software packages that can be used to calibrate your seismic images correctly in depth, thereby making the expensive data "appear" as good as it actually is. These Z-to-Depth conversion methods are a necessary requirement to reduce uncertainty in today's uncertain market. ■